

# Feasibility analysis of utilizing solar energy in Chittagong city

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**Abstract**— To meet the never ending demand of power solar energy or solar power can be a vital solution for a developing country like Bangladesh. As an emerging economy in South Asia, Bangladesh is one of the energy starved country in the world. There are some crucial reason behind this however the key reason is high price of fuel which is used to run the power plants. As Bangladesh is not enriched with natural resources like oil, gas specifically those ingredients which are utmost for producing power so it is high time for Bangladesh to focus on something which will not cost much. Though implementation of solar power through photovoltaic panel are introduced but the mass use of solar power are not seen. This is because of the high price of related equipment's and low quality of the equipment's. So if the focus can be shifted to the commercial users of power better result can be achieved. This is what is done on this research. This research focused on how solar power can be implemented more on economically stable users and it is well known that the owners of fuel stations are economically strong enough in this case. Another important reason for selecting fuel station is that fuel stations maintain enough open space especially in the rooftop where large scale photovoltaic panel can be easily implemented. In this research a comprehensive study is done on the fuel stations of Chittagong including how much unused space they have, how much power they consume in each month and what will be the result if they implement photovoltaic panel for their fuel station.

**Keywords**— Solar energy; Renewable energy; Photovoltaic panel;

## I. INTRODUCTION

The source of solar energy is believed to come from sun. The power radiated from the Sun on Earth is estimated to be about 175,000 TW, four times higher than the power we use in our energy intensive periods [1]. The sun energy could always be converted into other forms of energies; one of it is driving electron movements in photovoltaic cells to generate electricity. Direct current electricity is produced from the solar arrays, which is known as photo conversion process.

Bangladesh, an emerging economy in South Asia, is one of the energy starved country in the world. Per capita electricity generation including captive power is 292 KWh which is one of the lowest in the world. In spite of continuous efforts to

increase coverage, including solar power only 60% of its population has access to electricity. Which indicates that a large number of population of Bangladesh is out of the coverage of electricity. This is one of a hard barrier for Bangladesh on its way of rapid development. Present power generation capacity excluding 2323 MW of captive generation is 10620 MW (03 June, 2015) [3] of which private sector generation is mostly half to public sector generation. Presently the country faces a peak load shortage in hot summer of about 800-1000 MW [3].

On the other hand the massive rate of pollution from the power plants is also a headache for government. As the demand of power is increasing day by day at an emerging rate so there is no way but to establish more fuel based power plant. Which will greatly responsible for pollution and will be considered as an environmental threat. So a unique and environment friendly way to face the never ending energy demand is to implement or utilize the renewable technologies in a vast way.

## II. METHODOLOGY

Bangladesh is trying to reduce its dependency on natural resources specifically on natural gas to produce power by diversifying sources of primary. Bangladesh do not have much natural resources to continue its power production based on natural resources. Moreover fuel based power plant has a large establishment cost and environmental effect of those power plant is also a fact. That's why government is now focusing on implementing solar energy more than before. This research is conducted specifically on Chittagong city. There are some vital reason for selecting Chittagong as it is one of the most densely populated city and the commercial hub of Bangladesh.

In this paper the feasibility of implementing renewable technologies specifically solar energy are analysed. The research specifically focused on the fuel station of the Chittagong city because they maintain a large area for rooftop and also for vehicle movement. So it will be easier to get an overall idea about the productivity of solar power in Chittagong city.

### III. DATA ANALYSIS

Here the free area and total area of all the fuel stations of Chittagong are enlisted.

TABLE I  
LIST OF ALL FUEL STATION IN CHITTAGONG

SI	Name	Total RT Area (m <sup>2</sup> )	Total Area (m <sup>2</sup> )
1	Md. Sirajul Hoq & Sons Filling Station	39.4825	1416.911
2	Karnaphuli Prakritik Gas Limited	966.16	966.16
3	Kamal Brothers CNG Station	306.57	908.4691
4	Mir Filling Station	357.665	1170.54
5	Nahar CNG Filing Station Limited	111.48	250.83
6	Kharnapuli Filling Station	139.35	1672.2
7	QC Trading Limited	267.552	1153.818
8	Khan Brothers CNG (Pro) Limited	82.4952	537.1478
9	M/s Alhas Younus & co. Filling Station	167.22	436.63
10	Alhas Fayas Ahmed & Sons Filling Station	227.4192	576.5374
11	Badsha Meah & Sons Filling Station	89.7414	624.288
12	Southern CNG Limited	202.8936	1551.802
13	Chandgaon Filling Station & Intraco CNG Ltd.	120.77	751.6539
14	Hazi Khuilla Meah & Sons Filling Station	113.7096	611.8394
15	A B Filling Station	92.9	371.6
16	East End Automobiles Ltd.	167.22	1046.983
17	H N Automobiles Ltd.	141.6725	709.3844
18	Hazi Sarwar CNG Filling Stasion	155.9791	785.4695
19	Samantha Filling Station Ltd.	69.675	334.44
20	Hazi Md. Islam Khan	16.722	484.938

	Filling Station		
21	Kalurghat CNG Filling Station	220.6375	966.16
22	Al Madina CNG Filling Station	125.415	1300.6
23	Noapara CNG Filling Station	211.812	1360.056
24	Rahman & Co.	366.3976	1705.458
25	M.I.B. CNG & Filling Station	341.4075	1262.511
26	Amin Jute Mills Filling Station	16.722	434.772
27	Hazi Wazed & Sons Filling Station	142.137	520.7045
28	NAVANA Pure CNG Ltd.	229.463	664.235
29	Jalalabad Filling & Rahim Afroz CNG Station	86.397	855.7948
30	Anowarul Azim & Sons Filling Station	102.8403	840.5592
31	BRTC Filling Station	116.125	712.3572
32	Hazi Md. Islam Filling Station	116.125	743.2
33	Sheuli Patrol Pulp	23.4108	1068.35
34	Chistia CNG Re-Fuelling & Conversion Station	232.25	696.75
35	Jam Jam CNG Re-Fuelling Station	74.32	1858
36	Chowdhury Brother's Filling Station	33.444	501.66
37	M.Aiam CNG & Filling Station	139.35	780.36
38	Sena Filling Station	297.28	5109.5
39	City Corp. CNG Refuelling Station	942.006	1237.428
40	The Ctg. Police Institution Petrol Pump	41.805	1625.75
41	S H Khan CNG & Filling Station	371.6	1858
42	Tiger Pass Agency Ltd.	11.148	260.12
43	Hakkani Filling Station	208.096	940.6125
44	Mohanagar Filling Station	133.776	845.39
45	Kalka CNG Station	222.96	580.625

46	Hakkani Refueling Station	386.464	780.36
47	Bondorgao Filling Station	139.35	845.39
48	Noor-e-Modina CNG Filling Station Ltd.	260.12	836.1
49	Mir CNG & Filling Station	371.6	743.2
50	Almas CNG Filling Station	520.24	1672.2
51	Rainbow Gas Service Station	1393.5	3437.3
52	Kuliarchar CNG Conversion Refuelling Station	789.65	3762.45
53	Four Star CNG Refuelling Station	696.75	1560.72
54	Absar & Elias Enterprise Ltd.	3957.54	5688.732
55	M/s Yakub Ali Filling Station	111.48	520.24
56	Gazi Filling Station	297.28	789.65
57	Maulana Filling & CNG Works	27.87	710.685
58	Saikat CNG Filling Station	33.444	371.6
59	Highway CNG Service	55.74	650.3
60	Laila CNG Filling Station	668.88	1269.2
61	Saikat Filling Station	250.83	993.29
62	Patenga Re-Fuelling Station	35.1162	925.284
63	Standard Auto Service	46.45	125.415
64	Boshar Hoq & CO.	55.74	185.8
65	Khulshi Filling Station	520.24	1560.72
66	Shah Amin Ullah CNG Filling Station & Petrol Pump	501.66	3901.8
67	Paharica CNG Filling Station	394.825	743.2
68	Speed Track(PVT) Ltd.	167.22	1755.81
69	Salim & Sons	394.825	966.16
70	Ms Mansain	9.29	390.18
71	Haji Abdul Aziz Filling Station	13.935	325.15
72	Nabaron Agency	27.87	185.8
73	M/S Imam sharif Filling	120.77	445.92

	Station		
74	M/S Damman Filling Station	185.8	1114.8
75	M/S Absar Ahmed & Brothers	16.722	222.96
76	M Q Chowdhury & Sons	27.87	371.6
	Total	21122.68	82942.61

#### A. Mathematical Analysis

For mathematical analysis a fuel station named Badsha meah and son's filling station is selected as a model station.

##### i. Solar power station design

Roof top area=89.7414 m<sup>2</sup>

Total area=624.288 m<sup>2</sup>

We can set up 55 solar panels of 250w<sub>p</sub> on the roof top area and 384 solar panels on the total area of this filling station. But we are designing solar system for the filling station for power consumption. Power consumption of filling station is 475kWh in March'2015.

##### ii. Solar panel design

Consumption power per day=15.84kWh

Energy to load (KWh/day) = KW<sub>p</sub>\* Radiation \* System efficiency (η<sub>p</sub>)

$$\text{Or } 15.84 = KW_p * 4.2 * 0.55$$

$$\text{Or } KW_p = 6.87KW_p \text{ or } 6870W_p$$

We selected 250w<sub>p</sub> solar panel from market

So number of solar panel required=27.48≅28

##### iii. Battery calculation

Battery sizing watt hour rating:-

DOA\* Energy to load (Wh) = Purchase capacity of battery (Wh)\* DOD Or 3\*15840=Wh\*0.7

$$\text{Or Wh} = 6788.72$$

Wh capacity=Ah capacity\*Terminal voltage

$$\text{Or } 15840 = \text{Ah capacity} * 12$$

$$\text{Or Ah capacity} = 6788.72$$

We selected 130Ah solar battery from market

So number of battery=43.52≅44

##### iv. Inverter design

Power rating of Inverter=power required by the load /(Load factor\*Inverter efficiency)

$$\text{Or Power rating of Inverter} = 7000 / (0.8 * 0.9)$$

$$\text{Or Power rating of Inverter} = 9723VA = 9.8 KVA$$

v. Charge controller design

$$I = P/V$$

$$I = 15840/12$$

$$I = 1320 \text{ Amp}$$

vi. Cost calculation

Solar panel =  $28 * 250 * 62 = 434000$  Taka [Greenfinity energy Ltd. 1Wp=62 Taka]

Battery =  $44 * 14000 = 616000 = 616000 * 5 = 3080000$  Taka [NAVANA Battery Ltd.]

Charge Controller design =  $6000 * 25 = 150000$  Taka [Approximate]

Inverter =  $20000 * 25 = 500000$  Taka [Approximate, Giriraj Electronic]

Miscellaneous = 20000 Taka [Approximate]

Total cost = 4184000 Taka

vii. Income

TABLE II  
DAILY AND MONTHLY ELECTRICITY GENERATION

Month	Sun Shine(hr)	Daily Energy Generation(KWh)	Monthly Energy Generation(KWh)
January	7.63	53.41	1655.71
February	8.55	59.85	1675.8
March	7.56	52.92	1640.52
April	7.75	54.25	1463.7
May	6.97	48.79	1512.49
June	3.99	27.93	837.9
July	5.42	37.94	1176.14
August	5.38	37.66	1167.46
September	6.09	42.63	1278.9
October	6.49	45.43	1408.33
November	8.03	56.21	1686.3
December	7.38	51.66	1601.46
Total			17104.71

Considering, 1 KWh=6 Taka  
Total income/year =  $6 * 17104.71 = 102628.3$  Taka  
Considering, 1 KWh=7 Taka  
Total income/year =  $7 * 17104.71 = 119733$  Taka

viii. Payback period

Payback period means that the numbers of years required recovering the cost of the investment and for cost benefit analysis of our system it is needed. Here we consider six and seven BDT per kilowatt hour as electricity price is increasing in our country due to increase of fuel price.

Considering 1 kWh = 6 Taka  
Total cost of the system = 4184000 Taka  
Annual income = 102628.3 Taka  
Payback period = cost of the system/Annual income  
=  $4184000 / 102628.3$   
= 40.76 years

Considering 1 kWh = 7 Taka  
Total cost of the system = 4434000 Taka  
Annual income = 1106000 Taka  
Payback period = cost of the system/Annual income  
=  $4184000 / 119733$   
= 34.95 years

ix. Calculation of roof top area

Now we analysis total roof top area to design grid connection.

We can design 55 solar panel of 250w<sub>p</sub> on the roof top of this filling station.

So power produce =  $55 * 250 = 13.75$  KW

x. Inverter design for roof top area

Power rating of Inverter = power required by the load / (Load factor \* Inverter efficiency)

Or Power rating of Inverter =  $13.75 / (0.8 * 0.9)$

Or Power rating of Inverter = 19.097 ≈ 20 KVA

xi. Cost calculation for roof top area

Solar panel =  $55 * 250 * 62 = 852500$  Taka

Inverter =  $30000 * 25 = 750000$  Taka

Wiring = 4000 Taka

Structure = 8000 Taka  
Miscellaneous = 20000 Taka

Total cost = 1634500 Taka

*xii. Income roof top area*

Considering, 1 kWh=12 Taka  
Total income/year =12\*33598.54=403182.48 Taka  
Considering, 1 kWh=15 Taka  
Total income/year =15\*33598.54=503978.1 Taka

*xiii. Payback period for roof top area*

Considering 1 kWh =12 Taka  
Total cost of the system =1634500Taka  
Annual income = 403182.48 Taka  
Payback period = cost of the system/Annual income  
=1634500/403182.48  
=4.06years

Considering 1 kWh = 15 Taka  
Total cost of the system = 914500 Taka  
Annual income = 1634500 Taka  
Payback period = cost of the system/Annual income  
=1634500/503978.1  
=3.25years

*xiv. Calculation of total area*

Now we analysis total area to design grid connection.  
We can design 384 solar panel of 250w<sub>p</sub> on the roof top of this filling station.  
So power produce=384\*250watt=96 KW

*xv. Inverter design for total area*

Power rating of Inverter=power required by the load /(Load factor\*Inverter efficiency)  
Or Power rating of Inverter=96KW/(0.8\*0.9)  
Or Power rating of Inverter=133.33=134 KVA

*xvi. Cost calculation for total area*

Solar panel=384\*250\*62=5952000 Taka  
Inverter=60000\*25=15,00,000 Taka  
Wiring=10000 Taka  
Structure=6,00,000 Taka  
Miscellaneous=30000 Taka  
Total cost=8092000 Taka

*xvii. Income for total area*

Considering, 1 kWh=12 Taka  
Total income/year =12\*234578.9=2814946.8 Taka  
Considering, 1 kWh=15 Taka  
Total income=15\*234578.9=3518683.5 Taka

*xviii. Payback period for total area*

Considering 1 kWh = 12 Taka  
Total cost of the system =8092000 Taka

Annual income =2814946.8Taka  
Payback period = cost of the system/Annual income  
=8092000/2814946.8  
=2.88 years

Considering 1 kWh =15 Taka  
Total cost of the system =8092000Taka  
Annual income =3518683.5Taka  
Payback period = cost of the system/Annual income  
=8092000 /3518683.5  
=2.3 years

#### IV. CONCLUSIONS

Once power generation of Bangladesh was dominated by indigenous natural gas which was 90% during FY2010. Share of natural gas for power generation is 80.37% during FY2012 which is declined by 9.63%. It is estimated that the share of natural gas for power generation will be reduced by 52% and 20% during FY2016 and FY2030 respectively. Depletion of gas reserve has force to shift primary fuel option from natural gas to liquid fuel and coal.

As Chittagong is one of a densely populated city and also the commercial hub of Bangladesh so rapid industrialization is happening here. Which is responsible for environment pollution and this will be big threat in near future. If the government of Bangladesh continuously focus on the fuel based power plant definitely it will increase the threat of environment pollution.

So using solar power can greatly save us from environmental effect. It will significantly reduce the rate of environment pollution which might happen if fuel based power plant established.

In this paper specific discussion and calculation are done to analyze the feasibility of enhancing solar power in the fuel stations of Chittagong city. By this an overall idea can be gained about implementing solar power in Chittagong city.

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# *Blind Color Image Watermarking in DWT and DCT Domain for Copyright Protection*

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**Abstract**— The expansion of digitized media is because of rapid growth of interchange of multimedia data over internet that has created an imperious need for copyright protection of multimedia data. Digital watermarking is a proper solution to solve this problem. Hence, in this paper a blind watermarking technique for color images is proposed based on Discrete Wavelet Transform (DWT) and Discrete Cosine Transform (DCT). Watermark is scrambled by Arnold transform to increase robustness and embedded into host image where correlation between elements in column is maximum. Embedding is done by slightly changing the DCT coefficients of corresponding block of the host color image for each channel. However, in the time of watermark extraction neither host image nor the original watermark is required and thus introducing blind approach. Experimental analysis shows that performance of proposed technique is better enough against common signal processing attacks.

**Keywords**— *Color Image, Blind Watermarking, Arnold Transform, Normalized Correlation, DWT, DCT*

## I. INTRODUCTION

Digital watermarking is the technique of hiding digital information. It is the process of embedding a piece of digital information into any multimedia data such as an image, audio or video file to identify ownership of copyright data. Digital watermarks may be used to verify the authenticity or integrity of the carrier signal or to show the identity of its owner. A signal may carry several different watermarks at the same time. Unlike metadata that is added to the carrier signal, a digital watermark does not change the size of the carrier signal. Like traditional watermarks, digital watermarks are only perceptible under certain conditions and imperceptible anytime else. If a digital watermark distorts the carrier signal in a way that it becomes perceivable, it is of no use. Traditional Watermarks may be applied to visible media, whereas in digital watermarking, the signal may be audio, pictures, video, texts or 3D models.

A significant number of watermarking methods have been introduced on digital watermarking specially on digital image watermarking. Most of these methods based on either Discrete Wavelet Transform (DWT) or discrete cosine transform (DCT)

Some of works have been done by Hadamard transform. Image watermarking techniques can be divided into two groups in accordance with processing domain of host image. One is to modify the intensity value of the luminance in the spatial domain and the other is to change the image coefficient in a frequency domain. There are four factors which are essential to determine efficiency of watermarking scheme. Imperceptibility, robustness, capacity and blind watermarking are four factors of watermarking.

A wavelet transform involves convolving the signal against particular instances of the wavelet at various time scales and positions. We can model both frequency and location of frequency. DWT has been used in digital image watermarking more frequently due to its excellent spatial localization and multi-resolution characteristics, which are similar to the theoretical model of human visual system. A DCT is a Fourier-related transform similar to the discrete Fourier transform (DFT), but using only real numbers. The DCT transforms a signal from a spatial representation into a frequency representation. Combined DWT-DCT based watermarking with mid frequency embedding of DCT block of selected DWT sub band is proposed in [1]. The combined method is only for black and white images not for color images. Watermarking based on combined DWT-DCT transform embed watermark into low frequency of each DWT sub-band and low frequency band results less degradation due to noise [2]. In terms of finding maximum correlation and quantization result based blind color image watermarking were proposed for color image [3, 4]. Single SVD and combined SVD-DCT based approach for copyright protection proposed for images in [5, 6]. Robust watermarking approach based on different transform proposed in [8] for black and white image authentication. However, RGB segment based fragile algorithm [9, 10] proposed for color image authentication and multimedia secrecy.

In this paper, we propose a combined DWT-DCT based watermarking method. In our proposed method, watermark is embedded into the bit position where the correlation between pair of elements is maximum of the DCT blocks of selected DWT sub-band that can resist against various kinds of signal processing attacks. To ensure high security of watermark image Arnold transform is done with a secret key to make the proposed algorithm more reliable and more efficient.

## II. PROPOSED WATERMARKING METHOD

In our proposed method we will depict both the watermark embedding process and the watermark extraction process from watermarked image by using flowchart in details.

### A. Watermark Embedding Process

The proposed embedding process is shown in figure 3. The following steps are necessary to embed watermark image into host color image.

**Step 1:** Apply single level DWT on host image to decompose it into four sub-bands LL, LH, HL and HH. We use single level DWT since we need maximum valued decomposed band.

LL	HL
LH	HH

Fig. 1: Single level DWT decomposition of host image

**Step 2:** Select LH band since it is low frequency band and imperceptible against noise attack. Then divide LH band of host color image into R, G, B channels. Each channel is used separately to embed watermark.

**Step 3:** Divide the chosen coefficient set into 4x4 blocks. This block size provides more capacity with maximum robustness. Since, larger block size decrease capacity and smaller block size reduce robustness. So, 4x4 is a tradeoff between them

**Step 4:** Apply DCT on each block of selected coefficient set. DCT can be defined by the following equation.

$$F(u,v) = \sum_{x=0}^{N-1} \sum_{y=0}^{N-1} f(x,y)g(x,y,u,v) \quad (1)$$

where the kernel is defined by the equation below.

$$g(x,y,u,v) = \alpha(u)\alpha(v) \cos\left[\frac{(2x+1)u\pi}{2N}\right] \cos\left[\frac{(2y+1)v\pi}{2N}\right] \quad (2)$$

where  $\alpha(u) = \alpha(v) = \frac{1}{\sqrt{N}}$  for  $u, v = 0$  otherwise

$$\alpha(u) = \alpha(v) = \sqrt{\frac{2}{N}}$$

**Step 5:** Calculate correlation between each pair of elements in each column of DCT block. Figure 2 elaborate this graphically. Then determine the maximum correlation value. The maximum correlation valued position is the embedding position. Thus here watermark bit is embedded into the first column third and fourth row of the first DCT block of red channel as correlation between them is maximum.

↑↓	(1,1)	↑↓	(1,2)
↑↓	(2,1)	↑↓	(2,2)
↑↓	(3,1)	↑↓	(3,2)
↑↓	(4,1)	↑↓	(4,2)

Fig. 2 Finding correlation between pixels

**Step 6:** Watermark image is scrambled by Arnold transform. This process transfer a point (x,y) to (x',y') using the following equation

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} \pmod{1} \quad (3)$$

**Step 7:** Embed a watermark bit into selected bit position of a DCT block. Similarly embed whole watermark bit by bit into the DCT blocks of host image for each channel. If L denotes the matrix of the coefficients set after applying DCT then embedding is done using the following equation.

If message bit is 0, then

$$L' = (\text{abs}(L) * \text{watermark\_bit0}) \quad (4)$$

Else if message bit is 1, then

$$L' = (\text{abs}(L) * \text{watermark\_bit1}) \quad (5)$$

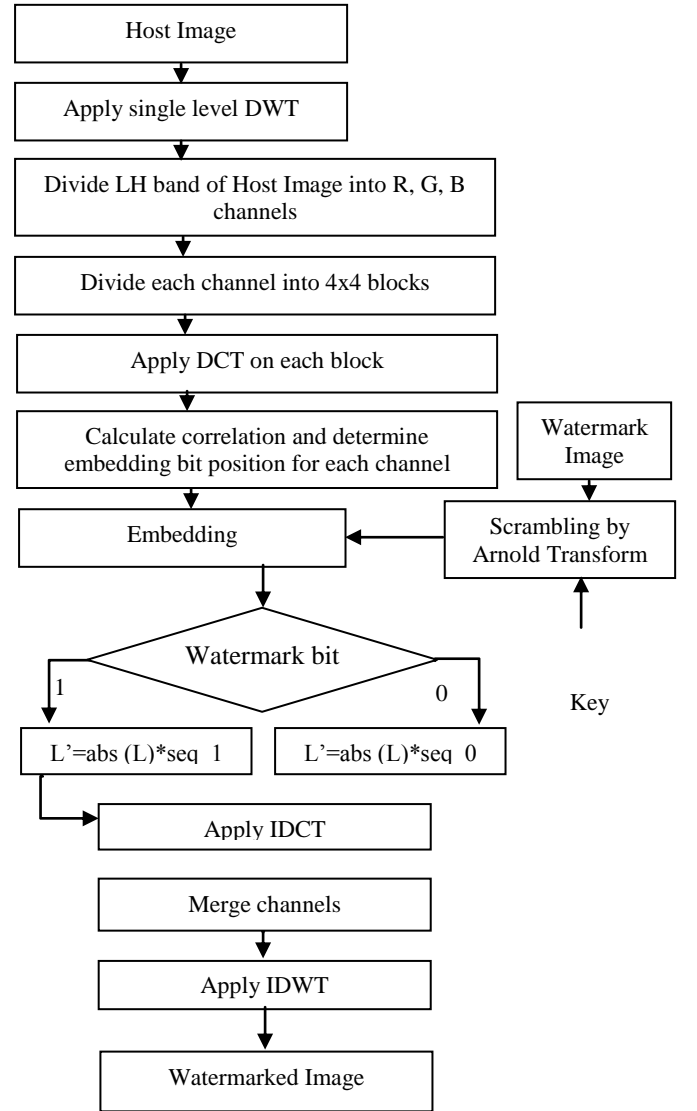


Fig. 3: Flowchart for proposed embedding process

**Step 8:** Apply inverse DCT transform on each block.

**Step 9:** Merge three channels.

**Step 10:** Apply inverse DWT to form the watermarked image.

### B. Watermark Extraction Process

The proposed extraction process is shown in figure 4. The following steps are necessary for extraction of watermark from watermarked image.

**Step 1:** Apply single level DWT on watermarked image to decompose it into four non-overlapping multi-resolution sub-bands LL, LH, HL and HH.

**Step 2:** Divide LH band of watermarked image into R, G, B channels. Each channel is used separately to extract watermark bit.

**Step 3:** Divide the chosen coefficient set into 4x4 blocks.

**Step 4:** Apply DCT on each block of selected coefficient set.

**Step 5:** Calculate correlation between each pair of elements of DCT block in column wise direction and then determine maximum correlation value among them.

**Step 6:** Extract values from embedded bit position of selected DCT block for each channel.

**Step 7:** Calculate sum of extracted bits. The result of sum is a signed magnitude as DCT coefficient gives sign value.

**Step 8:** Determine the message bit. If unsigned sum of extracted bits is approximate to 0 (less than 0.2 as NC calculated is maximum at this value) then watermark bit is 0, otherwise 1. Approximation is considered to facilitate comparison.

**Step 9:** Watermark is reconstructed from extracted watermark bits. Arnold transform is done with same key times to scramble the watermark.

### III. PERFORMANCE EVALUATION

In our proposed method we simulate the combined DWT-DCT based watermarking method by using MATLAB R2010a. The watermarked image is tested with some common signal processing attacks such as Gaussian noise, salt and pepper noise, speckle noise, median filtering, JPEG compression, rotation, cropping etc. We select 512x512 "lena.bmp" color image as the host image and watermark is a 64x64 "w.jpg" binary image.

Performance evaluation results are described in terms of evaluation metrics. Two common evaluation metrics are: imperceptibility and robustness.

**Imperceptibility:** Imperceptibility means the invisibility of watermark and a digital watermark is said to be imperceptible if the original host image and watermarked image are visually indistinguishable. It is determined by calculating peak signal to noise ratio (PSNR). The PSNR between the host image and the watermarked image is defined by the following equation that is used to compute the invisibility of watermark.

$$PSNR = 10 \log_{10} \frac{255^2}{MSE} \quad (6)$$

Where

$$MSE = \frac{\sum_{i=0}^{N-1} \sum_{j=0}^{N-1} \sum_{k=0}^{N-1} [I_1(i, j, k) - I_2'(i, j, k)]^2}{N \times N \times N} \quad (7)$$

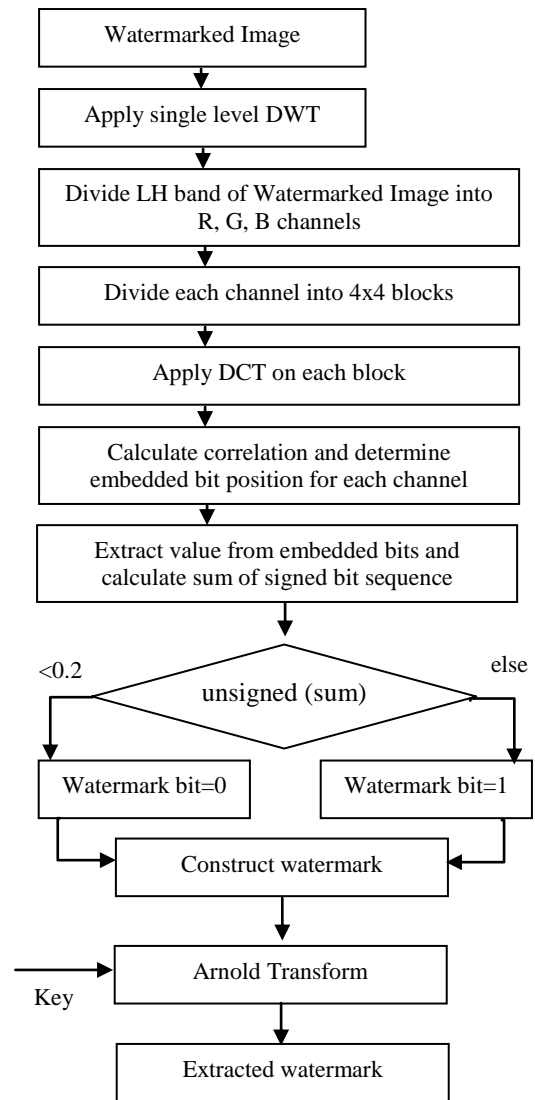


Fig. 4: Flowchart for proposed extraction process

First MSE (mean square error) is computed then PSNR is calculated.  $I_1(i, j, k)$  and  $I_2'(i, j, k)$  represent the R, G, B value of original host image and watermarked image respectively. Larger PSNR value indicates that the watermarked image is more imperceptible.

**Robustness:** Robustness is the measure of immunity of watermark against different type of attacks. It is determined by means of calculating the normalized correlation (NC). Similarity between the original watermark  $w$  and the extracted watermark  $w'$  called normalized correlation is computed by using the following equation.

$$NC = \frac{\sum_{j=0}^{J-1} \sum_{k=0}^{K-1} W_1(j, k) \cdot W_2(j, k)}{\sum_{j=0}^{J-1} \sum_{k=0}^{K-1} W_1(j, k)^2} \quad (8)$$

where  $W_1(j, k)$  is the original watermark image and  $W_2(j, k)$  is



the extracted watermark image from watermarked or attacked watermarked image.

NC can take any values between 0 and 1. The higher the NC value the extracted watermark is more likely to the original one. The original host image, watermarked image and different noise attacked images are shown in figure 5. PSNR value of watermarked image without noise is 51.2525dB. Figure 6 showed the extracted watermark under different attacks and the original watermark which is embedded in host 6(a).



Fig. 5: Pictorial representation of watermarked image under different attacks (a) Original host image, (b) watermarked image, (c) Gaussian noise (0.1), (d) Speckle noise (0.01), (e) Salt & pepper noise (0.01), (f) Poisson noise, (g) JPEG Compression (q.f=60), (h) Cropping 80x80, (i) Rotation 20°, (j) Contrast adjustment

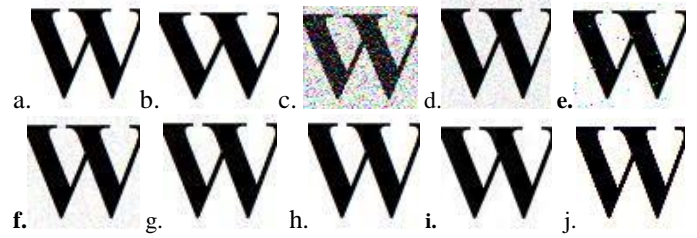


Fig. 6: Extracted watermark under different attacks (a) Original watermark, (b) extracted watermarked, (c) Gaussian(0.1), (d) Speckle(0.01), (e) Salt & pepper(0.01), (f) Poisson noise, (g) JPEG Compression 60, (h) Cropping 80x80, (i) Rotation 20°, (j) Contrast adjustment.

In Table I some data are provided for various kinds of noise attacks.

TABLE I. IMPERCEPTIBILITY AND ROBUSTNESS PERFORMANCE OF PROPOSED METHOD AGAINST DIFFERENT TYPES OF NOISE ATTACK

Noise Attack		
<i>Gaussian noise</i>	<i>Speckle noise</i>	<i>Salt &amp; Pepper noise</i>
Average=0, Variance=0.001	Variance=0.01	Strength=0.01
PSNR=31.3340	PSNR=28.1818	PSNR=27.1079
NC=0.9874	NC=0.9605	NC=0.9879

In Table II for JPEG compression some data are given.

TABLE II. IMPERCEPTIBILITY AND ROBUSTNESS PERFORMANCE OF PROPOSED METHOD AGAINST DIFFERENT TYPES OF JPEG COMPRESSION

JPEG compression		
<i>Quality factor</i>	<i>PSNR</i>	<i>NC</i>
90	34.7488	0.9880
80	33.5945	0.9871
70	32.9026	0.9850

TABLE III. IMPERCEPTIBILITY AND ROBUSTNESS PERFORMANCE OF PROPOSED METHOD AGAINST DIFFERENT TYPES OF DEGREE OF ROTATION

Degree of Rotation		
<i>Quality factor</i>	<i>PSNR</i>	<i>NC</i>
20	11.1777	0.9867
25	10.8612	0.9867
30	10.5637	0.9869
40	10.3708	0.9869

### Comparison Analysis

Table IV shows the performance results and comparison among ZHAO's [8] method, LAI's [11] method and the proposed method under some common signal processing attacks in terms of PSNR and NC value. The result showed that the overall efficiency of this proposed work is increased about 1 ~ 2 % .

TABLE IV. IMPERCEPTIBILITY AND ROBUSTNESS PERFORM COMPARISON WITH ZHAO[8] AND LA'S[11] METHOD

Attack	ZHAO's method		LAI's method		Proposed method	
	PSNR	NC	PSNR	NC	PSNR	NC
Gaussian noise(0.002)	26.4053	0.9646	29.4641	0.9842	29.4563	0.9837
Salt & pepper noise(0.01)	25.0209	0.9473	27.2611	0.9897	27.1079	0.9879
Speckle noise(0.01)	26.1639	0.9484	28.1960	0.9912	28.1818	0.9605
Poisson noise	27.4843	0.9543	29.7284	0.9935	29.7320	0.9775
JPEG compression (Q.F= 90)	33.7750	0.9988	34.7532	0.9898	34.7488	0.9880
Cropping (128x128)	19.8320	0.8666	18.8920	0.8344	18.3451	0.7823
½ area cropping at upper side	11.1022	0.7110	10.1370	0.6933	8.5870	0.6320
Median filter	25.0209	0.9473	31.1732	0.9602	31.1474	0.9583
Rotation25°	10.1011	0.9622	10.8602	0.9865	10.8612	0.9867

#### IV. CONCLUSION

In this paper, a combined DWT and DCT based color image watermarking method with determining maximum correction between each pair of elements of DCT coefficients set block is proposed. In this proposed method watermark is inserted into the bit position where correlation between pair of elements is maximum of each DCT block of selected coefficient set of DWT domain. In the time of watermark extraction neither host nor the original watermark is required which made the proposed method as a blind watermarking technique. The

combined technique improved the performance significantly compared to only DCT based watermarking algorithm. It is shown that almost in every case correlation between original and extracted watermark is more than 0.9 and also provide better PSNR values. The evaluation results show that proposed method has better invisibility and robustness against various types of common signal processing attacks. Analyzing the evaluation results it can be said that the proposed technique is suitable for image copyright protection. More over the proposed technique can be extended to work with color image as watermark and video processing.

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# The Online Laundry System

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**Abstract** -The people of the developing countries of the world do not have access to many easy resources and technology driven conveniences that people in the developed countries usually take for granted. The breathtaking growth of internet technology in recent years provided many easy and effective methods of making people's lives easier. The internet-based online laundry system is such an innovation. It can make an effective and much required connection between the service providers and the consumers. This paper describes an intuitive and low cost design and implementation of an online laundry system that utilizes the available software technologies such as Bootstrap, Phpgit, Xampp, etc. The designed system is easily implementable without the need of expensive resources and can be used by people who are just moderately internet literate. The implemented method of web application development will be especially useful to businesses and people in the developing countries where computing resources are not in huge abundance and internet access speed is not the fastest.

**Keywords**— link; service provider; consumer; administration; monitoring; component

## I. INTRODUCTION

As time passes, the world is evolving and becoming more and more technology connected. There is an imbalance of the situation as there is a lack of similar technological evolution in the developing countries. The underdeveloped and developing countries suffer backwardness towards evolution as it is not done in a regular basis and uniformly, rather it happens in only some parts. The innovation is lacking in most parts and need improvement. [9] And [11] talk about innovation and the role it plays in the world of online systems. Thus this paper focuses on improvement towards the system where everyone can have access, a system which is helpful to a commoner and also a rich person[6][7][8][10]. A man can access the same online system from his one pixel graphics phone and enjoy its services as same as a rich person with his smart phone. The access to the information methods and information with online system has been described by the papers [1], [2], [3], and [4]. The online laundry system is a kind of online system where the system itself provides service. The system works as a bridge between the customer and the owners of the laundry shop such that they can easily connect with each other without any hassle on the customer's part. Such online system can be an asset to the customer as a daily need to an overcome of help.

The service can provide a link which enables the consumer to have access to the list of service that can be provided by the owner and also take advantage of the service providing by the user. The customer or the consumer is given more priority in this online website more than the business person who will provide the service. Care has been given on this online system running efficiency, storage management, run-time requirement, graphical attraction and information availability. This website works in four component model basis.

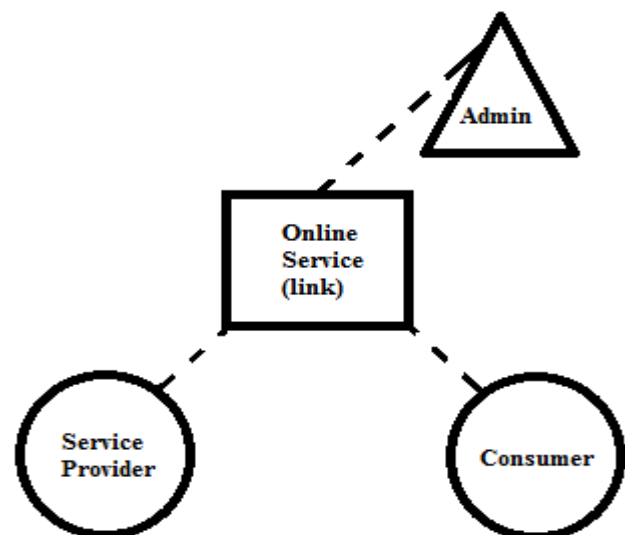


Fig.1 The four component model.

the fig.1 which is the four component model using which the online system will work on, rather than direct link between the consumer and the service provider there will be online system creating more than one service providers to link with and random choice given to the consumers.

## II. BACKGROUND STUDY

One of the biggest problems faced by the people in lesser developed or developing countries is the lack of easy methods of spreading information. People find it difficult to find the best services that are available to them because a lot of these service providers are not able to advertise themselves or their company to their potential customer base. The lack of information along with communication causes a vital problem in the economical growth and the countries development. This causes a lot of new companies and startups to fail early on and not be able to fulfill their true potentials in the business world. The lack of connection between firms and their customers can

also be bad for the customer because they may lose money by spending too much for services or not being aware of the best quality of service or product that is actually available to them. For these reasons, a website can be an excellent way for customers to interact with a large number of service providers to choose the best price and quality of service.

A recent study was conducted on the social usage of the internet for various purposes. It was observed that more than 50% of the age group who needs information uses the internet as daily support system. The usage of internet is vast for gaining knowledge. But while conducting the survey on the helpful usage of internet most of the interviewed complained that there is less information found at places.

An individual who wished to remain anonymous commented that he doesn't know what is in his neighborhood properly. Rather he included that even if he knows the place he cannot confirm the service quality and has to blindly depend on the shopkeeper. He also mentioned that if there was an informative website which can give directions and information's it can make adapting to a city or settling to a place much easy and helpful, especially a newcomer. Such surveys and interviews indicated the need of E-services such as this online system which can be of excellent use. In a country such as Bangladesh, telecom services play a huge role in connecting almost the entire population through the internet services. So the ease of availability of internet makes e-services an excellent medium by which people can be connected.

### III. EASE OF USE

A website as a medium of communication and interaction has the advantage to the customer and the service provider. It is free. Internet is easily available to most people in the city and with mobile phone operators having such a vast coverage over almost all corners of the country, mobile internet is available to nearly every individual of the country. Through the internet, customers and sellers are able to relay information back and forth regarding product and service description, and customers can communicate with other customers to exchange information about the quality of the service available to them.

### IV. THE SOFTWARE DESIGN

The software's which is used to design these online systems are

#### A. Bootstrap:

The bootstrap is the framework for developing html, CSS and JavaScript based website. This framework is used here to give the total design of the website. The total framework has been made from scratch due to the use of this template. Bootstrap gives headings, column boxes and all the designable option that an html code can give. Bootstrap is used to make use of chosen certain HTML elements; it also uses CSS

elements that required use of doctype rows and columns are used in a sequence such that the option button can be included. The software designs the whole website with including buttons with features the drop-down option is used also the navigation list is made with the help of bootstrap. There is a horizontal tab navigation option included. The pagination label with the advanced typographic thumbnail is also used in this online system. Various warning messages and confirmation message is inputted. The component in this website is implemented as of the CSS class which is applied to HTML elements in the page. The JavaScript component is used in form of JQuery plugin. Several additional plugins are used like auto-complete function, the dropdown function, the tab and the tooltip, alert button, collapse is used here.

#### B. Phpgit

The phpgit is used to customize the styles and embedded to the page. The page takes a lot of interfaces to be used in the front end of the site. The site uses phpgit as highlighting syntax methods used to browse of several parent versions the tree browsing type which is used by the phpgit gives some nice icons and interfaces.

#### C. Code-igniter2.0.1

The code-igniter is based on the model view and controller pattern. It is certified software which gives more speed to the website then using normal php coding. This code-igniter source code is used with the git-hub [5]. This helped to build the dynamic optional applications of the website and to increase the php speed on the website.

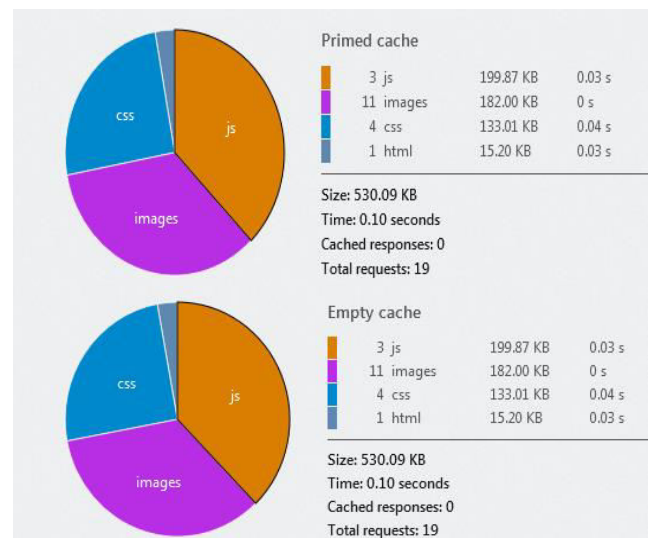


Fig.2The Network performance

#### D. Xampp

Xampp is a cross-platform web; it is a server with a solution of stack-packages. It is developed by the Apache Friends. It mainly consists of Apache HTTP Server, the

database and the interpreters for the scripts written in the php like programming languages. It is a local host server like program that has allowed to test the website on run base and test the console with speed and domain implementation output given by the online system. It works on all equally like Linux, Windows and Mac. In this online system it is basically used as a development tool to test the programs online performance. It is also useful to check the loading of the database to work perfectly. This server is also used to work on the database of the website.

### V. METHODOLOGY

The online system works is programmed using bootstrap template and using php.git. It includes two visible parts. The user part the administration part which is known as the admin sector. The sections or the parts are divided according to the user and the administrators comfort and needs. The whole website consists of different web pages according to the functions which are or will be required by the users.

However if the user has a problem and wished to cancel the order, he/she can always send a complain message through the complain box which will later notify the administrator to cancel the order placed. As the website/ online system prefers the cash on delivery method with a delivery charge of 40tk minimum. The cancellation of order will not cause any loss on the side of the users of the website. The user can also directly contact with the admin for any problem faced in the website. The user can also send message to the admin for any cancellation of account or password change. The admin can take the message first hand and deal with the problem, by notifying the user through his email address. The admin will have a signal notification on his/her homepage of the website so that he/she can work on the users problems first hand. Furthermore the user and the admin will have an order log where the user can check his order history. The admin can also check the order history of all the registered users in the website. They can also print a hard copy of the order history.

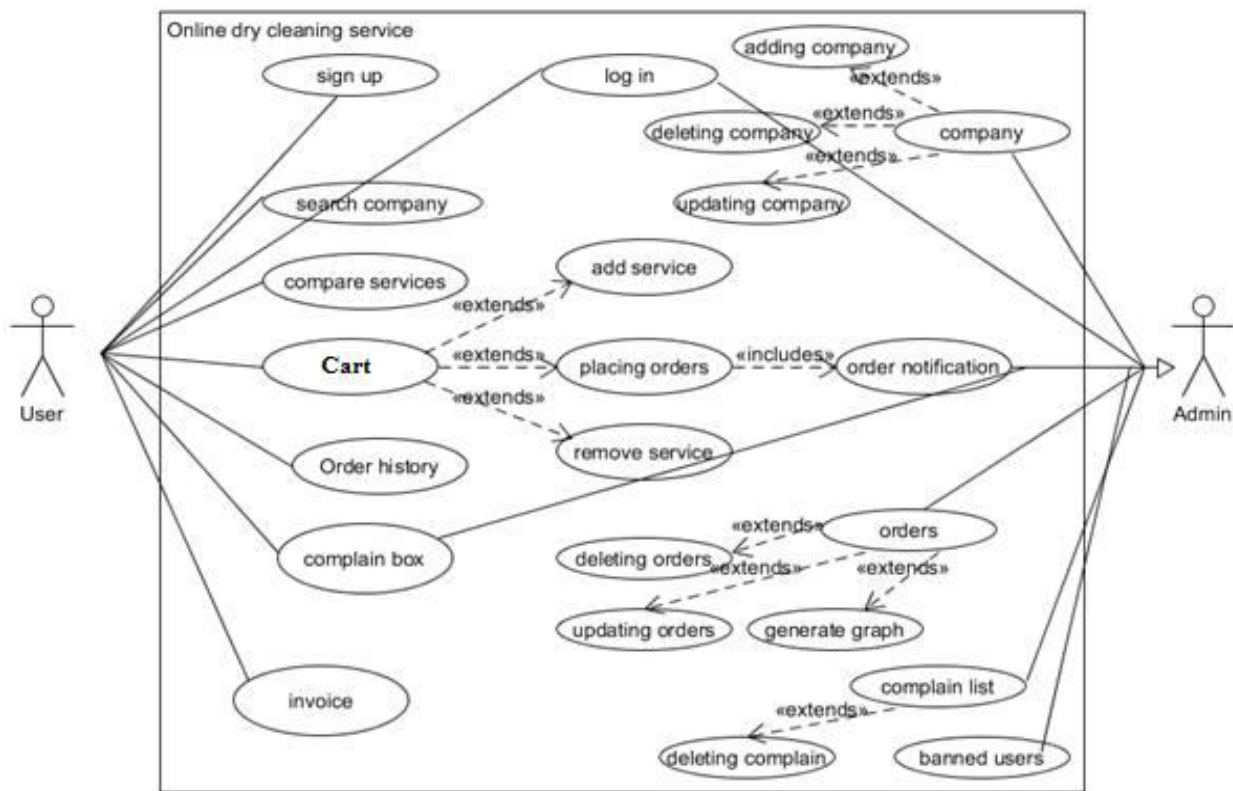


Fig.3The User Case diagram

The diagram fig 3 shows the user part having sign up page where the user can register to login and use the page the sign up page has a different page which can turn back to the login page as well. The user can also have the access to order from a

company and have an order list. The user can use the company order function to order the respective order they need to put in the option. There will be pickup and delivery date option chosen by the user themselves as such they can choose

according to the user's urgent requirement. The user orders the service and the order is then confirmed into the cart of the website the added cart then extends to the function of adding and also removing the order according to the user's wishes but all this has to be done before confirmation. In other orders after confirmation only the orders placed will extend to the notification went to the admin who then performs the job of picking up the laundry from the customer according to the given date and taking it to the laundry shop and deliver it back on the time mentioned.

The user can check through the order log to check on the previous orders they have used. This order log can serve as a printable hardcopy handout to keep track on the service taken and used by the user in the website. There is a complain box option for the user where the user can send complains to the administrator of the website to help monitor or even upgrade the website according to the users comfort. The user also has an option known as the compare function. The compare function is provides to user benefit function given the user having different choices to begin with thus giving a manual choice of recommendation for the user himself/ herself.

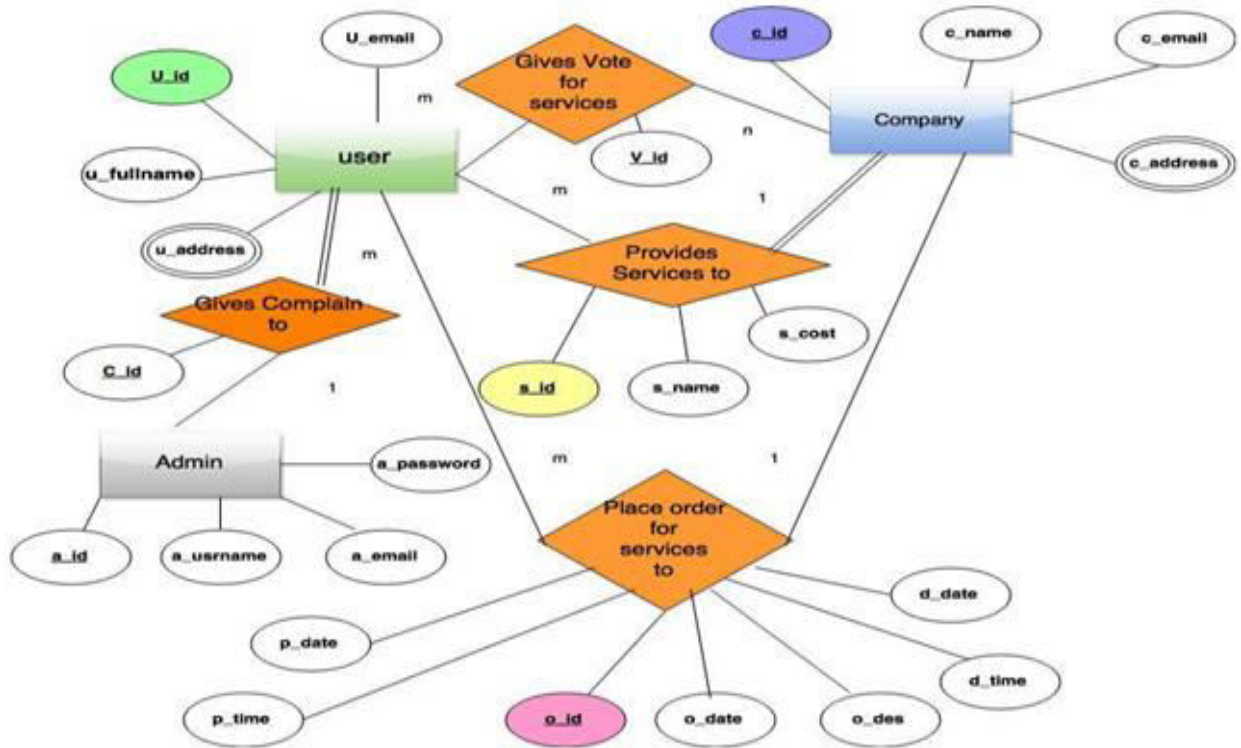


Fig.4The database ER diagram

The compare function can allow the user to compare the laundry shops around his/her area, specially the price difference of the company to make them suitable for the user to choose. The user can also complain about the company and request the administrator to ban the company in the website. The login page on the other hand has both features for users and the administrator. The administrator has the ability to add a new company and as such banning the user they can also ban a company. The administrator has to update a company service and update orders if required. The administration in this online system has more responsibility to look after the whole process of function appearing and transaction happening in between the user a service company. The

website will work as a third party communication system between the customers and service providers such that there can be healthy and hassle free relation between them.

The administrator can track down both the company and the customer. The above diagram shows the division of the sections in the website according to the requirements. Like the company has to have its address their companies ID its name. As such the user has to have their ID, name and address with their user information. The above diagram also gives a map of the information stored in the website. The user has their information stored along with the company information stored for the company. The website beside this stores complain

along with the person issuing it with the complain ID. This can have an amount of complains stored and notified to the administrator. The user votes are also stored in the database website to rank the company as vote id. The order section also has a database of itself as order ID, order name, order address.

The date and time of order and pickup is stored in the database. The total price of the order of customer is also stored

There are also database tables that can be accessed by single individual and the others can be accessed by more than one individual. In other words there is a pictorial view of the access from one to one and many to many and one too many database access shown at the fig 4. The many too many database access is indicated by the symbol 'm', 'n'. The single time access to the database is shown with the symbol '1'. This online system has been design to work efficiently according to the user's wishes and take less storage so that it can upload faster. But care has been taken that it can be attractive enough to have visual comfort for the customers who are going to use the website.

The laundry business at the introduction of this online system gets free advertisement of their laundry shops and customer reviews of their shop. It is useful for the customer; it also is a good place to get reviews and ideas for the local laundry shops. This helps the laundry shop improve themselves from customer reviews. The customer can enjoy the ease of online laundry service and be also a critic to the business.

## VI. CONCLUSION

We have successfully designed and implemented an online laundry system that effectively connects the businesses and the customers and thus help both the parties. The system is easy to use. The lack of such a system in a country like Bangladesh makes it an excellent choice for adoption by such countries, as this provides a low cost and easy path to migration to a hybrid business structure where both online and brick-and-mortar versions of the business can coexist and help each other.

## ACKNOWLEDGMENT

We are grateful towards Ali Abdullah Khan. By lending us his time and guiding us with asceticism to complete this project.

in the database to keep record. The diagram shows where table database can have public access and public view like the company homepage and company descriptions are public view but the order of the individuals and the administrator homepage and complain box along with the order receipt will only be viewed privately. Even the upgrading page needs to be viewed privately.

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# Development of an Online Bus Ticket Booking System for Transportation Services in Bangladesh

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**Abstract**—Although web applications are seeing an explosive growth worldwide, unfortunately developing nations are a long way behind utilizing the web or online applications to enhance the quality of lives of their people. This paper describes the design and development of an online ticket booking system so people can compare bus routes, schedules, and book or buy bus tickets remotely and conveniently. The software framework is designed in such a way that this system can be easily developed and deployed at a low cost in a developing nation like Bangladesh. A few programming applications have been utilized to exhibit the entire framework. The usage of the framework required to utilize PHP, HTML, JavaScript, CSS and MySQL. The whole framework can efficiently handle online ticket booking and handling.

**Keywords**—Online Bus Ticket Booking System; framework; PHP; MySQL (key words)

## I. INTRODUCTION

In modern times, people are so busy with their life. They like everything will be easy to do. In the meantime, internet has been rapidly changed. Now everyone wants that, every single problem will be solved by just one click.

The Online Bus Ticket Reservation System is an online application that permits guests check transport ticket accessibility, purchase transport ticket and pay the transport ticket online. This system is made for all the home/office clients as they can book their ticket from home or anywhere.

The increase in the number of computer and the mobile phone users on one hand is shrinking the world itself and on the other hand is resulting in the manufacture of more number of computers and phones with ever-new technologies and facilities. In today's world mobile phones have become pervasive devices, which is used as Camera, Music Player, Web Browser, for playing games etc. Thus for combining all these features within a single device have emerged several new ideas and technologies. One of these new technologies is Android Phones. Android is basically an operating system incorporated in mobile phones now a days.

## II. THEORY

Online ticket booking gives the flexibility to the clients and additionally the transport administrators. It gives clients to pick

diverse choices in light of their travel model. It additionally expanded the franchising cost for the transport administrators. In the meantime, the transport administrators were additionally thinking that it hard to screen their bus seat filling data. Numerous little and medium transport administration associations do not have their own particular online transport ticket booking framework. Online Bus ticketing framework, web entry is an aggregate web ticketing operations offering the advantage of aggregate in-house administration of transport timetables, ticket bookings, ticket deals, report era, and different business capacities connected with ticket deals. It additionally offers the force of choice making to clients to make a ticket booking through transport administrators' notoriety, execution and positioning. This effective Internet based ticket-booking framework that permits a full control of not just on the ticketing stock, but also the site's substance. The essential parts of an Online Bus Ticketing System web entry that gives improved support of the transport operators and clients comprise of the accompanying.

## III. EXISTING SYSTEMS

To use the existing methods for web application development for online ticket booking system, a great deal of manual work must be done. The amount of manual work increments exponentially with expansion in administration. They also need great deal of working staff and additional considerations on each record. In existing systems, there are also different issues as if keeping records of things, tracking accessible seats, costs of per/seat and settling bill era on every bill. In addition, finding out insight concerning any data is extremely troublesome, as the client needs to experience every one of the books physically. The major issue is absence of security.

## IV. PROPOSED FRAMEWORK

The framework is exceptionally basic in configuration and execution. The framework requires low framework assets and the framework will work in all arrangements. It must have the following elements:

- a) Needs a great deal of working staff and additional consideration onevery one of the records.
- b) Requires information exactness.
- c) Records are productively kept up by DBMS.



- d) DBMS likewise gives security to the data.
- e) Any individual over the world, having web can get to this administration.
- f) Availability of seats can be enquired effectively.
- g) Passengers can likewise wipeout their tickets effectively.
- h) Minimum time required for the different preparing
- i) Better Service.
- j) Minimum time required.

This would offer the organization some assistance with preparing and compose its timetables even more effectively.

## V. SYSTEM DESIGN

The system design of this web application using the following items:

### A. Principles Of Booking System Analysis

- i. Comprehend the ticket issue in the recent past you start should make the transport ticket dissection model.
- ii. Create prototypes that empower a client will see all the how human machine connection will happen
- iii. Record those transport ticket beginning for and the purpose behind each prerequisite.
- iv. Utilize various behavioral sees for booking prerequisites such as fabricating data, capacity and Models.
- v. Fill in on kill vagueness.

### B. ENTITY RELATIONSHIP DIAGRAM (ERD)

- Entity Relationship Diagram: This depicts relationship between data objects. The bus attribute of each data objects noted.
- In the entity - relationship diagram can be described using a Data object description. Data flow diagram serves two purposes: (i) to provide an indication of booking how data are transformed as they move through the bus ticket system. (ii) To depict the ticket functions that transformation the data flow.
- Data Objects: A data object is a representation of booking almost any composite information that must be understood by the ticket bus software. By composite information, we mean something that has a number of different properties or attributes. A data object encapsulates data only there is no reference within a data object operation that act on the bus data.
- Attributes: Attributes define the ticket properties of a data object and take on one of three different characteristics. They can be used to: (i) Name an instance of data object. (ii) Describe the bus ticket

instance. (iii) Make reference to another instance in other table.

- Relationships: Data objects are connected to one another in a variety of different ways. We can define a set of object relationship pairs that define the relevant relationships.

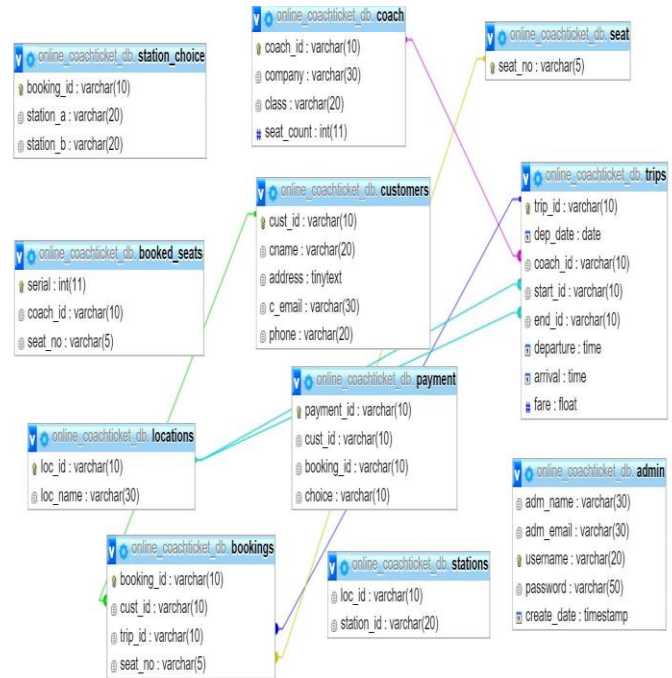


Fig.1: ER Class Diagram of the Database

## VI. SOFTWARE USED IN PROJECT

Implementation of the system required to use

- i. PHP,
- ii. HTML,
- iii. CSS,
- iv. JavaScript,
- v. MySQL
- vi. Bootstrap

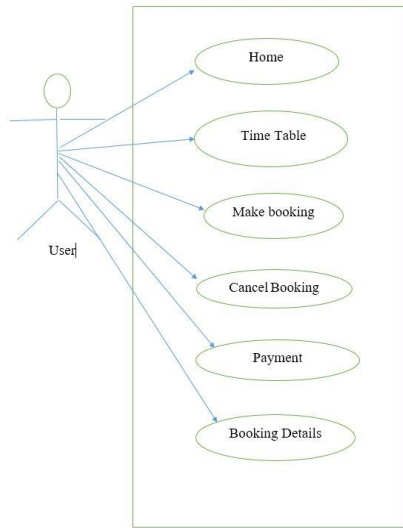


Fig.2: Use Case Diagram for User

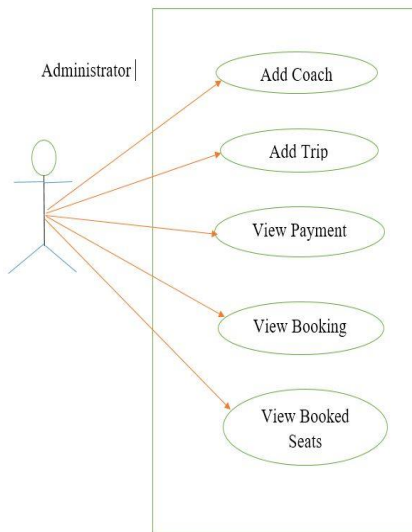


Fig.3: Use Case Diagram for Administrator

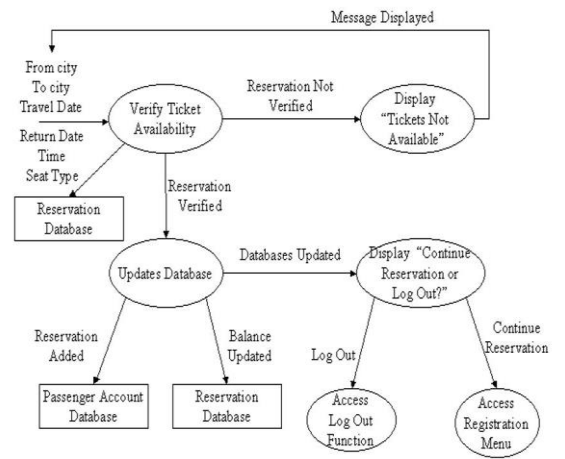


Fig.3: Data Flow Diagram of the System

1. **PHP:** PHP will be a universally useful server side scripting dialect initially intended for web improvement to prepare dynamic web pages. For this purpose, PHP code may be inserted under those html sourball records and translated toward a web server for an PHP processor module, which generates those web page record. PHP need been used to create those script code and the structure of the undertaking web page.
2. **HTML:** Hypertext Markup Language (HTML) is the fundamental mark-up language for web pages like air travel ticket booking website. HTML elements are the basic building blocks of Webpages. The purpose of a web browser is to read HTML documents and compose them into visible or audible web pages. The browser does not display the HTML tags, but uses the tags to interpret the content of the page.
3. **JavaScript:** JavaScript is a prototype-based scripting language that is dynamic, weakly typed and has first-class functions. It is a multi-paradigm language, supporting object oriented, imperative and functional programming styles.
4. **CSS:** Cascading Style Sheets (CSS) is a style sheet language used here to describe the presentation semantics (the look and formatting) of the document written in a mark-up language. Its most common application is to style webpages written in HTML and XHTML, but the language can also be applied to any kind of XML document, including plain XML, SVG and XUL. As CSS used to support the webpage, that specially written in HTML.
5. **MySQL:** MySQL is a relational database management system (RDBMS) that runs as a server providing multi-user access to a number of databases. The SQL phrase stands for Structured Query Language. MySQL has been used to connect the whole database systems of the air ticket management and make a worthwhile web page script.

- 6. **Bootstrap:** Bootstrap is a combination of HTML, CSS and JavaScript designed code to help build user interface. It is a free collection of tools for creating web application. It is also called front-end-framework

VII. RESULT

Fig. 4 to Fig. 14 describe the user interfaces at first user need to search his/her trip, the booking system, and overall working of the web application.

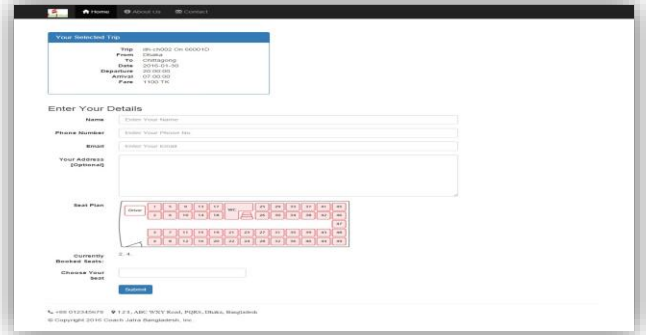


Fig.7: Seat Plan

Fig.4: Homepage

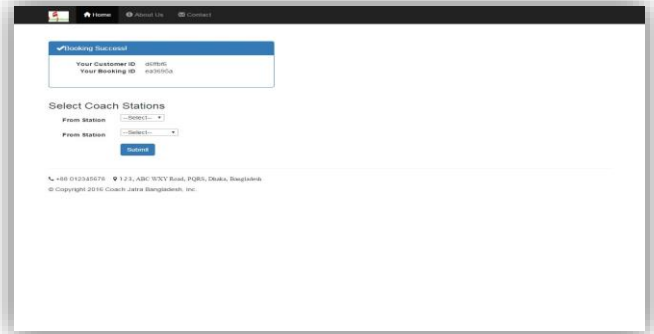


Fig.8: Booking Confirmation

Date	Coach	Seats	From	To	Departure	Arrival	Fare	
2016-02-02	60001B	47	Dhaka	Chattogram	06:00:00	14:30:00	500	Book
2016-01-30	60001D	50	Dhaka	Chattogram	03:00:00	07:00:00	1100	Book
2016-02-02	60001B	45	Dhaka	Chattogram	03:00:00	06:00:00	1000	Book
2016-02-05	60001A	49	Dhaka	Chattogram	09:00:00	19:00:00	800	Book
2016-02-05	60001B	45	Dhaka	Chattogram	09:00:00	23:00:00	1200	Book
2016-02-16	60001B	45	Dhaka	Chattogram	12:00:00	20:00:00	1200	Book
2016-02-18	60001B	45	Dhaka	Chattogram	12:00:00	20:00:00	1200	Book

Fig.5: Schedule

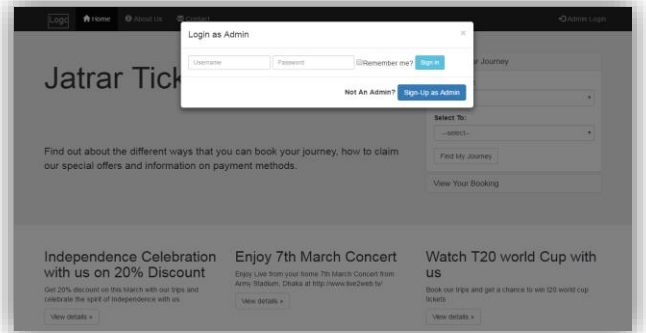


Fig.10: Admin Login

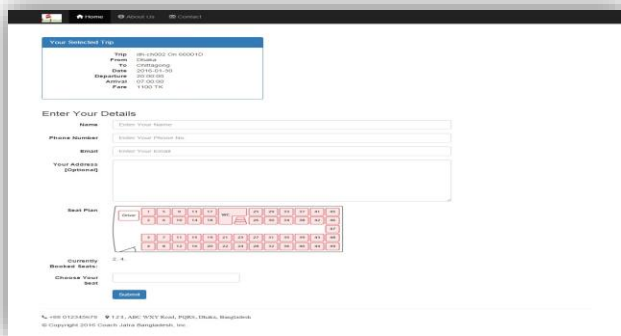


Fig.6: Ticket Details

Date	Trip ID	Booking ID	Customer ID	
1	2016-01-28	dh-0001	03c5fbc	0395601
2	2016-02-01	dh-0001	7869ed3	2039192
3	2016-02-01	dh-0001	933ca8f	8a61914
4	2016-02-01	dh-0001	985f1c4	0302565
5	2016-02-02	dh-0001	3c29455	5ea8583
6	2016-02-02	dh-0001	0ba0765	8a338a
7	2016-02-02	dh-0003	ca39595	b701463
8	2016-02-16	dh-0006	118806	5d86c14
9	2016-02-16	dh-0006	23a9a40	11c9a87
10	2016-02-16	dh-0007	6d50337	41c496c
11	2016-02-16	dh-0007	9a81f5d	ad5c3a5
12	2016-02-03	dh-0001	4d723d0	7201a8e
13	2016-02-03	dh-0001	85e66d0	62d39d7
14	2016-02-03	dh-0001	8036d0e	c066a0e
15	2016-02-04	dh-0001	863645	37307a5

Fig.11: View Booking

Payment ID	Customer ID	Booking ID	Payment Option	Mobile
1	026206	026207	station	
2	105201	118005	station	
3	1e50a5	3c29a55	station	
4	0a0988	019635	station	
5	8729c4	83660e	station	01626816956
6	99e5d4	188ee50	station	
7	9c00a8	a1c496c	bkash	01626816956
8	a051242	8e6338e	bkash	01622044429
9	a117a5	a563a5	bkash	01626816956
10	a5ee194	72018e	bkash	
11	a8e4b52	35c9c28	bkash	212112
12	ae05065	8e6d194	bkash	
13	1c517a7	1139a47	station	
14	c1495e1	9495a5	bkash	01626816956
	0331a2	7809eaf	bkash	

Fig.12: View Payment

Coach ID	Seat #
1	10012R
2	12001B
3	12002S
4	13002A
5	16002S
6	66001D
7	69001B

Fig.13: View Booked Seats

Coach ID	Coach Company	Coach Class	Total Seats
9	66001D	Surda	premium 49
10	67002E	Tanzat	supreme 50
11	68001A	Green Line	premium 49
12	69001B	Hard	standard 44
13	70001C	barisal express	standard 40

Add A Coach

Coach ID:

Coach Company:

Coach Class:

Total Seats:

Fig.14: Add Coach

### VIII. FUTURE WORK

Online ticket booking systems are becoming more and more promising, but still there is still a lot more work to be done. The future improvements of our project are:

- 1) Connection with the bank database should be more secure and all banks should allow the airline systems to share their secure database.
- 2) The total process of booking ticket should become more users friendly and easy that any person can use the system at his first attempt.

- 3) Developing an efficient online ticket booking system should be quicker, fast and errorless.
- 4) Developing backups for data and integrated security systems.
- 5) Extended data storage capacity, SSL data security and customer feedback and online help options.
- 6) Error free and efficient server.

### IX. CONCLUSION

This paper has described and easy-to-implement and cost-effective framework developing web air ticket management. This framework will permit clients can book their transport ticket online, which should be easy, secure, and hassle-free. It has been a huge task to bring this project is near completion, even though modification of some features is still being worked on

### ACKNOWLEDGMENT

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# Designing an IC layout for Bengali alphabet character using dot matrix display

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**Abstract**— To meet the elevated demand of performance oriented and technically flexible electronic device integrated circuit has opened a new era of advancement in the field of electronics. System design is getting more attention because system design is pre-requisite of performance oriented electronic device. The remarkable step in the field of electronic system design is the size reduction and compact technology. Integrated circuit(IC) enhances the revolution faster and wider. Considering the ongoing demand of the new era, this research focused on designing a dot matrix display used IC for Bengali alphabetic character. This electronic device will make life easier and comfortable. This design will provide the comfortable shape of character and is more suitable for joint Bengali character than other segment display.

**Keywords**— MOS, CMOS, Dot matrix Display, IC, Alphabetic Character.

## I. INTRODUCTION

With the challenge of the modern civilization Bangla language become a vital factor of IC design technology as huge number of people are native to this language. For the new age's challenge of making technology free and friendly to the humanity, Bengali alphabetic character is getting good emphasis for developing different program and chips. Considering the mentioned steps designed a dot matrix display used IC for better performance after a step of designing the 26-segment display. Some microcontroller based works such as (Display unit for Bangla alphabet character) only work with Bangla numerical numbers such as (১,২,৩,৪). This method has some difficulties with Bangla Alphabet Character.

Bangla alphabetic characters are represented using dot-matrix system [5]-[6] where a large number of dots are to be manipulated. On the other hand for English alphanumeric LED displays are available in three common formats [7]. For displaying only numbers and hexadecimal letters, simple 7-segment displays such as that shown in [7] is used. To display numbers and the entire alphabetic, 18-segments displays such as that shown in [7] or 5×7 dot-matrix displays such as that shown in [7] can be used. 11-segment display for Bengali and English numerals [8]-[9], 12-segment for Bangla, English, and

Arabic numerals, and 9-segment for only English and Arabic digits [8], 9-segment [10] and 10-segment [11]-[12] for Bangla digits and 16 segments for multilingual [14] are already proposed. Since, Bangla Alphabetic characters are represented using dot metrics as a result the cost of the display unit increased due to storage space, a large number of dots, power loss, and design complexity. But recently very few researchers addresses the point to represent Bangla Alphabetic characters using segmented display unit [15]-[18]. Still there is no standard segmented display unit for Bengali alphabetic characters. Also some segment are capable for different character such as vowel, consonant and not capable to display the joint characters. Considering the demand and flexibility we found very negligible number of works which consider all constrain and provided any solution. A number of difficulties and limitations are found for users which are tried to overcome. Finally designed an IC using dot matrix display.

## II. DESIGN METHODOLOGY

Accurate display of Bengali alphabet character is a challenge since the Bangla alphabet are more gnarled such as (ঞ, ঞ) and complex than any other alphabet like English alphabet. Besides this there is a challenge to make the technology more convenient user friendly and cost effective. The entire process divided into 4 sequential steps. After theoretical analysis, compared the simulated data that means practical data with theoretical value. From this comparison, the research followed this steps to achieve research desired goal. Figure 1 shows the flow chart of the proposed IC design.

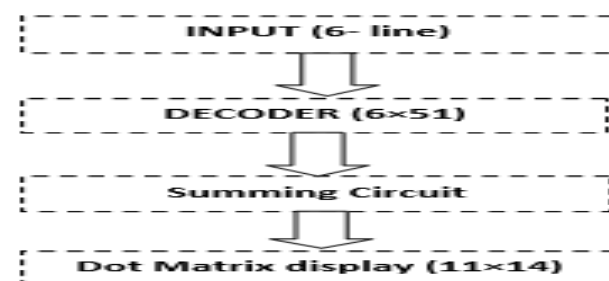


Figure 1. Block diagram of the device

### III. SYSTEM IMPLEMENTATION

#### A. Input Lines

According to Banglapedia there are 51 characters in Bengali. For this 51 output signal is required. To get 51 signals it is required to have 6 signals as input line. By using this 6 input we can specify our desired output signal according to binary value. The magnitude of this DC voltage is always 5 V. Since the construction of circuit is complex so any voltage less than 5 V may be insufficient for the display to operate. Cause there are internal losses. Figure 2 shows the 6 input

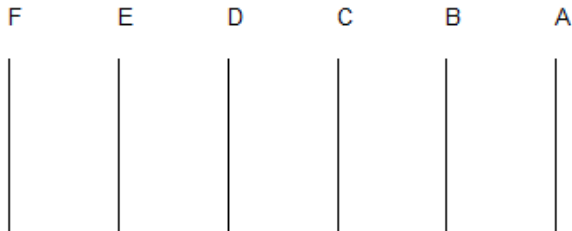


Figure 2. Input Lines

lines.

#### B. Decoder circuit

A binary code of  $n$  bits is capable of representing up to distinct elements of the coded information. A decoder is a combinational circuit that converts binary information from  $n$  input lines to a maximum of unique output line. Here we have used  $(6 \times 51)$  decoder. That means the decoder collects the binary information from the 6 input lines and converts it into 51 output lines. Figure 3 shows the decoder circuit.

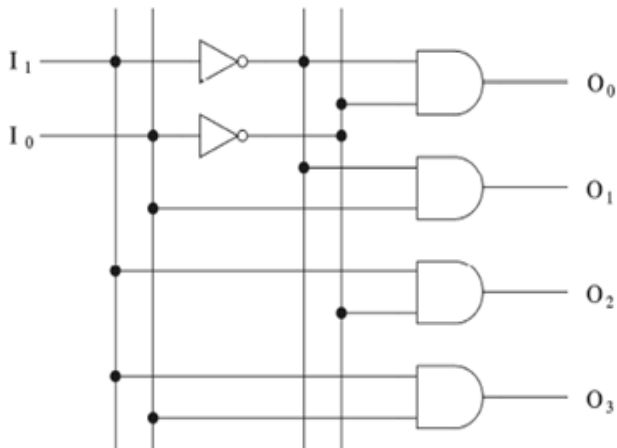


Figure 3. Decoder circuit

#### C. Summing circuit

The main objective of summing circuit is to collect the decoder information for one segment of display. In description we can say it collects the output signal of decoder to determine which segment of the display will be on and which will be off. Summing circuit can easily be made by OR logic gate. Figure 4 shows the schematic diagram of summing circuit.

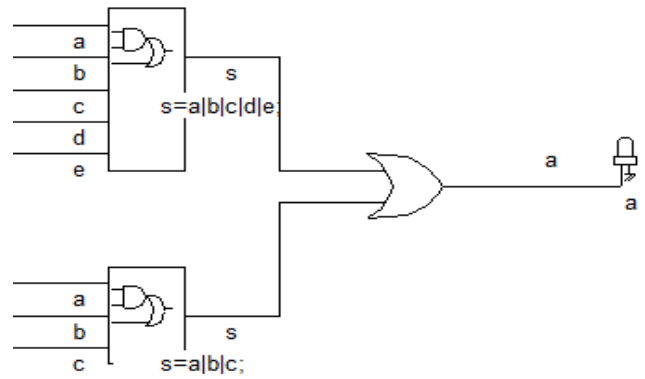


Figure 4. Summing circuit

#### D. Interconnection in dot matrix display

To represent the joint word through the IC, initially tried it with Dot Matrix display. And at last successfully done with the Dot matrix display. One of the advantages of dot matrix display is the complex and diverse character can be designed by it. Here we have used  $(11 \times 14)$  dot matrix display. Figure 5 shows the interconnection of dot-matrix Display. Figure 5 shows the interconnection of dot-matrix display.

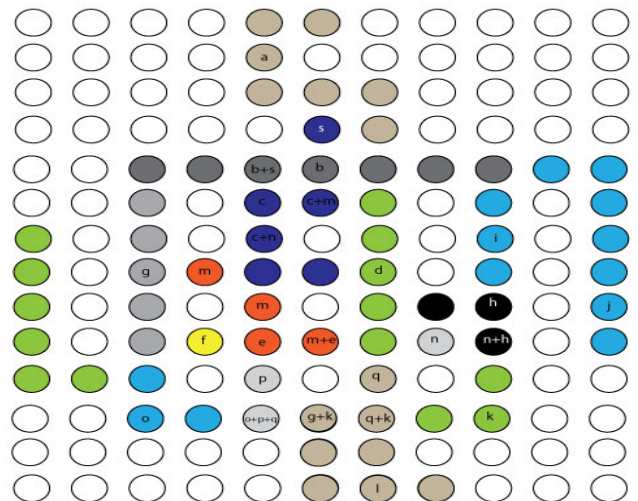


Figure 5. Dot matrix display interconnection

### IV. LAYOUT DESIGN

Since segment display is not applicable for joint word we have chosen the dot matrix display. Then by following the previous method we have designed an IC for dot matrix display. We have interconnected those entire required element. Then we have found these types of schematic diagram. Figure 6 shows the schematic diagram of our designed IC for dot matrix display. Later we have again tested the performance of our newly built IC. The following figure shows a view of performance testing for different Bangla word through time diagram.

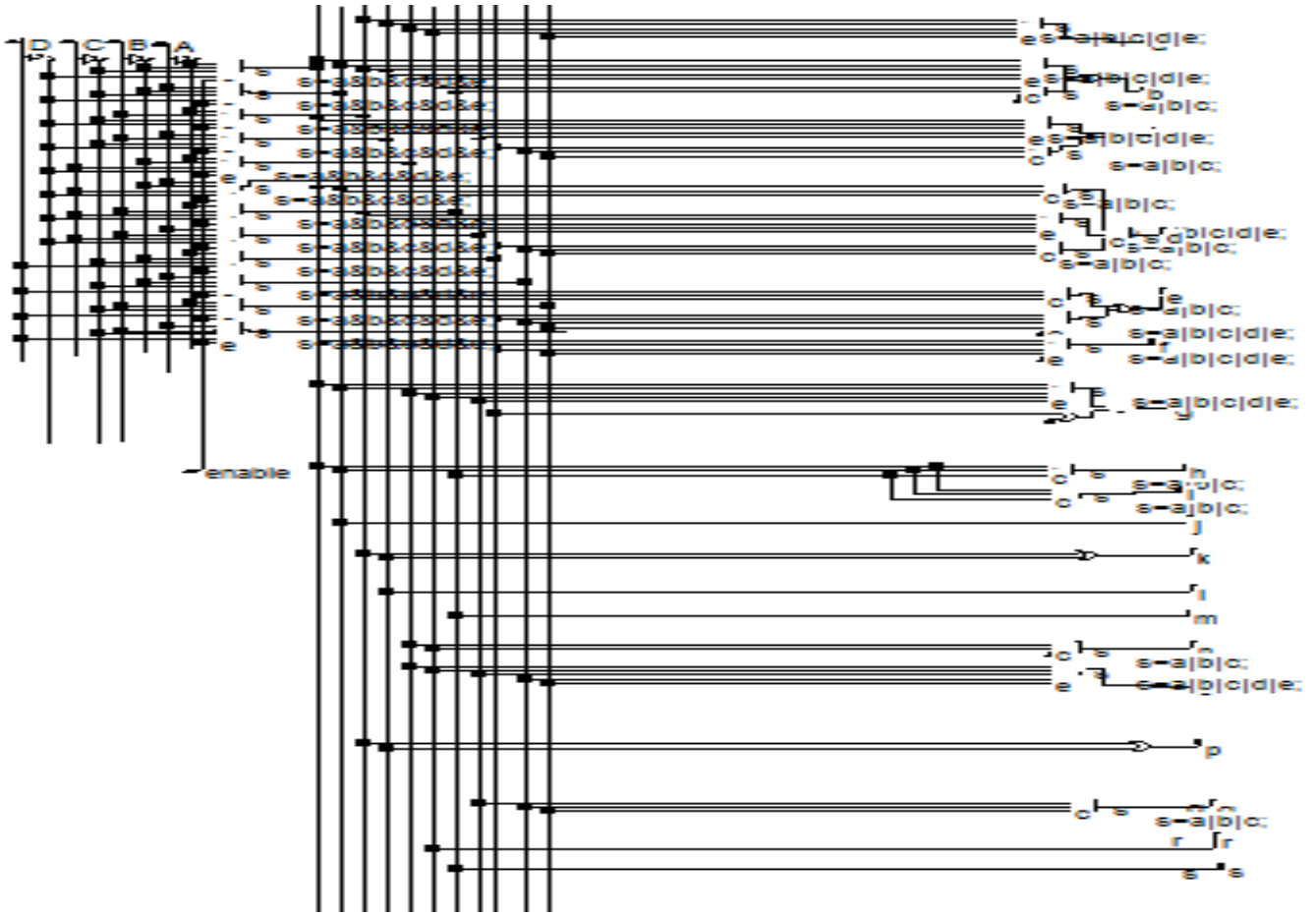


Figure 6. Schematic diagram

TABLE I. INTERCONNECTED DOT MATRIX

Interconnection	Matrix number (position)
a	M_14, M_15, M_24, M_34, M_35, M_36, M_46, M_56.
b	M_52, M_53, M_54, M_55, M_56, M_57, M_58
c	M_64, M_65, M_74, M_84, M_85
d	M_66, M_76, M_86, M_96, M_106
e	M_104, M_105
f	M_103

g	M_62, M_72, M_82, M_92, M_102
h	M_97, M_98, M_108,
i	M_68, M_78, M_88
j	M_59, M_510, M_610, M_710, M_810, M_910, M_1010
k	M_118, M_128, M_125, M_126, M_127,
l	M_135, M_145, M_147, M_146
m	M_75, M_84, M_95
n	M_107, M_108

<b>o</b>	M_112,M_122, M_123, M_124,
<b>p</b>	M_114,M_124,
<b>q</b>	M_124, M_125, M_126,M_116,
<b>r</b>	M_70,M_80,M_90, M_100, M_110, M_111
<b>s</b>	M_64,M_74,

V. DOT MATRIX VIEW

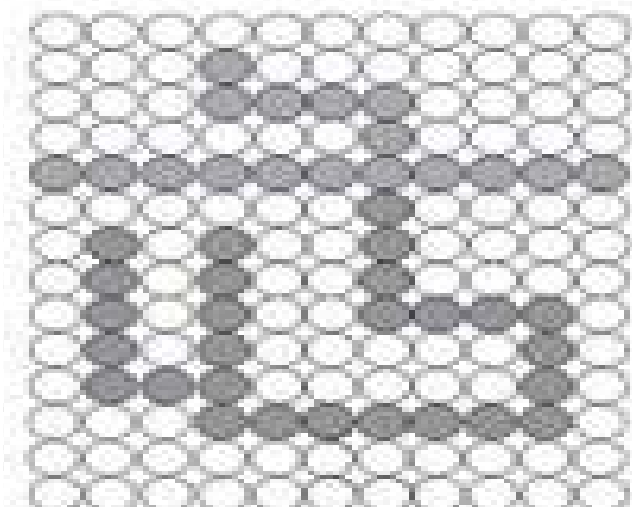


Figure 7. Dot matrix view of bengali alphabet ঔ

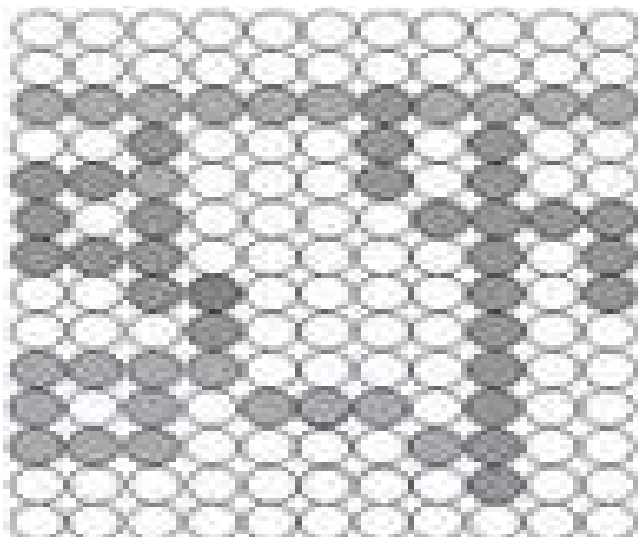


Figure 8. Dot matrix view of bengali alphabet প

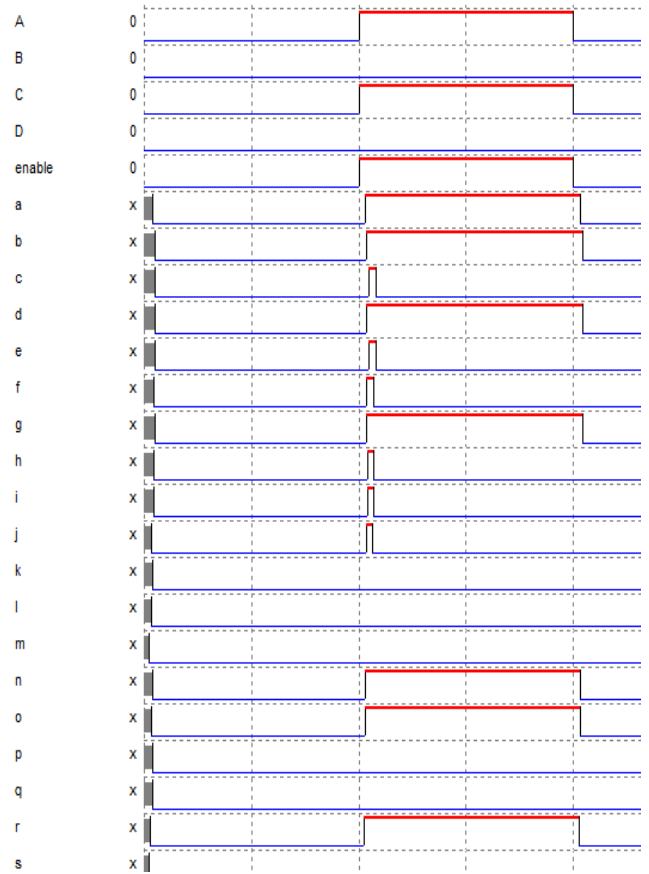


Figure 9. Time diagram for ঔ

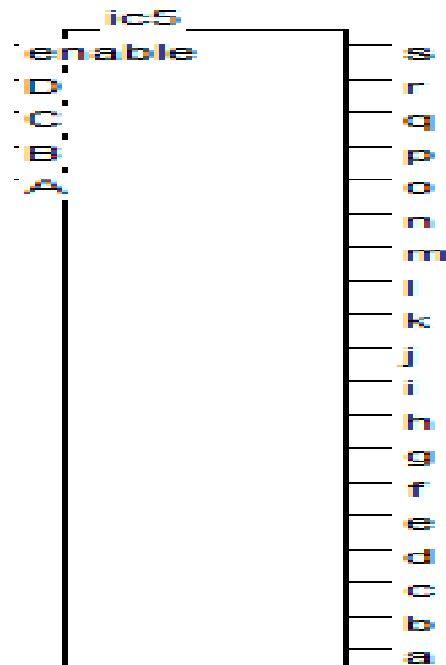


Figure 10. External view of designed IC



## CONCLUSION

Bengali alphabetic character is quite different and complex than English as it have several joint character. To overcome the complexity and lacking's of the segment display we proposed, analysed, designed and simulated the Dot matrix display used IC which provided display of joint character. The entire simulation was performed by the assistance of DSCH and micro wind software. Though the designed IC has some drawbacks including slow response and complexity but it can be improved.

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# SCIEV Impact of Scaling Channel Length on the Performances of Nanoscale FETs

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**Abstract**—The investigation of short-channel effects (SCE) due to channel length reduction for four different types of n-channel FETs: Bulk MOSFET, SOI MOSFET, DG MOSFET and CNTFET are carried out in this work. Simulators are used to investigate SCEs like threshold voltage ( $V_{th}$ ) roll-off, subthreshold Swing (SS) and  $I_{on}/I_{off}$  ratio. Our study shows that DG MOSFET, SOI MOSFET and Bulk MOSFET reach their scalable limit at 30 nm, 50 nm and 100 nm channel length respectively due to elevation of leakage power consumption as they exhibit rapid degradation of  $V_{th}$ , SS beyond 100mV/decade and less  $I_{on}/I_{off}$  ratio. On the contrary, CNTFET can be scaled down below 10 nm as it shows negligible SCEs with stable  $V_{th}$ , ideal SS (60mV/decade) and high  $I_{on}/I_{off}$  ratio as channel length decreases. Our numerical analysis shows CNTFET creates only 1.11%  $V_{th}$  variation whereas DG MOSFET creates 39.33%  $V_{th}$  variation. CNTFET's advantages over MOSFET make it viable for faster and enhanced applications in nanoelectronics.

**Keywords**—Short-channel Effects, Bulk MOSFET, SOI MOSFET, DG MOSFET, CNTFET, Threshold Voltage, Subthreshold Swing,  $I_{on}/I_{off}$  ratio.

## I. INTRODUCTION

Today MOSFET (Metal Oxide Semiconductor Field Effect Transistor) has become one of the most effective silicon based semiconductor devices for VLSI chips. Scaling down the size of transistor and increasing the integration of transistor in a single chip are the themes of semiconductor technology. So the field effect transistor devices with small size, low leakage current, low power consumption, near ideal subthreshold swing, higher drive current and high performance are highly demanded. The advanced semiconductor devices have been scaled down to nanometer level and the device size is further shrinking as predicted by Moore's law [1]. During last four decades semiconductor device technology has been changing with a stunning speed [2]. As channel length has gone down to lower nanometer level, conventional Bulk MOSFET suffers severe performance degradation due to short-channel effects. Some of these effects are known as threshold voltage roll-off, drain induced barrier lowering (DIBL) which leads to subthreshold swing above 60mV/decade, increased leakage current and lower  $I_{on}/I_{off}$  ratio. The short-channel effects limit the scaling capability of FET. After the scaling of Bulk MOSFET has reached its limit, many new devices such as Silicon on Insulator (SOI) MOSFET, DG MOSFET etc. have been proposed and constructed to overcome device scaling

difficulty. SOI MOSFETs have many numerous advantages over Bulk MOSFET such as reduced parasitic capacitance and less short-channel effects [3]. DG MOSFETs obtained additional performance improvement that overcome scaling difficulty of SOI MOSFETs. In the 45nm process era, the DG MOSFET has become significant in terms of its superior properties. The MOSFET device scaling might not be extended to 10nm because silicon based technology will soon reach its limit when the channel length goes down to 10 nm [4]. Therefore, search for alternatives to MOSFETs have started through research. Now the semiconductor industry is looking for different materials and devices to integrate with the present silicon based technology. Carbon nanotube (CNT) is a promising material for future electron devices. As scaling is expected to reach 10nm era, the CNT based FET has become necessary due to its unique electrical properties in this region. The CNTFET is widely expected to take over for the long lasting industrial favorite than the silicon based FETs cause much progress has been made in recent years showing that CNTFETs can overcome all the limitations of silicon FETs in many ways [5].

## II. DEVICE STRUCTURE

### A. Conventional Bulk MOSFET

Fig. 1 shows a conventional n-type Bulk MOSFET. The MOSFET's three terminals are: Source, through which the carriers enter the channel. Conventionally, current entering the

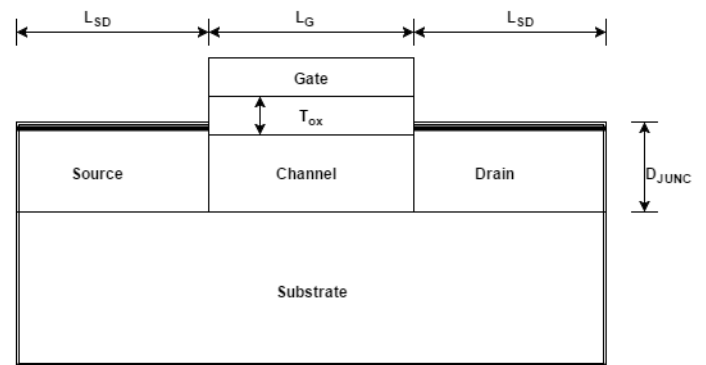


Fig. 1. Structure of a conventional n-type Bulk MOSFET

channel at Source is known as source current ( $I_s$ ). Drain, through which the carriers leave the channel. Conventionally, current entering the channel at Drain is designated by  $I_d$  and drain to source voltage is designated by  $V_{DS}$ . Finally Gate, the terminal that modulates the channel conductivity. By applying voltage at gate terminal we can control  $I_d$ . The source and drain regions are heavily doped with n-type materials and the gate is doped with p-type materials. As insulator silicon di-oxide ( $\text{SiO}_2$ ) is used. The oxide thickness is denoted by  $t_{ox}$  and it is grown by exposing the silicon to oxygen and then adding heat. The oxide grows upwards on silicon surface. The distance between source and drain is called channel length and denoted by  $L$  in the figure. Finally the polysilicon metal contacts grown onto the regions using Chemical Vapour Deposition (CVD). According to channel formation conventional MOSFETs are divided into two types: Enhancement type and Depletion type. In Enhancement type MOSFETs there is no conduction channel at  $V_g = 0V$ . We apply a voltage at gate to turn ON the device. We will simulate and conduct our analysis using this kind of MOSFET. In Depletion type MOSFET channel is created at  $V_g = 0V$ . We apply voltage at gate to turn OFF the device [6].

### B. SOI MOSFET

After the scaling of conventional Bulk MOSFET reached its limit and short-channel effects arise engineers strived to design new and improved MOSFET structure that can reduce the effects that hinder scaling of devices. Thus Silicon On Insulator (SOI) MOSFET was proposed and constructed. The SOI technology features a low capacitance which leads to high speed operation. The supply voltage can be lowered to cut the power consumption while operation speed is not compromised. Moreover tolerance to high temperature and high voltage is comparatively higher in SOI. A thin layer about tens of nanometer active silicon is placed on top of a thick layer of insulator such as silicon dioxide ( $\text{SiO}_2$ ) or sometimes referred as Buried Oxide (BOX) [7] and this dielectric isolation of silicon reduces the parasitic or internal junction capacitance on components and thus improves device performance by a huge percentage [8].

We conducted our analysis on fully depleted SOI (FDSOI) MOSFET. Fig. 2 shows an FDSOI MOSFET which has identical terminals as any conventional MOSFET. The buried

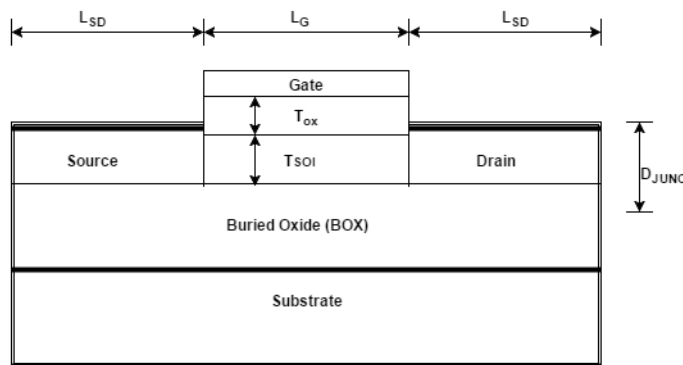


Fig. 2. Structure of a n-type SOI MOSFET

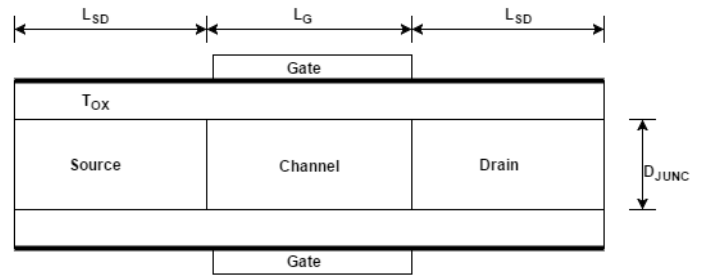


Fig. 3. Structure of a conventional n-type DG MOSFET

oxide region and the junction depth is designated by BOX and  $T_{SOI}$ .

### C. DG MOSFET

As conventional Bulk MOSFET are amenable to short-channel effects and thus leakage power consumption, different structures like Silioco on Insulator (SOI) MOSFET and Double Gate (DG) MOSFET are proposed to reduce these effects. With one extra gate, the gate to channel coupling is doubled resulting in good reduction of SCEs. As two gates control the channel from both sides, DG MOSFET achieves better electrostatic control over the channel. So we can perform more scaling of gate length. For all these reduction of negative effects DG MOSFET is better alternative to conventional Bulk MOSFET and it provides higher current density, higher sub threshold swing at low supply voltages [9].

Fig. 3 shows a general structure if a DG MOSFET. The gate on the upper side is called the top gate and another one is in the lower side of the channel, known as bottom gate. Due to these two gates the gate to channel coupling gets doubled and hence the short-channel effects drastically reduce.

### D. CNTFET

Carbon nanotubes (CNT) are rolled up sheets of graphene. CNT is auspicious substitute to conventional silicon technology for future nanoelectronics because of their unique electrical properties [5]. One of the most imaging features of carbon nanotube is its application on electronics field especially in carbon nanotube field effect transistor (CNTFET). CNTFET is a three terminal device consisting of a semiconducting nanotube or an array of nanotubes bridging source and drain contacts and acting as a carrier channel which is turned on or off via gate contact. The switching operation of CNTFET is controlled by the modulation of Schottky barrier formed at the nanotube and metal (drain/source) contacts. When  $V_g = 0V$ , the barrier height is so large that the minimum current ( $I_{off}$ ) occurs. But above the thresholds the Schottky barrier is very thin which enables hole injection from the source or electron injection from the drain contact into the nanotube. So the tunneling resistance controls the on current and hence delivers more on current ( $I_{on}$ ) [10] [11].

Schematic of CNTFET is shown in Fig. 4. The model of CNTFET that is taken into consideration for simulation purpose is a single-walled carbon nanotube field effect transistor with intrinsic channel region and having chirality of (11,0).

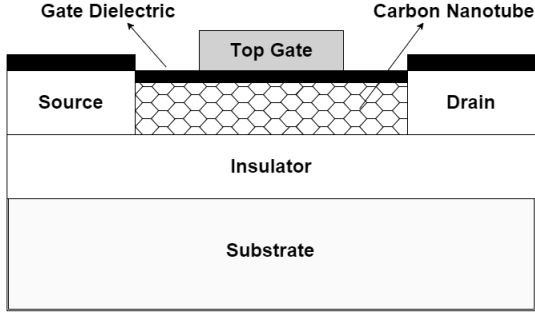


Fig. 4. Structure of a conventional n-type CNTFET

### III. SHORT-CHANNEL EFFECTS

Reduction of gate length is a trend of VLSI devices since the beginning of transistor technology (1969). Density of transistor in an integrated circuit and increase of switching speed is the main two driving reasons for channel length reduction. A transistor device is known as a short channel device when the gate length of the device is on the same magnitude as the depletion region of drain and source junctions. As channel length scaling of FET devices continues, many limitations are imposed upon the performance of the devices. These performance limiting factors are known as short-channel effects. The short-channel effects includes threshold voltage ( $V_{th}$ ) roll-off, drain-induced barrier lowering (DIBL) i.e. the reduction of  $V_{th}$  induced by drain voltage and increase of subthreshold leakage current.

#### A. Threshold Voltage ( $V_{th}$ )

$V_{th}$  depends on material properties and device geometry. Threshold voltage variation is undesirable because circuit designers would like  $V_{th}$  to be invariant with transistor dimensions and biasing conditions. So to minimize leakage power a stable  $V_{th}$  is absolutely necessary with scaled geometries. The threshold voltage of DG MOSFET and CNTFET can be expressed by (1) and (2) respectively [12] [13].

$$V_{T_0} = \Phi_{GC} - 2 \cdot \phi_F - \frac{Q_{B0}}{C_{ox}} - \frac{Q_{ox}}{C_{ox}} \quad (1)$$

Here,  $\Phi_{GC}$  is the work function difference between the gate and the channel,  $2\phi_f$  is the gate voltage necessary to change the surface potential,  $\frac{Q_{B0}}{C_{ox}}$  is the gate voltage component to offset the depletion region charge and  $\frac{Q_{ox}}{C_{ox}}$  is the gate voltage necessary to offset the fixed charges in the gate-oxide and Si-oxide junction.

$$V_{th} = \frac{aV_{II}}{\sqrt{3}qD_{CNT}} \quad (2)$$

Here,  $a = 2.49\text{\AA}$  is the lattice constant,  $q =$  charge of an electron and  $V_{II}$  is the carbon II to II bond energy, 3.033 eV.

#### B. Drain Induced Barrier Lowering (DIBL)

As channel lengths are reduced, the charge in the channel is no longer entirely controlled by the gate but to a certain degree by the drain bias as well. In long-channel devices, the potential barrier is flat along most of channel. The drain depletion region

acts to reduce this barrier at the drain boundary of the channel. For short channel devices, boundary at the drain side of the channel becomes influential over a significant portion of the channel, in comparison with the gate contact. Thus lowering the potential barrier makes it harder for devices to fully turn off and can result in significant leakage currents in their off state. DIBL can be alleviated by increasing the channel doping concentration. The DIBL of a FET device can be expressed as (3) [14].

$$DIBL = \frac{\Delta V_{th}}{\Delta V_{ds}} \quad (3)$$

An extreme case of DIBL is punchthrough in which the source and drain depletion regions overlap and create a conduction path independent of gate bias. This can either occur at the surface and renders a MOSFET useless, since the gate no longer has any influence over the channel.

#### C. Subthreshold Swing (SS)

SS indicates how effectively the flow of drain current can be stopped when gate-source voltage is less than ( $V_{th}$ ). It is an important parameter which determines the scalability limits of FETs. Small subthreshold swing in devices leads to lower leakage current consumption. So small subthreshold swing is required to provide a faster transition between off current ( $I_{off}$ ) and on current ( $I_{on}$ ). The subthreshold swing for a FET device can be expressed as (4) [15].

$$SS = \frac{dV_{GS}}{d(\log I_{DS})} \quad (4)$$

Where  $V_{GS}$  is the gate voltage and  $I_{ds}$  is the drain current. SS is calculated from  $I_d$ - $V_g$  characteristics curve using this equation.

#### D. $I_{on}/I_{off}$ Ratio

$I_{on}/I_{off}$  ratio is the figure of merit for having high performance (more  $I_{on}$ ) for the transistor. A low leakage power consumption (less  $I_{off}$ ) is required to decrease static power dissipation. High on current reduces the gate switching delay. Therefore a high on-off current ratio indicates improved FET's performance. The  $I_{on}/I_{off}$  ratio is expressed by (5) [16].

$$I_{on}/I_{off} \text{ ratio} = \log_{10} I_{on}/I_{off} \quad (5)$$

### IV. SIMULATION ANALYSIS AND RESULT

Numerous transfer curves ( $I_d$ - $V_g$  curves) and current voltage curves ( $I_d$ - $V_d$  curves) of Bulk MOSFET, SOI MOSFET, DG MOSFET and CNTFET varying channel length are simulated using nanoHUB simulator tools: MOSfet, CNTFET Lab, FETToy etc. and influences of this parameter on threshold voltage, subthreshold swing and  $I_{on}/I_{off}$  ratio are presented in this section. Moreover a detailed observation and reason behind the effects of this parameter variations are elucidated in different subsections. FETToy 2.0 is a set of MATLAB scripts using the NEGT function that calculate the ballistic I-V characteristics for a conventional MOSFETs. The CNTFET Lab simulator utilizes Non-Equilibrium Greens' Function (NEGF) techniques using a pz-orbital nearest-neighbor tight binding. The input parameters and different physical values of the materials of the devices are shown in TABLE I.

TABLE I. PARAMETERS USED IN SUMULATION

Parameters	Bulk MOSFET, SOI MOSFET and DG MOSFET	CNTFET
Channel length	Variable	Variable
Oxide thickness	2nm	2nm
Dielectric material	SiO <sub>2</sub>	SiO <sub>2</sub>
Dielectric constant	3.9	3.9
Source/Drain doping Concentration	2e20/cm <sup>3</sup>	2e20/cm <sup>3</sup>
Buried Oxide Thickness (For SOI only)	50nm	—
Chirality	—	(11,0)
Nanotube Diameter	—	0.8611nm
Temperature	300K	300K
Gate to source voltage	0.5-1 V	0.5-1 V

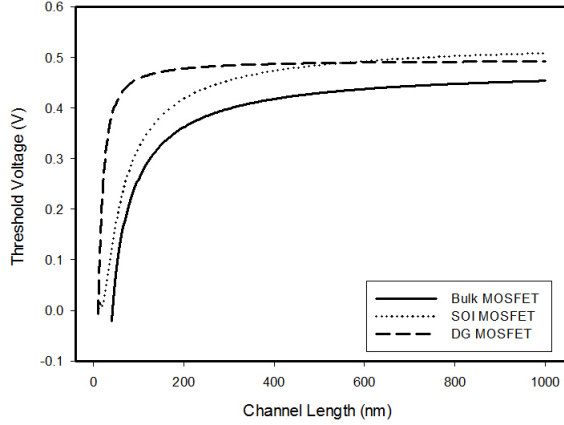


Fig. 5.  $V_{th}$  roll-off for Bulk MOSFET, SOI MOSFET and DG MOSFET

#### A. Bulk MOSFET, SOI MOSFET and DG MOSFET

The FET devices have become smaller and smaller in order to achieve higher packing density. These devices characteristics and performances are changed with the variation of channel length. So it is expected that the channel length plays key role in FET characteristics and performance.

Fig. 5 shows drastic degradation of threshold voltage in DG MOSFET below 30nm whereas SOI MOSFET and Bulk MOSFET show rapid degradation below 100nm and 200nm respectively. As the channel Length reduces, the ability of the gate electrode to solely control the charge distribution in the channel is reduced. Due to the arising short channel effects, the field originating from the source/drain can influence the channel region. Thus “threshold voltage roll-off” occurs.

In Fig. 6, the DG MOSFET shows SS above 100mV/decade below 40nm whereas Bulk MOSFET and SOI MOSFET exhibit comparatively high SS below 100nm and 50nm respectively. We know that the sensitivity of the surface potential to gate voltage variation is evaluated by SS. The reduction of channel length produces SCE, which in turn reduces this sensitivity. Thus SS increases as channel length reduces.

In Fig. 7, DG MOSFET shows higher  $I_{on}/I_{off}$  ratio at lower channel length than SOI MOSFET and Bulk MOSFET respectively. DG MOSFET shows rather satisfactory performance as channel length decreases by keeping the  $I_{on}/I_{off}$  ratio at  $10^3$  ranges. The  $I_{on}/I_{off}$  ratio of DG MOSFET

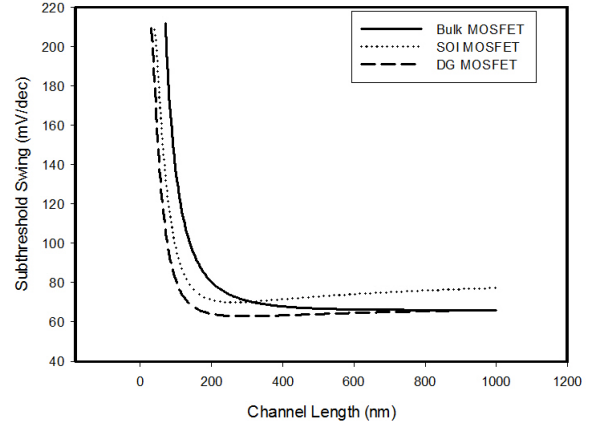


Fig. 6. SS vs channel length for Bulk MOSFET, SOI MOSFET and DG MOSFET

decreases below 70nm whereas the  $I_{on}/I_{off}$  ratio of Bulk MOSFET and SOI MOSFET decreases below 200nm and 150nm respectively. DG MOSFET shows better on-off current ratio due to its high tolerance to SCE. The bulk and SOI MOSFET are more susceptible to SCE and for comparatively high channel length they exhibit high leakage current.

From these observations it is concluded that DG MOSFETs channel length can be scaled down more than SOI MOSFET and Bulk MOSFET respectively. DG MOSFET can suppress the SCEs because the bottom gate can effectively screen the field penetration from the drain. On the other hand, SOI MOSFETs have a higher immunity to SCE compared with Bulk MOSFET’s because of the difference in source/drain junction depths between the devices.

#### B. CNTFET vs DG MOSFET

Because of superior short channel performance of DG MOSFET compared to Bulk MOSFET and SOI MOSFET, we conducted our performance study to observe the SCEs only for DG MOSFET and CNTFET.

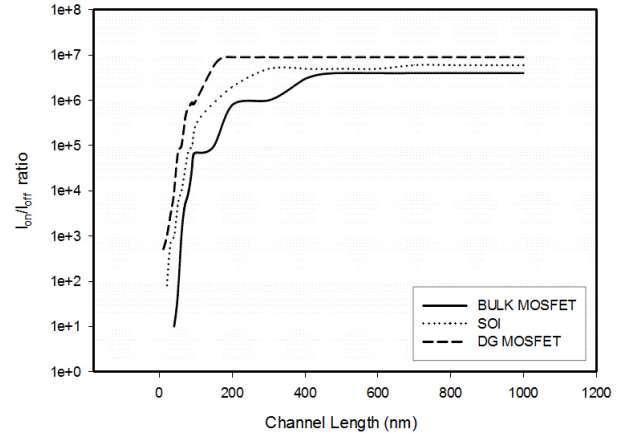


Fig. 7.  $I_{on}/I_{off}$  ratio vs channel length for Bulk MOSFET, SOI MOSFET and DG MOSFET

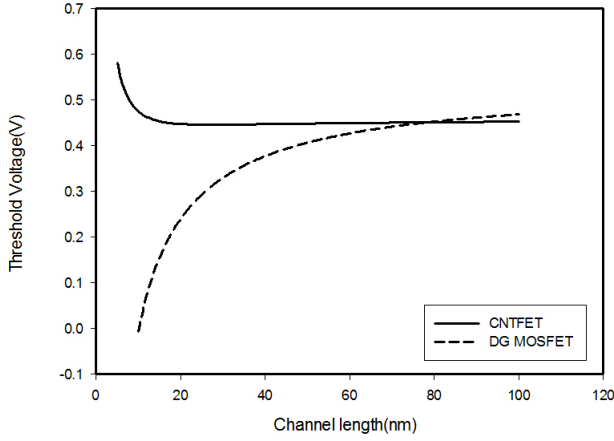


Fig. 8.  $V_{th}$  vs channel length for DG MOSFET and CNTFET

From Fig. 8, it is observed that at below 10 nm channel length the threshold voltage is increased rapidly in case of CNTFET device whereas in case of DG MOSFET device the threshold voltage decreases drastically below 30 nm channel length. For conventional MOSFETs in nanometer regime both quantum capacitance  $C_q$  and insulator capacitance  $C_i$  have significant impact on gate capacitance  $C_g$  and thus threshold voltage. So as  $C_q$  increases  $C_g$  increases and threshold voltage decreases. But CNTFET has the unique property of quantum confinement at deep nanometer channel lengths. CNTFETs  $C_g$  drastically decreases with the reduction of the diameter of CNT. This in turn drastically increases the threshold voltage with the reduction of channel length below 10nm [17].

Fig. 9 shows the subthreshold swing variation of DG MOSFET and CNTFET due to channel length reduction. In subthreshold region, DG MOSFET swings exponentially after 50-40nm whereas the SS of the CNTFET stays somewhat stable even after the channel length is decreased to 10nm. CNTFET offers high carrier mobility, large mean free path, ballistic conduction and less heat dissipation which makes it immune to most short channel effects. As there is no scattering in the channel formed using CNT and due to its excellent electrostatics and gate control, scaling of CNTFET offers much stable SS.

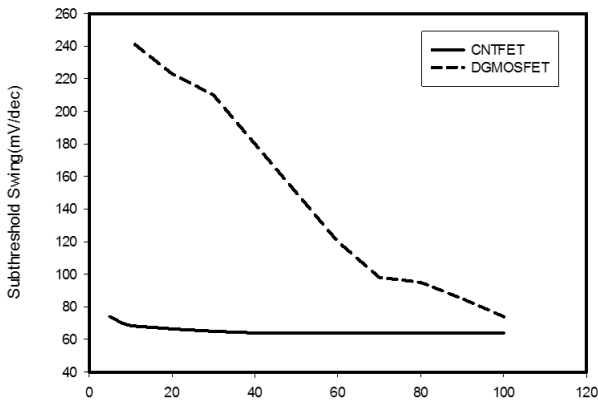


Fig. 9. SS vs channel length for DG MOSFET and CNTFET

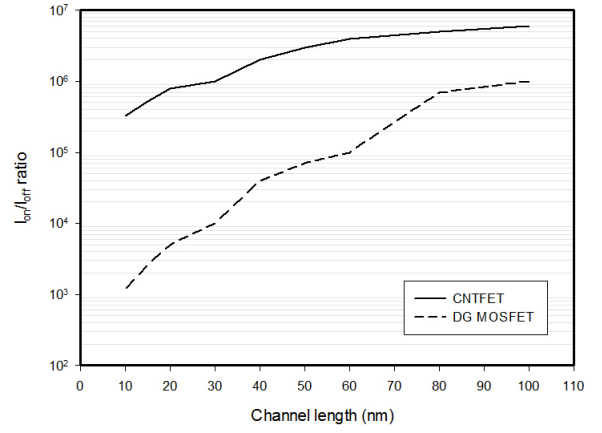


Fig. 10.  $I_{on}/I_{off}$  vs channel length for DG MOSFET and CNTFET

In Fig. 10  $I_{on}/I_{off}$  ratio for DG MOSFET and CNTFET is plotted with respect to channel length reduction. CNTFET shows better  $I_{on}/I_{off}$  ratio than DG MOSFET due to its non resistive ballistic conduction property of electrons at room temperature. As the scattering mechanism is totally ignored, the current density of CNTFET is much higher than DG MOSFET. The on-off ratio of CNTFET could be tuned between  $10^6$  and  $10^9$  order of magnitude, which is much higher than DG MOSFET.

### C. Performance Evaluation

Summary of our findings is shown in TABLE II.

TABLE II. IMPACT OF SCALING CHANNEL LENGTH

FET Type	Exhibits $V_{th}$ roll-off below	SS increases above 100mV/dec. below	$I_{on}/I_{off}$ ratio decreases below
Bulk n MOSFET	Lc=200nm	Lc=100nm	Lc=200nm
SOI MOSFET	Lc=100nm	Lc=50nm	Lc=150nm
DG MOSFET	Lc=30nm	Lc=40nm	Lc=70nm
CNTFET	Never (Shows rapid gradation below 10nm)	Increases but does not exceed 100mV/dec.	Lc=10nm

It is seen from the TABLE II that CNTFET can be scaled down more than DG MOSFET, SOI MOSFET and Bulk MOSFET respectively. Finally we designed a CNTFET and a DG MOSFET with 30nm channel length to evaluate the performance between the devices. From the simulation results we performed numerical analysis of the threshold voltage variations due to the impact of reduction in channel length. Our analysis shows that when channel length is reduced a CNTFET creates only 1.11%  $V_{th}$  variation whereas DG MOSFET due to short-channel effects creates 39.33%  $V_{th}$  variations. Thus it is evident that CNTFETs have less threshold voltage variations, higher drive current, better subthreshold swing, lower leakage current and thus better scaling capability compared to DG MOSFET.

### V. RELATED WORKS AND RESEARCH CONTRIBUTION

There are few numerical works on FET's performance based on reducing channel length. K. K. Young analyzed that

SCE is well suppressed in thin film SOI MOSFETs when compared to Bulk MOSFETs [18]. Ankita Wagadre analyzed the performance of DG MOSFET over conventional MOSFET for reducing SCE [19]. Some unique features and special properties like large mean free path, excellent carrier mobility and improved electrostatics at nanoscale makes carbon nanotube the promising candidate for solving the limitation of scaling in silicon transistors [20]. Recently finding out the remarkable progress in performance and physical understanding of carbon nanotube based FETs have started through research. Sanjeet Kumar Sinha and Devi Dass analyzed the effect of different parameters on the performances of CNTFET [17] [21]. So far researchers have analyzed the short-channel effects for only one or two types of FETs whereas in this work short-channel effects of four different structured FETs have been investigated and also performance evaluation using numerical analysis of the simulated data is performed. Our findings can provide knowledge about the optimum parameters required for enhanced FET design with superior performance. Our future research plan includes detailed study of other parameters like gate insulator thickness, gate insulator material and temperature on FET performances.

## VI. CONCLUSION

A study of the effect of scaling channel length is performed using nanoHUB simulation tools. The SCEs like threshold voltage roll-off, subthreshold swing and  $I_{on}/I_{off}$  ratio which are very important issues related to performance analysis of short-channel MOSFETs were discussed in this research. Our analysis reveals that CNTFETs channel length is more scalable compared to DG MOSFET, SOI MOSFET and Bulk MOSFET respectively. Moreover the CNTFET provides zero  $V_{th}$  variation, a much less SS in the subthreshold region than DG MOSFET and thus consumes very low leakage power as channel length decreases. Thus CNTFET technology is found to offer devices with much better scalability and enhanced performance in terms of threshold voltage roll-off, subthreshold swing and  $I_{on}/I_{off}$  ratio compared to conventional Bulk MOSFET, SOI MOSFET and DG MOSFET structure thereby providing scope for further miniaturization of devices.

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# Microcontroller Based Automated Domestic Security System for Bangladesh Perspective

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**Abstract**—Domestic security is one of the leading concerns amongst citizens of Bangladesh. An efficient but low-budget automated security system to prevent intruders from gaining access to one's residence is now of cardinal importance. Fortunately, the advent of microcontrollers have opened marvelous realms in the field of domestic digitization, providing expeditious automated systems devoid of complexity and exorbitant costs, which is supportive to the socio-economy, component availability and maintenance skills of technicians in typical developing countries such as Bangladesh. This paper focuses on the design and construction of an automated security system using readily obtainable electronic components which can be easily assembled and maintained, but at the same time, providing a strong, seamless and efficient solution to domestic security.

**Keywords**- Microcontroller, Domestic Security, PIR Sensor

## I. INTRODUCTION

A common issue amongst citizens of Bangladesh, particularly residents of its capital city, is the absence of reliable domestic security measures. The crime index of Bangladesh was 68.56% in 2016, while that of Dhaka, the capital city, was even higher: an index of 69.57% from January 2016 to April 2016. The index for breaking into homes and theft was 71.57% [1]. The data makes it discernible that the residents of this country, especially those residing in Dhaka city, require efficient security measures. Most house-owners rest the security of their houses on the reliance and ability of security guards. However, there are several shortcomings:

1. Most security guards in the city have no professional training. Hence, most of them are unable to cope up with emergency situations.
2. Security guards cannot always keep an eye on every nook and corner of the residence all the time.
3. Security guards cannot provide 24/7 service.
4. Often, security guards are found to be circuitously involved in the crimes mentioned in Figure 1.

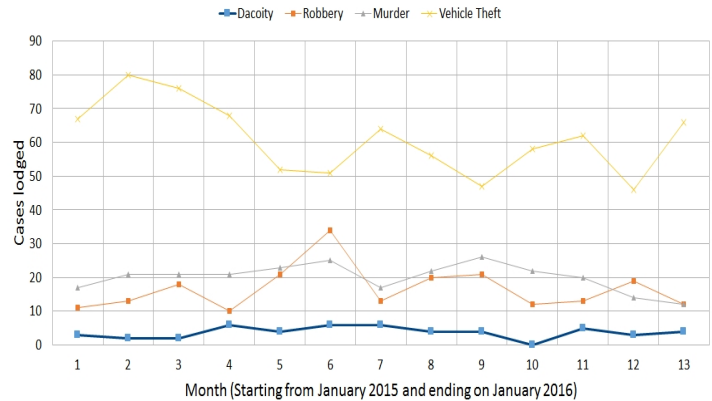


Figure 1. An example of the types and incidence of cases lodged by Dhaka Metropolitan Police in 2015-2016 [2]. Most of these crimes, particularly those that involve breaking into houses and stealing of property could be averted if the residents had proper security measures.

Automated security systems have been around for quite a long time and are being used extensively in restricted areas such as banks, vaults, airports and museums. However, most of these systems are expensive and require skilled engineers to be assembled and maintained. Furthermore, most of these systems involve closed-circuit cameras for monitoring purposes, hence, a dedicated 24/7 workforce is necessary for monitoring the camera feed. As a result, the quandaries present with employing security guards are somehow integrated in security systems available in the market. Such systems are not ideal for use in homes; hence, a new security system that curtails the mentioned weaknesses is imperative.

Considering the socioeconomic status of citizens and level of skill of locally trained technicians of Bangladesh, an automated security system that uses microcontrollers would be advantageous for the residents looking to improve the security of their homes.

An embedded system is defined as a system controlled by a computer but whose primary function is not computational [3]. The last part of the definition implies that an embedded system solves a real world problem without apparently letting the user worry about all the calculations and computational processes that occur in the background. Microcontrollers are merely the “computers” that power embedded systems.



This paper presents the design and implementation of a security system that uses the AVR family of microcontrollers.

## II. LITERATURE REVIEW AND RELATED WORKS

From Bangladesh, we found the work of one group to be closely related to our work. It was a thesis project by T. Muhtadi et al. entitled “Museum Security System” [4]. The authors designed a cheap security system for use in museums. They used photoresistors and passive infrared sensors as the sensor circuitry, omitting the force sensitive resistor used in our designed system. This system uses interaction with android applications and omits use of physical interaction present in their system. This system, costing about the same as their system, incorporates more features such as integration with android applications, use of three separate sensors rather than two for seamless security, incorporation of an attention grabbing alarm circuitry using light and sound and use of flexible methods to operate the entire system. We have diminished the existence of software bugs in the system, for example, the system being unable to disarm once the alarm circuitry being activated, present in the Museum Security System.

## III. MATERIALS AND METHODS

### A. Method of Operation

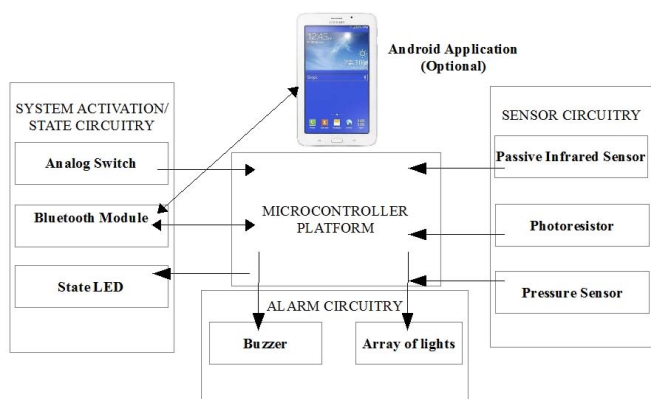


Figure 2. Block diagram of the designed automated domestic security system. Black lines portray the flow of information from each module to another.

The block diagram in Figure 2 describes the system of operation and design of the security system. The system is constituted of primarily four parts. The microcontroller platform is responsible for controlling the entire control system. The sensor circuitry detects the presence of intruders through the application of three sensors for impeccability and efficacy. The system activation/state circuitry is used to activate the security system. It is also used to know the current state of the security system, for example: whether the system is armed or not. The alarm circuitry is activated whenever the sensor circuitry is “disturbed”. It warns the user through the use of light and sound.

Since, android operated smartphones are now within reach of most citizens of this country, the system has been designed

to facilitate remote operation and control via android application. However, considering the fact that many residents of this city yet don't own a smartphone, the option to activate and deactivate the system using a simple switch has also been included in the design.

The system is first activated via the android application or the switch. The state LED glows instantly, informing the user that the system is armed and ready for use. If any of the three sensors detect any corresponding form of disturbance, the data is sent to the microcontroller. The microcontroller platform then activates the alarm circuitry, which warns the user of the presence of infiltrators. At the same time, the microcontroller commands the Bluetooth module to display a warning message on the android application.

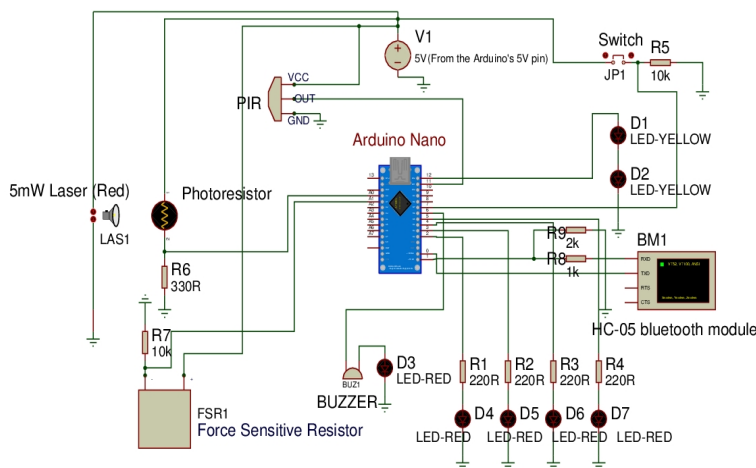


Figure 3. Schematic Diagram of the entire system

### B. The Microcontroller Platform

In our designed system, the Arduino Nano (version 3.0) microcontroller development platform has been used, which is powered by the Atmel Atmega 328P microcontroller. Although Arduino allows faster prototyping and easier programming, the Arduino is not suitable for commercial use, as space taken up by the Arduino is large compared to microcontrollers and cost of the finished product will increase if one employs the Arduino platform.

Hence, the actual security system must be made using the actual Atmel Atmega 328P microcontroller.

### C. The Sensor Circuitry:

In order to increase the success rate, faultlessness and efficiency of the security system, three types of sensors have been used:

1. **Passive Infrared Sensor:** A passive infrared sensor detects electromagnetic radiation in the Infrared region of the electromagnetic spectrum. Warm blooded animals emit Infrared Rays, hence, the sensor detects human motion by picking up infrared rays emitted by intruders. Such sensors normally consist of a translucent window through which infrared energy enters the sensor. The rays then strike the surface of a set of sensors made from pyroelectric materials,

which generates a potential difference across the output pin of the sensor. This voltage drives the output of the sensor, which is high when the voltage is high.

In this particular project, the HC-SR501 PIR sensor module has been used. This particular sensor can detect infrared radiation within 7 meters of the sensor at an angle of 100 degrees as shown in Figure 7, which provides a broad field of view. The sensor has a large bandwidth for operating temperature, ranging from -15 degrees Celsius to 70 degrees Celsius, making it ideal for use in diverse climatic regions such as Bangladesh. In a nutshell, the sensor provides efficient sensing at an affordable price.

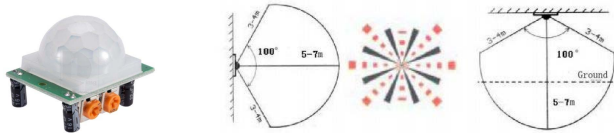


Figure 4. (Left) The HC-SR501 PIR sensor module; (Right) The range of the sensor in three dimensions [Image courtesy of <http://www.jamesrobertson.eu/images/2013/feb/10/hc-sr501-pir-sensor-range.jpg>]

2. Photoresistor: The photoresistor is a light sensitive resistor whose resistance decreases with an increase in light intensity falling on the resistor. Photoresistors are created from semiconducting devices such as Cadmium Sulfide.

In this project, the photoresistor has been used in conjunction with a laser emitter module. The photoresistor is connected to a potential divider circuit. Light from the laser emitter module is incident on the surface of the photoresistor. If the intruder attempts to break into the house through the laser beam, then the light beam between the emitter and photoresistor is broken, which increases the voltage drop across the photoresistor. This is detected by the microcontroller platform, which then activates the alarm circuitry.

In this system, a photoresistor of maximum resistance of approximately 1 Mega Ohms has been used.

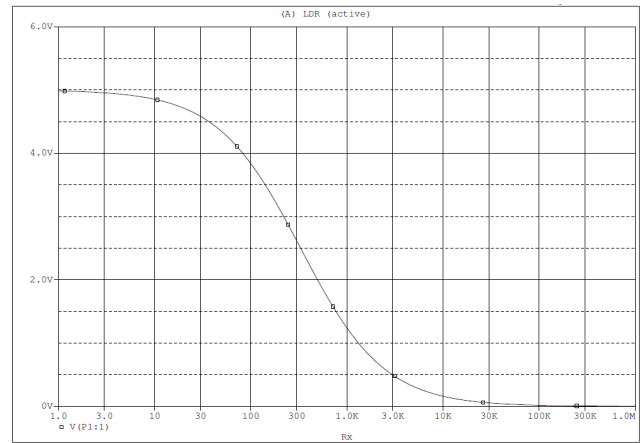
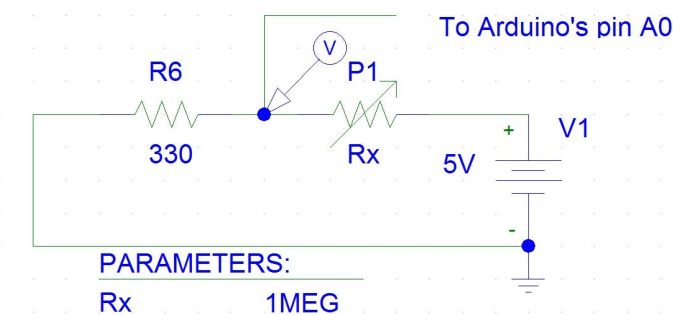


Figure 5. (Top) Schematic of the photoresistor circuit (Bottom) Voltage across A0 pin of Arduino against Resistance of photoresistor, simulated in PSpice 9.1

Mathematically:

$$V_{A0} = \left[ \frac{R_{LDR}}{R_{LDR} + R_6} \right] V_{Input} \tag{1}$$

where,

$V_{A0}$  = Voltage across pin A0 of the Arduino Board in volts

$R_{LDR}$  = Resistance of photoresistor in Ohms

$R_6$  = Resistance of the other resistor in Ohms (330 Ohms in this case)

$V_{input}$  = Input voltage across the potential divider circuit in volts (5V in this case)

Arduino's analog pins by default can measure voltages from 0V to 5V by subdividing the voltages in 1024 different values, that is, 10 bits. Thus, if the voltage across pin A0 is 2.5V, then the value of this voltage would be half of 1024, which is 512 [5]. It is possible to change the maximum voltage that can be measured by an analog pin using the AREF (Analog Reference) pin on the Arduino board.

In the main program, the microcontroller has been set to activate the alarm circuitry if the input value of pin A0 is less than 450. According to the resolution of analog pins in the previous paragraph, a value of 450 corresponds to a voltage of 2.20 V. From the graph in Figure 5, the resistance of the photoresistor is approximately 0.42 kilo Ohms at this voltage. For a typical photoresistor, the relationship between light intensity and resistance of photoresistor is given by:

$$R_{LDR} = \frac{500}{Lux} \tag{2}$$

where,

Lux = Intensity of Light measured in Lux

$R_{LDR}$  = Resistance of photoresistor in kilo Ohms

From equation 2, when the resistance across the photoresistor is 0.42 kilo Ohms, the light intensity is 1190 Lux.

1190 Lux is a reliable value. The value ensures that cunning infiltrators cannot trick the system by focusing a torch light on the photoresistor while blocking the laser beam.

Figure 6 shows the arrangement of the laser emitter module and the photoresistor to secure a window. The use of small reflecting mirrors allows the use of only a single laser emitter/photoresistor pair to secure a particular structure of the house rather than using a plethora of sensors, which reduces the cost of the security system to great extents.

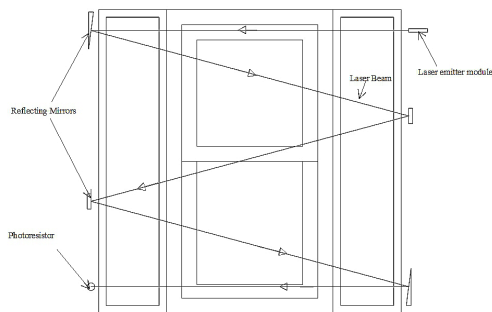


Figure 6. Arrangement of the laser emitter module and the photoresistor to secure a window using mirrors.

3. Pressure Sensor: A force sensitive resistor, commonly known as pressure sensor, is a variable resistor whose resistance decreases with an increase in force applied on the resistor.

Force sensitive resistors consist of a conducting polymer sheet, which itself is constituted of both conducting and non-conducting particles. When a force is applied on the resistor, the number of conducting particles that touch the conducting electrodes increases, hence, resistance of the resistor decreases with increasing force [6].

The sensor has been meant to guard doors. The sensor, akin to the photoresistor, has been connected to a potential divider circuit. When the intruder steps on the resistor, the resistance of the force sensitive resistor decreases, thus, voltage drop across the force sensitive resistor decreases. This is detected by the microcontroller platform, which immediately activates the alarm circuit.

In this particular security system, a square shaped force sensitive resistor (Part number 406) manufactured by Interlink Electronics has been employed. The resistor has a sensing area of 1.5" X 1.5" and a thickness of 0.018". When no force is applied, then the resistance of the resistor is greater than 1 Mega Ohms [7].

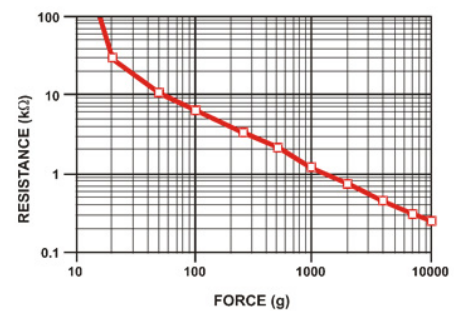
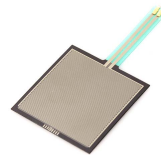


Figure 7. (Left) A 406 force sensitive resistor from Interlink Electronics. (Right) Resistance versus Force curve of the 406 force sensitive resistor. [Image courtesy of <https://cdn.sparkfun.com/assets/parts/2/9/6/8/09376-1.jpg>]

The graph in Figure 7, taken from a datasheet by the manufacturer, shows the resistance versus force curve for a typical force sensitive resistor [8].

In the main program, the microcontroller has been set to trigger the alarm circuit if the value of pin A1 is greater than 400. From the subdivision of voltages into 1024 values discussed in the photoresistor section, the value of 400 corresponds to a potential difference of 1.95V. From the graph in Figure 8, the resistance of photoresistor with a voltage of 1.95V is approximately equal to 15.6 kilo Ohms. From the graph in Figure 7, this corresponds to a force between 30 and 40 grams. This threshold force ensures that non-human subjects such as insects are ignored by the security system.

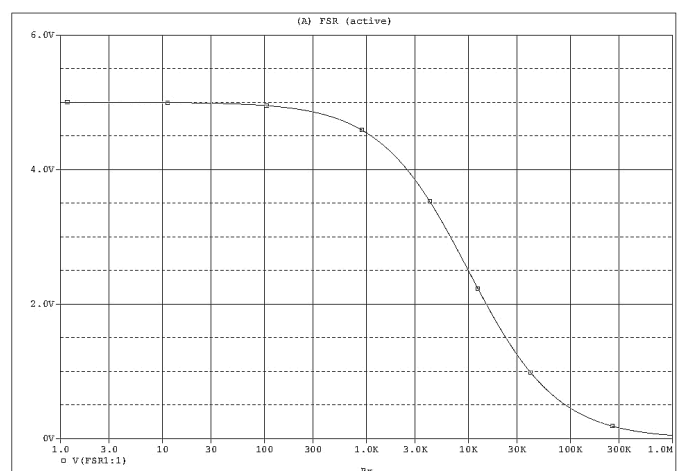
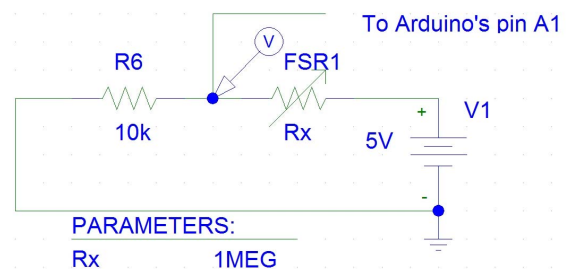


Figure 8. (Top) Schematic of the Force Sensitive resistor circuit (Bottom) Voltage across A1 pin of Arduino against resistance of the force sensitive resistor, simulated in PSpice 9.1

#### D. Alarm Circuitry:

The alarm circuitry consists of two parts:

1. Buzzer: A low voltage piezo-buzzer is connected to pin 6 of the Arduino, which is activated if the sensor circuit detects any disturbance. The buzzer generates a continuous high pitched (2-3 kilo Hertz) noise if there is a potential difference across the buzzer pins.

Using an android application called Sound Meter by Smart Tools, the sound pressure level of the buzzer was measured and found to be 82 decibels, which is equal to the sound intensity of a typical alarm clock. Hence, the buzzer guarantees that the house owner is bound to wake up once the security system detects an intruder.

2. Array of lights: An array of red light emitting diodes (LEDs) has been connected to pins 2, 3, 4 and 5 on the Arduino Board. The LEDs flash once the alarm system is activated.

The Arduino has been programmed to flash the LEDs in a pattern similar to the scanner light that was attached to the frontal part of the car featured in the Knight Rider television series [9].

#### E. System Activation/State Circuitry:

The system facilitates both remote and manual switching. This circuitry consists of three parts:

1. The State LED: Two orange LEDs have been connected in series and connected between the ground pin and pin 12 of the Arduino. The LEDs glow once the system has been armed, that is, activated and ready for use.

2. The Analog Switch: A push button has been added to the system to allow the user activate the system manually. Schematic of this part of the circuit is shown below:

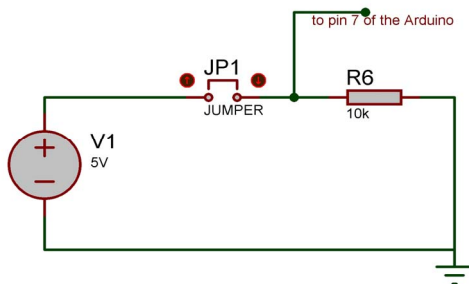


Figure 9. Schematic of the push button circuitry

If the push button is pressed the first time, then the Arduino detects a change in potential difference across pin 7, which then activates the security system. If the button is pressed again, then the system is deactivated.

3. Bluetooth Module: To facilitate remote activation of the security system using an android application, a HC-05 Bluetooth module has been added to the Arduino. The module allows serial communication between the Arduino and other applications via Bluetooth. The Fritzing diagram shows the connections from the Bluetooth module to the Arduino Board.

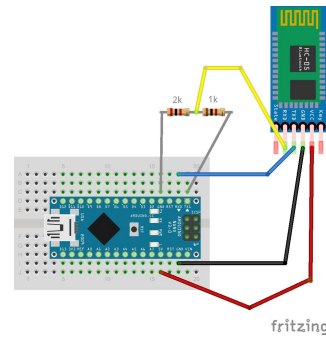


Figure 10. Fritzing diagram of the connections of the Bluetooth module

An android application called Bluetooth Terminal can be used to communicate with the security system.

When the security system is turned on for the very first time, then the system takes 25 seconds to arm itself, which is displayed on the application as shown in Figure 11. The system can then be activated by typing 'A' from the application. If the system then detects any intruders, besides activating the alarm system, a warning message entitled "Warning! Warning! Intruder Alert" is sent to the application by the microcontroller platform via the Bluetooth module.

The application does have several shortcomings, such as having to pair with the system manually and lacking a graphical user interface. Hence, a dedicated android application especially developed for this system would be beneficial.

The range of the Bluetooth module is only 10 meters. This does not pose any significant problem because the remote switching process was developed to be used from near the house. Furthermore, using other wireless networks increase the cost of the security system to great extents.

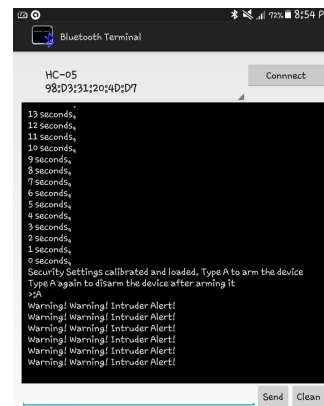


Figure 11. Screenshot of the Android application in action

#### IV. IMPLEMENTATION, COST & COMPARATIVE ANALYSIS

Figure 12 shows a typical setup of the designed security system. In this setup, two of each type of sensor has been used in various parts of the house. The sensors have been placed strategically to ensure that the house-owners are not deemed as intruders, for example: PIRs have not been used in the bedroom and dining room. The wires connecting the various is to be piped through covers attached at very low positions to the

wall, so that the pipes don't mar the aesthetic value of the house. For safety reasons, two buzzers have been used: one in the bedroom of the home-owner and the other in the security guard's room, so that the guard may also be alerted as well if any intruder tries to break into the house.

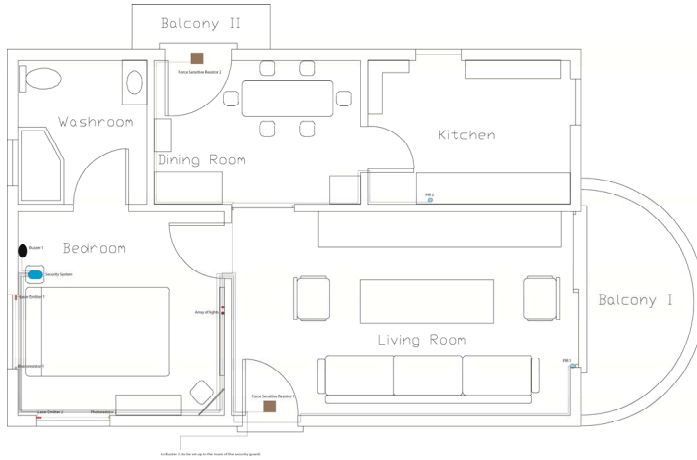


Figure 12. Typical sensor placement in a particular house.

The number of sensors may be varied depending on the house owner. The cost of the security system will increase as the number of sensors increases.

The main box housing the microcontroller is set in the bedroom as shown in Figure 12. It is powered by a simple AC-DC adapter. In order to ensure that the system operates when a power cut occurs, an uninterruptible power supply will supply the low power necessary to operate the security system.

TABLE I. BILL OF MATERIALS FOR PROTOTYPING THE SECURITY SYSTEM

Feature	Quantity	Unit Price (USD)	Cost (USD)
Arduino Nano 3.0	1	8.21	8.21
HC-SR501 PIR Sensor	1	2.35	2.35
5 mW Laser Emitter Module	1	3.43	3.43
Photoresistor (1M)	1	0.07	0.07
Force Sensitive Resistor (406)	1	11.65	11.65
Buzzer	1	0.26	0.26
HC-05 Bluetooth Module Breakout	1	8.09	8.09
Analog Switch	1	0.03	0.03
LED Yellow - 5mm	2	0.02	0.04
LED Red - 5mm	5	0.02	0.10
Miscellaneous (jumper wires, resistors)	-	-	0.75
<b>TOTAL</b>			<b>34.98</b>

Table I shows that the prototype was built in under \$35 (all materials were bought from techshopbd.com) [10]. A commercial prototype of this security system consisting of the same number of sensors would cost less than the stated price. However, the cost of the complete security system would

increase since the users would want to use more than one of each type of sensor, as shown in Figure 12. It is estimated that the minimum commercial value of such a security system would be somewhere between \$60- \$80, which would increase if the user wants to employ more sensors.

It is to be noted that the minimum value of a CCTV camera is around \$40. Furthermore, CCTV cameras also require other machinery such as a monitor for continuous monitoring, so total cost will rise. Thus, it is evident, that the designed security system has a greater value for price, which will attract more customers.

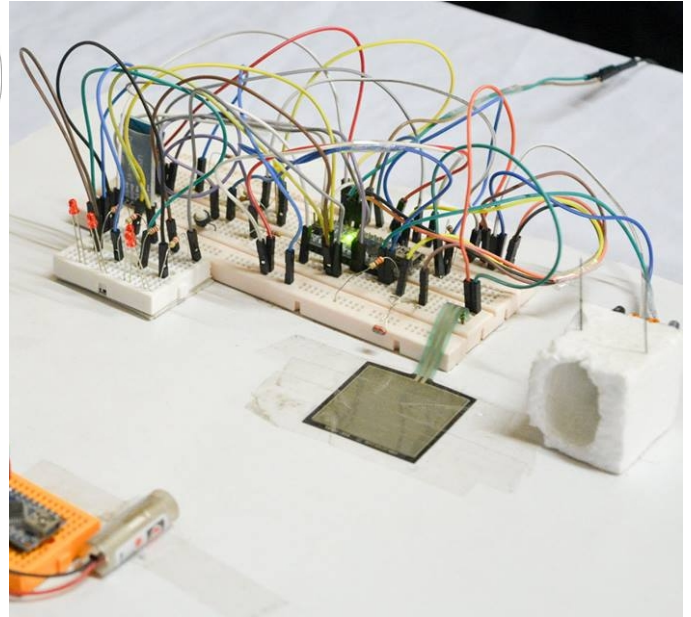


Figure 13. Actual prototype of the system built by the author. The force-sensitive resistor taped to the base, the laser emitter module and the array of lights built on the mini breadboard can be seen clearly. The PIR sensor is hidden inside the Styrofoam structure to prevent noise from affecting the output of this sensor.

## V. RESULTS, CONCLUSION AND FUTURE WORK

The designed security system was merely a prototype and was not tested on a large scale. However, the prototype was tested under various conditions such as change in light levels and speed of objects passing through the laser beam and in front of the PIR sensor. The prototype detected the intruder almost every single time (statistical data was not recorded as there was no scope to test the product on a large scale).

However, several modifications need to be brought to the commercial prototype:

1. The Arduino is to be replaced by an actual microcontroller, which is 3.5 times cheaper than the Arduino Nano [11][12].
2. For safety reasons, the buzzer used in the prototype needs to be replaced by a more powerful buzzer such as an AC buzzer. As a result, a relay circuitry would be needed to activate such buzzers.

3. The LEDs used in the array of lights needs to be replaced by more powerful light sources such as LED bulbs.
4. The photoresistor needs to have only a narrow bandwidth of light intensity so that cunning intruders may not trick it through a torch light.

<https://www.techshopbd.com/product-categories/boards/1454/arduino-nano-v3-0-china-techshop-bangladesh>. [Accessed: 11- Apr- 2016].

Microcontroller based automated domestic security system has been designed keeping in mind the socioeconomic status of the citizens of this country. However, the security system may be improved in certain ways, which will, unfortunately, increase the cost of the system:

1. Wi-Fi or GSM may be used to control the security system remotely. As a result, the user may get an intrusion alert on his/her mobile phone via SMS or E-mail instantly when an intrusion occurs when he/she is away from home.
2. Cameras may be attached to the security system that will click photos instantly once an intrusion occurs.

The system may be used in offices and industries parallel to current security systems being used there without any modifications to the older security system. The security system can be used besides using CCTV cameras. As a result, the designed system is not only limited to homes, but can be used in offices and banks as well.

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# An Expert System to Suspect Chronic Kidney Disease

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**Abstract**—Chronic Kidney Disease (CKD) is one of the major health problems in the world. According to statistics, many people die of CKD, because the disease is not suspected timely. Therefore, suspicion of CKD plays a vital role to save many lives. But the suspicion of CKD is hampered due to some uncertainties. However, this paper represents an expert system that suspects CKD from the observation of signs-symptoms of patients. Patient's history is also considered for this purpose. Belief Rule-Based Inference Methodology Using Evidential Reasoning Approach is used to develop the system. This system handles uncertainties that come from signs-symptoms and clinical domain knowledge. Real patients' data, collected from Chittagong Medical College & Hospital, are used to construct the knowledge base. The physician's consultation is also considered in this case. The system is tested over 95 patients and it has been observed that the system is more efficient in suspicion of CKD than the manual system.

**Keywords**—Belief Rule Base (BRB), Belief Rule Base Inference Methodology using Evidential Reasoning (RIMER), Expert System, Chronic Kidney Disease (CKD), Uncertainty

## I. INTRODUCTION

The condition of irreversible kidney damage is considered as Chronic Kidney Disease (CKD), which can reach up to end stage renal disease (ESRD) [1]. It is considered as a major public health problem. Some 13% of US population is suffering from CKD [2], [3]. The number of ESRD patients was approximately 14500 in 1978 and it increased to 100359 in 2002 [4]. The patients of CKD related to dialysis and transplantation was about 340000 in 1999 which increased up to 651000 in 2010 [4], [5]. 10% adult people in UK are suffering from CKD [6]. The number of the CKD patients is not small in the developing countries like Bangladesh, India etc. Therefore, CKD is a fact of great concern for the people around the world. Though medical science has been developing and treatment of CKD is available, the death rate is not decreasing in that proportion.

Because, CKD is not suspected at the early stage of the disease and treatment for CKD is not provided in time. So it becomes clear that, an early suspicion of CKD can save many lives. Hence, there should be a system to suspect Chronic Kidney Disease. The development of such a system named "An Expert System to Suspect Chronic Kidney Disease" is presented in this paper. This system is developed based on Rule-based Inference Methodology using Evidential Reasoning (RIMER) [7] approach, which suspects CKD from signs, symptoms and histories of the patients. The system is capable of handling uncertainties. Uncertainties can exist in both sign-symptoms and medical domain knowledge [8]. For handling uncertainties rationally, reliably, and correctly researches have been conducted for more than four decades [9]. RIMER approach handles the uncertainties that come from the limitation of human knowledge. The paper is organized as follows:

An overview of Chronic Kidney Disease together with its Sign-symptoms and Patient's History is described in Section II. In Section III, the review of the existing work related to the proposed system is represented. Section IV provides an overview on the RIMER methodology. Section V presents the assessment of Chronic Kidney Disease. Result and discussion is presented in Section VI and Section VII concludes the paper.

## II. CHRONIC KIDNEY DISEASE

The major health problem of today's world is Chronic Kidney Disease (CKD). Chronic Kidney Disease is a heterogeneous disease that affects the function and structure of the kidney [10]. The decreased kidney function or kidney damage for three or more months is called Chronic Kidney Disease [5]. Chronic Kidney Disease is classified into 5 stages [3], [6]: (1) normal, (2) mild, (3) moderate, (4) severe and (5) end stage renal disease (ESRD). In each of these stages patient has some signs and symptoms. The signs and symptoms in stage 1 to 4 are almost

same[11]. Stage 1 to 4 is referred to the early stage of CKD. End stage renal disease (ESRD) shows some more signs and symptoms than the other stages. In this paper all these signs and symptoms are estimated [11]-[13]. Chronic kidney disease is determined from physical condition and history of a patient. Physical condition covers general condition, skin condition, pulmonary condition, cardiovascular condition, neuromuscular condition, gastrointestinal condition, hematologic condition and endocrine-metabolic condition of a patient [11]. Each of these conditions exposes some signs and symptoms [11]. The signs and symptoms of early stages take after the signs and symptoms of end stage of kidney disease (ESRD). However, patient's histories [11] are some issues that the patient or any member of the patient's family experienced.

### III. BACKGROUND STUDY

Many expert systems have been developed for kidney disease [14]-[16]. For example, S. Soman, G. Zasuwa and J. Yee built an expert system for chronic kidney disease which is a clinical support system[17], E Crowe, D Halpin, P Stevens developed an expert system on the identification and management of chronic kidney disease [18]. However, the expert system represented in this paper is based on only the signs and symptoms rather than any laboratory test.

### IV. OVERVIEW OF RIMER METHODOLOGY

An expert system has two components: a knowledge base and an inference engine. To construct the knowledge base, the experts establish rules. User's observation facts are sometimes considered in this case. The proposed system is developed based on Rule base Inference Methodology using Evidential Reasoning (RIMER) Approach. The knowledge of the expert system is constructed by the collection of some If-Then rules from the experts. The basic rule base representation is done as

If {(Anemia is High) ^ (Bleeding diathesis is Medium)} then {Hematologic condition is (High, 0.6), (Medium, 0.3), (Low, 0.1)}

In this system, inputs are provided based on the signs, symptoms and histories of the patients. The inputs may be High, Medium or Low for each sign, symptom or the history. For example, if a patient says that he/she does not sleep at all then, the input for the 'sleep disorder' will be 'High'.

In RIMER approach, inputs for each attribute are transformed into referential values [7]. For that, some matching degrees are used. For

example, 1 is transformed into (High, 1.0) or 0.5 is transformed into (Medium, 1.0). When the patient provides the input 'High' the system takes the input '1' and transform that into referential values like, (H, 0.4), (M, 0.5), (L, 0.1). After that, the system calculates the activation weights and updates the degree of belief if the degrees provided by the experts are not complete. For example, if the consequence of a rule is {(H, 0.4), (M, 0.4), (L, 0.1).} then, the degree of belief is not complete because  $0.4+0.4+0.1 < 1.0$ . At that case, the degree of belief is needed to update.

The inference in RIMER approach is done by combining the all the belief rules. The rules are aggregated by using Evidential Reasoning (ER) Approach [7], [19]. ER approach calculates the probability masses [20] and unassigned probability masses [20]. Then it aggregates all the rules and provides the final results.

### V. ASSESSMENT OF CHRONIC KIDNEY DISEASE

In this section, the design and implementation of Belief Rule Base Expert System (BRBES) to suspect Chronic Kidney Disease is discussed. An architectural design of the proposed system is represented in the following figure.

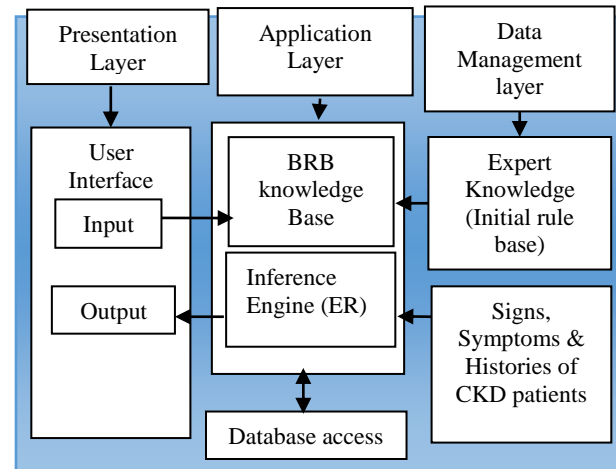


Fig. 1 BRBES Architecture

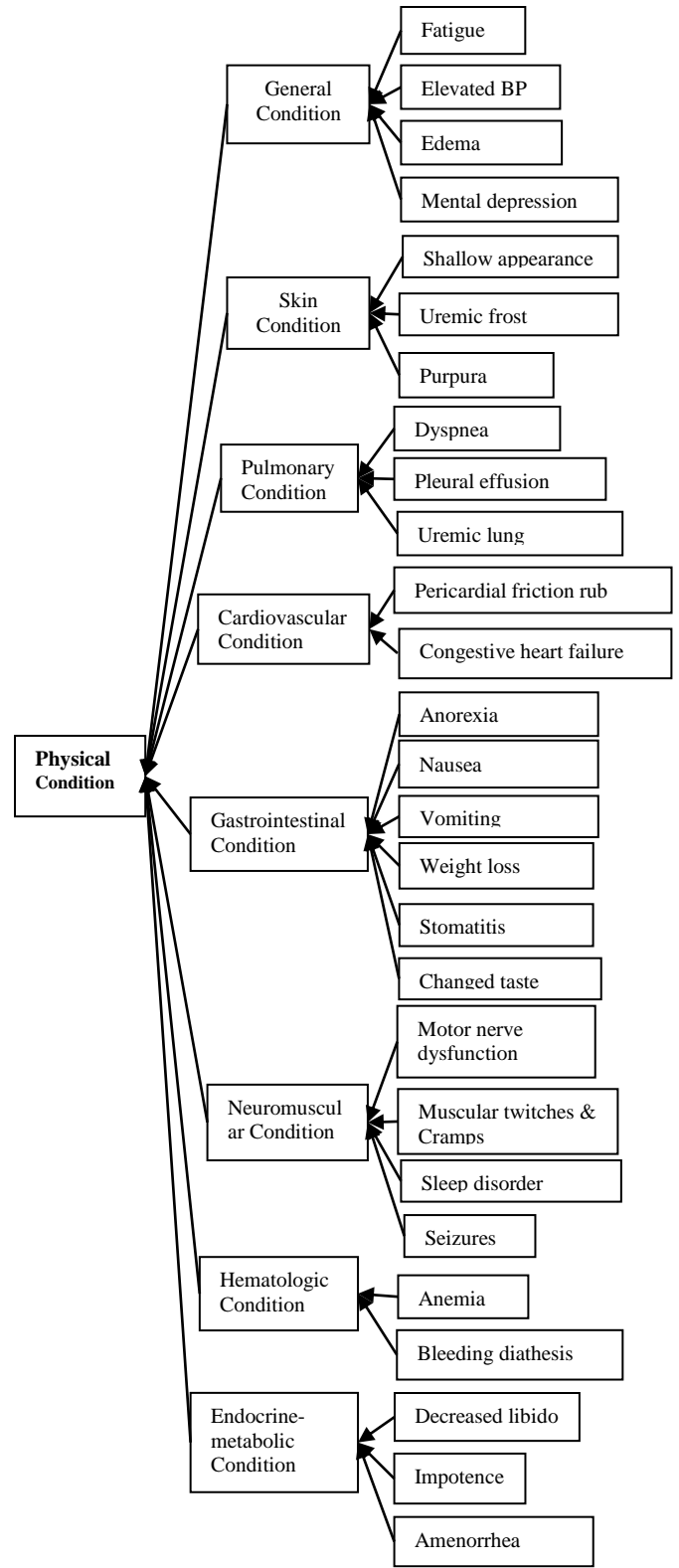
The BRBES architecture is a three layers architecture. The layers of BRBES are presentation layer, application layer and data management layer.

#### A. Knowledge Base Construction for the suspicion of CKD

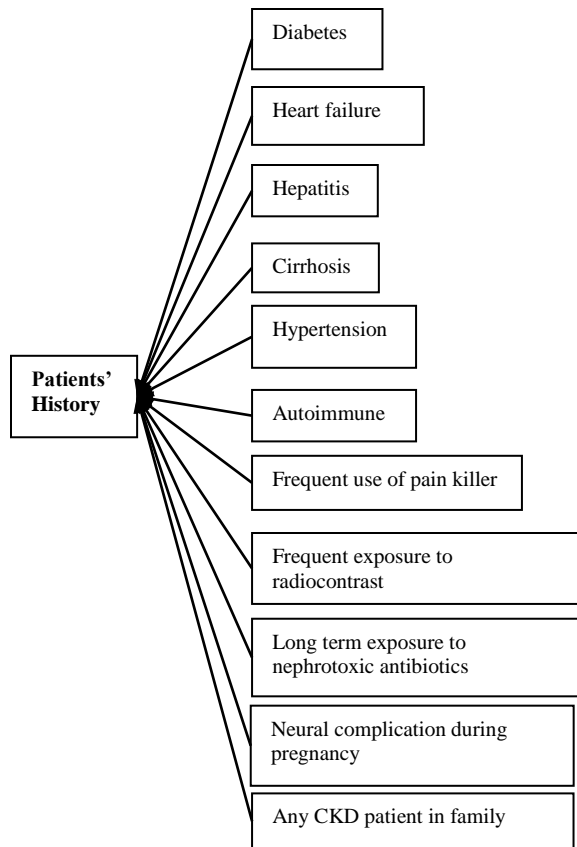
A BRB framework has been developed to construct a BRB knowledge base. For constructing



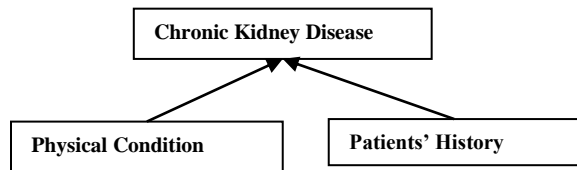
this framework primary data are collected from Chittagong Medical College & Hospital. The domain knowledge is acquired from [1]-[6], [10]-[13]. The BRB framework is shown using an Architectural Theory Diagram (ATD), which is shown in the following figure:



(a)



(b)



(c)

Fig. 2. BRB framework represented through ATD

### B. Inference Engine

Finally, an inference engine is developed based on Evidential Reasoning Algorithm to determine CKD [7], [20]. The system acquires the inputs from patient or physician. The experts assign rule weights and attribute weights. The final aggregation is done by using the ER Approach. The combined rules provide the final results. The results generated by system are represented through some confidence level. For example, the result for a certain patient may be  $\{(H, 0.6), (M, 0.3), (L, 0.0)\}$ . This results mean, the system is 60% sure that the CKD level of that patient is High, 30% sure that the CKD level is

Medium and 0% sure that the level is Low. The remaining 10% is unknown.

## VI. RESULTS AND DISCUSSION

Signs, symptoms and histories of the patients are considered as the clinical data, which are used to suspect Chronic Kidney Disease. The expert system is used to suspect CKD in some patients and the results are estimated. The results of a patient are shown in the following figure.

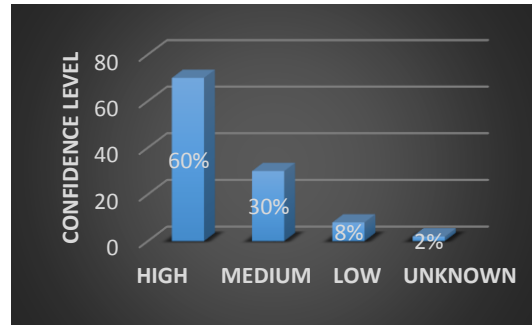


Fig. 3. Results of a CKD patient

The help of two physicians does the manual suspicion of CKD. A comparison between the suspicion efficiency of the manual system and the expert system is presented in the following figure to show that the proposed expert system provides a better performance in the suspicion of CKD than the existing manual systems.

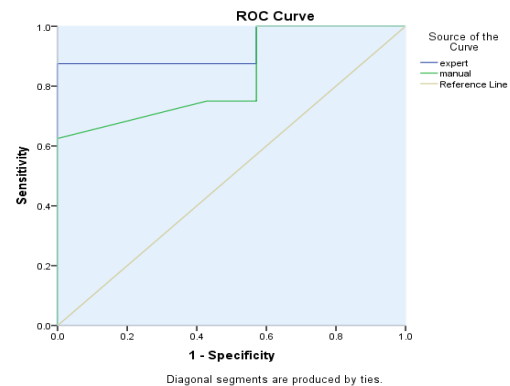


Fig. 4 ROC Curves Illustrate the Performance of BRB Expert System and Manual System

The above figure shows two ROC (Receiver Operating Characteristics Curve) curves. The green curve represents the manual system's performance in the suspicion of Chronic Kidney Disease where the blue curve shows the performance of expert system in the suspicion of Chronic Kidney Disease. The

AUC (area under curve) of manual system is 0.830 where AUC of expert system is 0.929. So, it becomes clear that the expert system provides the better performance than the manual system in the suspicion of Chronic Kidney Disease.

#### VII. CONCLUSION

The objective of this research is to suspect Chronic Kidney Disease dealing with uncertainty. It is a matter of great regret that CKD is rarely suspected primarily. So implementing an expert system that suspects CKD in the earliest time is necessary. The system is implemented with a very user-friendly interface. The physicians can use the system easily.

In future, a rich knowledge base will be developed with a huge number of rule bases. At that time the system will be more accurate, robust and powerful.

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# Study of Single Junction Si Solar Cells for Maximum Efficiency

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**Abstract**—In this article single junction Silicon solar cells have been studied varying p and n type region thickness and doping concentration, front texture thickness and angle. The PC1D solar cell simulator was used to conduct the study. The change in power output showed a proportional and inversely proportional relationship for n and p type thicknesses respectively. For the doping concentration, the power output showed proportional values until a certain value after which it started dropping. In the case of texture thickness, the lowest thickness showed the highest power output value. As for texture angle a specific value could be found for highest power output. The maximum efficiency combining all the values was found to be 24.075%.

## I. INTRODUCTION

In 2015 it was predicted the energy demand of this world would be more than 10 TW but by 2018 it might jump to 18 TW. By mid 21st century this energy demand will leap to 1.5 times its present demand and it is estimated to be 30 TW. Producing the energy is not a great problem because the global coal will run for at least one more century. However, there exists a catch. Fossil fuels like gas, octanes and diesels will end before this civilization's very eyes.

Here, the greatest challenge is producing clean energy. The world needs 20 TW non-CO<sub>2</sub> energy source by mid 21st century to stabilize the excess amount of CO<sub>2</sub> in the atmosphere. The simplest scenario is using photovoltaic technology, as it is the most established technology in non-CO<sub>2</sub> producing energy. Other alternatives also exist but their usage is not as wide as photovoltaics[1][2]. However nuclear fusion energy will soon be a tougher competition for pv technology.

In 1839 Becquerel while studying the effect of light on electrolytic cells discovered photovoltaic effect. It took a long period before considerable efficiency was achieved before considering it as an alternate energy source. Solar cells developed rapidly in the 1950s owing to space programs and used on satellites. However, the energy crisis of the 1970s greatly stimulated research and development for PV solar cells. Keeping this future in mind, efficiency improvement of solar cell materials is necessary to make it an economical energy source for the masses.

## II. SIMULATION AND RESULTS

Several tests in more than 100 steps were run to make sure the study was accurate. The surface area was constant and was

chosen to be 200cm<sup>2</sup>. The light on top of the solar cell was AM1.5 solar spectrum. The n-type region was on top of the p-type region in the solar cell.

### A. Influence of n and p-type thickness on power output

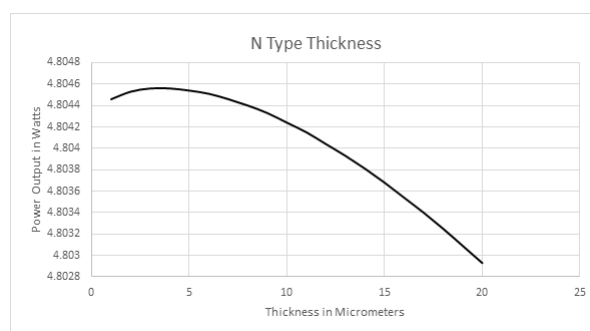


Fig. 1. Si power output vs n type thickness

N type thickness was varied from 1 to 20μm in 100 steps. At 1μm the power is high but it went higher as the thickness approached 2μm. The highest power output was found for the thickness of 2μm. Increasing the thickness more resulted in decrease of the output power. Too much low thickness will result in less absorption and too much thickness will result in the problem of junction being further away from where light was incident. So maximum power output was found for 2μm.

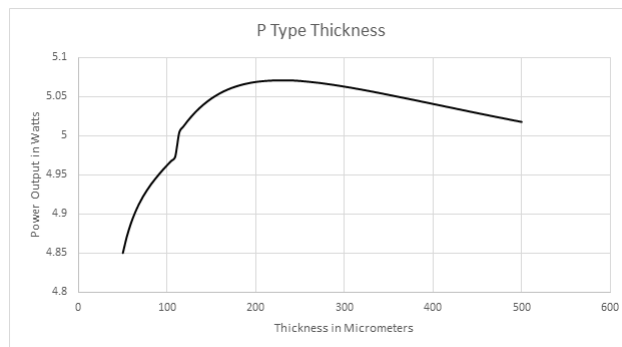


Fig. 2. Si power output vs p type thickness

Here simulations were run for the thickness of p-type region, which is the bottom region of the solar cell, keeping the n-type

region thickness value constant where the power output was maximum. The doping concentrations for n and p regions were kept at  $1 \times 10^{14} \text{cm}^{-3}$  constant. The thickness sweep was run from  $50 \mu\text{m}$  to  $500 \mu\text{m}$  in 100 steps. The power output increased up to a point, then it started decreasing as the thickness was increased. The best results were found for  $250 \mu\text{m}$ .

The best thickness proportions between the top n-type region and bottom p-type region seen are 2:250 which is 1:125 in ratio.

### B. Influence of n and p-type doping concentration on power output

N type doping concentrations show where the value of output power is maximum. The starting is at  $1 \times 10^{14} \text{cm}^{-3}$ . Increasing the concentration up to  $4.95 \times 10^{17} \text{cm}^{-3}$  in 100 steps show the corresponding graph where it is seen the more the doping concentration is increased the power output gets high up to a point then drops lower and lower. For this sweep the n and p region thicknesses were kept at optimum values and the p region doping concentration was kept at  $1 \times 10^{14} \text{cm}^{-3}$ . The highest output power was found at  $5.06 \times 10^{16} \text{cm}^{-3}$  and it was set. And then the simulations for the p type doping concentrations were done.

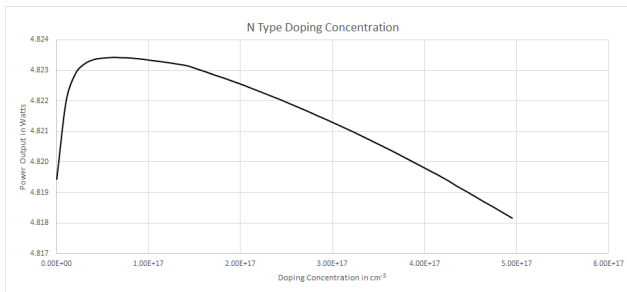


Fig. 3. Si power output vs n type doping concentration

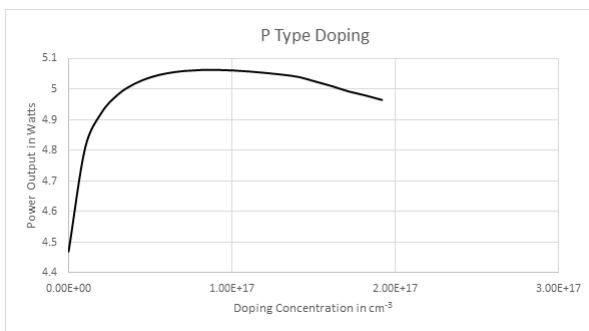


Fig. 4. Si power output vs p type doping concentration

Here similar results could be found for the p type doping concentrations. The highest value was found for  $8.09 \times 10^{16} \text{cm}^{-3}$ . After more doping, power output went up up to  $8.09 \times 10^{16} \text{cm}^{-3}$  then kept dropping.. The sweep was done in 100 steps, so the generated curve is quite accurate because it contains so many number of steps. Highest power output is found for  $8.09 \times 10^{16} \text{cm}^{-3}$ .

### C. Texture Thickness Curve

In the previous simulations the solar cell had a flat front surface. Here the surface was textured. Texture thickness was added to simulate the power output and simulation sweeps were run from  $0.01$  to  $1 \mu\text{m}$  to find out the optimal values of thickness. These simulations were done in 100 steps so that the results are accurate. It is evident that the lowest thickness parameter brings out the best results which is  $0.01 \mu\text{m}$ .

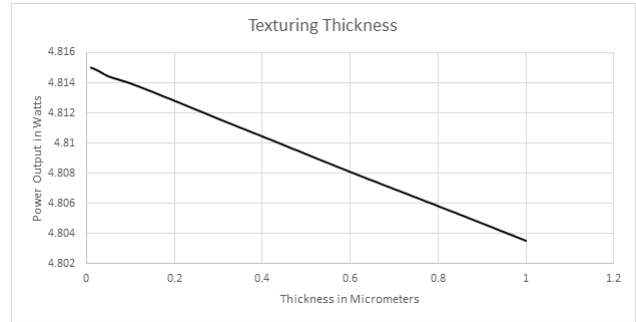


Fig. 5. Si power output vs texture thickness

### D. Optimum Texture Angle

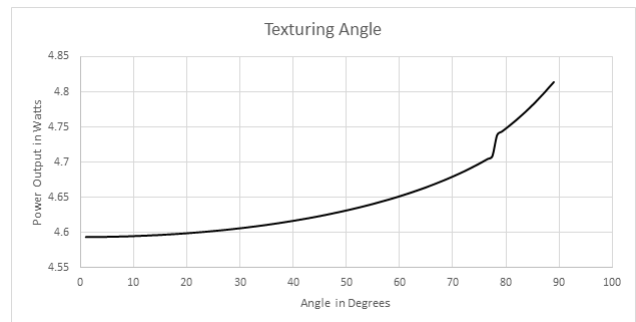


Fig. 6. Si power output vs texture angle

The texture angle is the angle formed between the normal on the surface of the n type material and the inclined texture surface. The calculation is done generally in degrees. The texture is positioned above the top surface of the solar cell, which is the n-type material in this case.

The textures on front surface are angled in a certain degree which will always be greater than zero and less than 90 degrees. So to find the optimal angle for which the power output will be highest, a simulation need to be done considering all the possible angles and their corresponding power output. the sweep was run from 1 to 89 degrees. From these values the highest power output was found for 89 degrees of texture angle.

### E. Resultant I-V Curve

The I-V curve for the single junction silicon solar cell is shown here. This is also the power output curve. The voltage

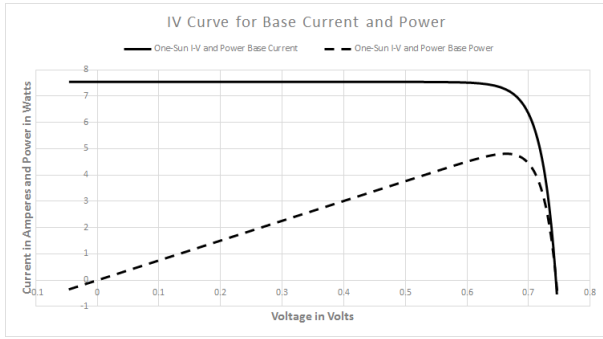


Fig. 7. Si I-V Curve

is standard for all silicon solar cells, and it is dependent on the band gap of the selected material so nothing much can be changed here. The main change happens where current output is changed thus the output power is changed. Here the higher current value refers to a cell that generates and transfers more electron-hole pairs. This is the determining factor of a good solar cell where more EHP can be generated.

Here the maximum power output is shown to be near 4.815W where the incident total power input on the solar cell surface is 20W because of the area being  $200\text{cm}^2$  and incident intensity is  $0.1\text{Wcm}^{-2}$  as per standards given for AM1.5 solar spectrum.

### III. DISCUSSION

Relationship between thickness and power output is in varying orders based on regions considered. The thickness of n region seems require a different kind of thickness compared to p region thickness. For n region, the increase of thickness resulted in dropping of power output. Only exception was that  $2\mu\text{m}$  had higher power output than  $1\mu\text{m}$  but after that the values kept dropping.

Considering the fact that Si is an indirect material, this should not be the case. The lower thickness of the active region implies that the P-N Junction should be close to the surface plane where light is falling. As much as possible for higher  $I_{sc}$  However, it should not be too much for resistive loss issues[3].

This is due to the fact that the junction needs to be closer to the surface because there charge collection probability is the highest. Lower thickness results in lower photon absorption and higher thickness results in lower charge collection. So here the optimal value is  $2\mu\text{m}$ .

For p region, the thing is different. The lower thickness will result in less absorption but the solar cell will have less resistance due to lower thickness of that region. On the other hand, higher thickness will increase the absorption amount but hinder the power output by increasing the thickness by a good amount. The curve here suggest the highest power output was found for  $250\mu\text{m}$ . This is because of Silicon being an indirect band gap material, the thickness has to be higher compared to other direct band gap materials like GaAs or Ge to compensate for it. This is why when a GaAs can work at thicknesses like  $1\mu\text{m}$  for p region, Silicon requires a lot more than that.

For the doping concentrations, it can be assumed that the p and n regions have conflicting requirements in terms of substrate doping. High doping decreases equilibrium minority carrier concentration required for high  $V_{oc}$  but at the same time increases recombination rate. For any type of solar cells, n region is supposed to be thin. This could also be seen in our simulation results. It is usually doped heavily to reduce resistive losses, but p side is usually doped lightly for high  $V_{oc}$ [4].

For n type and p type doping concentrations, the optimum values were found to be  $5.06 \times 10^{16}\text{cm}^{-3}$  and  $8.09 \times 10^{16}\text{cm}^{-3}$  respectively. Here it can be seen that simulation doping concentration is very different from theoretical assumptions.

For the doping concentration regarding the n region, according to the results found in II(C), it is evident that the increase of the doping beyond a certain value in the active region, n-doped, negatively affects the power output of the solar cell because of Auger recombination. The increase in recombination results in lower EHP lifetime and thus lowers the power output of the cell.

Using all the found optimum parameters, the simulated single junction silicon solar cell gave out a maximum power output of 4.815W which is 24.075% of total incident power 20W. Here, front surface reflection parameter is considered 10%. This is an arbitrarily considered reflectance value to keep the efficiency parameters within practical range. Without front surface reflectance, the efficiency would go up to 25.33%. So using external anti-reflection technology, reduction in reflection can have effect of increase in efficiency by up to  $\approx 1\%$ .

Finally the efficiency that is found out by selecting the optimum parameters turns out to be 24.075% whereas in the current market, the commercially available solar cell modules have around 12-16% efficiency[5].

### IV. CONCLUSION

The obtained results give very accurate and specific parameters based on thousands of simulations for maximum possible efficiency for the basic Si solar cell, which is calculated to be around 24.075%. Here light reflection is considered to be 10%. Other efficiency improving techniques such as AR coating and rear surface texturing were ignored. Including anti reflective coating will decrease the amount of reflection and increase power output. Further optimization of design considering those techniques could improve the achieved efficiency by a small margin.

TABLE I  
HIGHEST EFFICIENCY PARAMETERS FOR SINGLE JUNCTION SI CELL

Parameter	Value
n region thickness	$2\mu\text{m}$
p region thickness	$250\mu\text{m}$
n region doping concentration	$5.06 \times 10^{16}\text{cm}^{-3}$
n region doping concentration	$8.09 \times 10^{16}\text{cm}^{-3}$
front surface texture thickness	$0.01\mu\text{m}$
front surface texture angle	89 degrees

#### ACKNOWLEDGMENT

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# Biogas and Biogas Technology as a Solution of Energy Crisis in Bangladesh- Economical, Environmental and Social prospects.

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**Abstract**—The issues of energy crisis, depletion of fossil fuel and global warming are growing concern in the world. To cope up with this situation, the role of renewable energy is becoming more and more significant to meet partially demand of global energy. Biogas is an auspicious renewable energy source to solve the energy crisis problem at a great extent. As Bangladesh is an agricultural country, it has blessed with plenty of biomass which has been used for extracting energy by generating biogas. Animal manures being accessible in the rural areas are greatly used in producing biogas to be used for cooking and electricity. In Bangladesh around 59.6% of the total population is covered by electricity and 6% is covered under natural gas network. About 62.59% of total electricity develops from natural gas. The main concern of this paper is to quantify the solution of energy crisis through biogas and assess the economical, environmental and social impacts of biogas technology in Bangladesh.

**Keywords**—Renewable energy, biogas, poultry waste, cattle manure, municipal waste, prospects of biogas.

## I. INTRODUCTION

Fossil fuels are extensively used in transportation, power generation and machinery energy source due to its high heating power, availability and quality of combustion characteristics, but its reserve is draining day by day. Bangladesh, as a developing nation has been struggling to keep up with the energy demand for its large population. Bangladesh has installed power plants having the generating capacity of 11877 MW where maximum generation is 8177 MW and 93.9% power comes from fossil fuel [1]. The renewable energy policy of Bangladesh government envisions that 5% of total energy production will have to be achieved by 2015 and 10% by 2020 [1]. Biogas is one of the auspicious renewable energy sources which refer to a mixture of different gases generated by the decomposition of organic matter like agricultural waste, municipal waste and animal manure in the absence of oxygen. About 102.6 million tons Cattle dung from 25.5 million cows and buffaloes, 12.9 million tons poultry waste from 291.5

million chickens and ducks and 8.65 million tons municipal waste are produced in Bangladesh every year [2]. Such a large amount of these wastes have great economical value which can be utilized to produce biogas for cooking, heating and electricity generation. Besides, production of biogas from organic waste avoids emitting of methane and nitrous oxide in the environment. According to the intergovernmental panel on climate change, nitrous warms the atmosphere 310 times more than carbon dioxide and methane does so 21 times more [3].

## II. BIOGAS AND ITS COMPOSITION

Biogas is a combustible mixture of gases. It consists mainly of methane ( $\text{CH}_4$ ) and carbon dioxide ( $\text{CO}_2$ ) and is formed from the anaerobic bacterial decomposition of organic compounds in absence of oxygen. The gases are produced from the waste products of the respiration of these decomposer microorganisms. The composition of the gases depends on the substances that are being decomposed [4]. It has burning properties like natural gas. It is about 20% lighter than air and calorific value is (5000-7000) kcal per cubic meter. It usually burns with 60% efficiency in a conventional biogas stove [5].

TABLE I. Components of biogas [6]

Components	Percentage
Methane ( $\text{CH}_4$ )	60-70
Carbon dioxide ( $\text{CO}_2$ )	30-40
Hydrogen ( $\text{H}_2$ )	2-2.5
Nitrogen ( $\text{N}_2$ )	1-1.5
Oxygen ( $\text{O}_2$ )	0.3-0.4
Hydrogen Sulfide ( $\text{H}_2\text{S}$ )	0.1-0.2

### III. ANAEROBIC DIGESTION

It is a oxygen-free complex biological process, in which the organic matter is decomposed partially by the combined action of several types of microorganisms to generate biogas.

The production of biogas by anaerobic digestion is influenced by various factors such as temperature, pH condition of the input charges, nutrient concentration, loading rate, toxic compound etc. The temperature range required for anaerobic digestion is 30°C- 70°C. Temperature between 35°C-38°C is considered optimum. There are three common temperature ranges: the psychrophilic (below 20°C), the mesophilic (between 20°C and 40°C) and the thermophilic (above 40°C). The optimum range of pH value is 6 to 7 to provide the better existence of methane producing bacteria [4]. The anaerobic digestion process and utilization of biogas are given below:

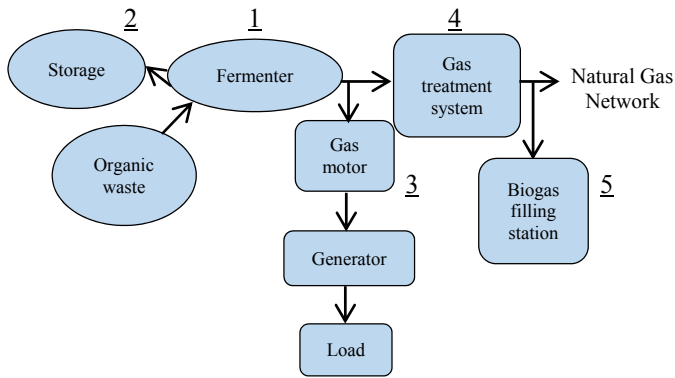


Fig. 1. Energy production in a biogas plant.

1. The fermentation tank contains the micro-organisms that anaerobically digest the biomass (in a sealed light-proof vacuum) to produce the biogas and carbon dioxide.
2. Residual materials left over after fermentation can be used as fertilizer, substantially reducing the use of fertilizer or can be composted.
3. In a Combined Heat and Power (CHP) plant, the biogas is combusted to produce both electricity and heat.
4. The Gas upgrading plant increases the methane content to 98% while improving the overall quality of the biogas by removing CO<sub>2</sub> and other impurities.
5. The upgraded biogas can then be feed directly into existing natural gas networks or can be utilized as transport fuel.

### IV. STATISTICS AND ENERGY ANALYSIS OF ORGANIC WASTE IN BANGLADESH

#### A. Poultry waste

Bangladesh is a promising place for poultry industry. As a result, a number of poultry farms have continually increased over the past years. The main objective of the poultry industry was to assist to the food supply against the backdrop of an ever growing demand from a highly dense population. Nowadays,

poultry industry has become flourishing as a home grown economy that provides employment to a large number of people in terms of poultry feed supply, production and marketing and creating poultry related products. In 2013, the country had approximately 245 million chickens and 46 million ducks respectively that produced 12.9 million tons of waste [2].

TABLE II. Energy calculation chart [7]

Waste and droppings per chicken/duck per day	Amount of biogas produced from 1 kg of poultry waste	Amount of biogas for 1 KW electricity generation
0.1 kg	0.074 m <sup>3</sup>	0.71 m <sup>3</sup>

Total number of chickens and ducks= 291000000

So, Total amount of poultry waste= (0.1×291000000) kg  
= 29100000 kg

Total amount of produced biogas= (29100000×0.074) m<sup>3</sup>  
= 2153400 m<sup>3</sup>

Total electricity generation= (2153400÷0.71) KW  
= 3032957 KW= 3033 MW

#### B. Cattle dung

Traditionally cattle dung has been utilized as a fertilizer, though today dung is collected and used to produce biogas. This gas is rich in methane and is used to provide a renewable and stable source of electricity. According to the international energy agency, bioenergy (biogas and biomass) have the potential to meet more than a quarter of the world demand for transportation fuels by 2050. In 2013, the country had approximately 24 million cows and 1.5 million buffaloes respectively that produced 102.6 million tons of waste [2].

TABLE III. Energy calculation chart [6]

Dung from one cattle per day	Amount of biogas produced from 1 kg of cattle dung	Amount of biogas for 1 KW electricity generation
10 kg	0.034 m <sup>3</sup>	0.71 m <sup>3</sup>

Total number of cattle's= 25500000

So, Total amount of cattle waste= (10×25500000) kg  
= 255000000 kg

Total amount of produced biogas= (255000000×0.034) m<sup>3</sup>  
= 8670000 m<sup>3</sup>

Total electricity generation= (8670000÷0.71) KW  
= 12211267 KW= 12211 MW

### C. Municipal waste

Municipal waste disposal is one of the main problems being confronted by all nations across the world. The daily per capita per person solid waste produced in Bangladesh is about (300-400) gram and approximately 8.65 million tons municipal waste was generated in 2013. If we carefully analyze these waste, we will realize that most of these are biodegradable.

TABLE IV. Energy calculation chart

Amount of municipal waste per day	Amount of biogas produced from 1 kg of municipal waste	Amount of biogas for 1 KW electricity generation
21500000 kg	0.076 m <sup>3</sup>	0.71 m <sup>3</sup>

Total amount of municipal waste= 21500000 kg  
 Total amount of produced biogas= (21500000×0.076) m<sup>3</sup>  
 = 1634000 m<sup>3</sup>  
 Total electricity generation= (1634000÷0.71) KW  
 = 2301408 KW= 2301 MW

From the above calculations TABLE V has been drawn that shows the possibility of total amount of biogas production and electricity generation from organic waste in Bangladesh.

TABLE V. Energy from organic waste (2013)

Source of organic waste	Amount of produced biogas in cubic meter	Amount of generated electricity in MW	Percentage of generated electricity
Poultry waste	2153400	3033	17.3
Cattle dung	8670000	12211	69.6
Municipal waste	1634000	2301	13.1
Total amount	12457400	17545	100

From TABLE V, we can draw a pie chart which shows the percentage of possibility of electricity generation from poultry waste, cattle dung and municipal waste in Bangladesh.

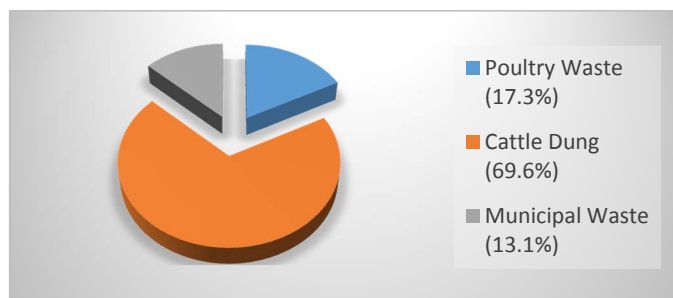


Fig. 2. Possibility of electricity generation from organic waste (2013)

### V. ECONOMICAL, ENVIRONMENTAL AND SOCIAL PROSPECTS

Biogas technologies have great significance for energy access, energy security, deplete dependency on fossil fuels, moderating climate change, sustainability and socio-economic benefits.

#### A. Economical prospects

Biogas has great potential to cover a variety of markets, including electricity, heat, transportation fuels and also to use the gas for direct combustion in household stoves and gas lamps. Bangladesh has installed power plants having electricity generating capacity of 11877 MW where maximum generation is 8177 MW and peak demand is 10283 MW until 2015 [1]. From TABLE V, total electricity generated from organic waste is 17420 MW. In 2013 if we could utilize at least 10% of total amount of organic waste, 1754 MW electricity would be produced which was able to fulfill 21% of peak demand out of 8339 MW in Bangladesh [1].

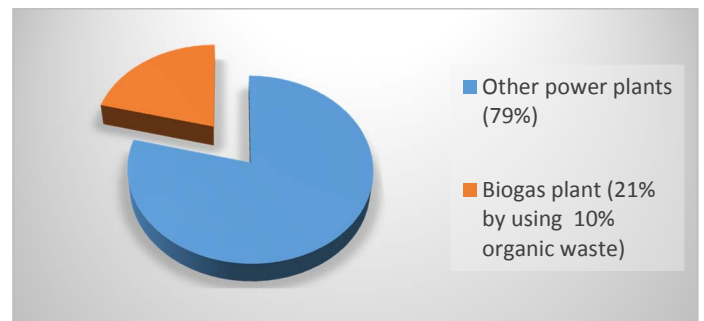


Fig. 3. Possibility of electricity generation in Bangladesh (2013)

Fig. 3 shows how biogas could play a vital role to fulfill 21% of peak demand if 10% of total amount of organic waste was utilized in 2013.

Biogas enables us to save the energy cost and earn money by selling biogas to the neighbors.

Soil fertility in Bangladesh is gradually diminishing. One of the major factors is excessive utilization of chemical fertilizers. The by-product of a biogas plant, namely slurry, can be the best alternative supplement to chemical fertilizers for maintaining the fertility of soil. It has no toxic or harmful effects. The nutrient quality of slurry is higher than that of compost manure and chemical fertilizer, as the minimal loss of nitrogen in slurry is more effective as fertilizer than composted cattle dung. Undesirable plant seeds are killed inside the digester during the retention time for biogas production. Thus, less labor is needed for weeding in agricultural production for whoever uses this slurry. Besides that, the demand for organic products is becoming more popular around the world.

### B. Environmental prospects

There are increasing concerns about growing greenhouse gas (GHG) emissions and their impact on worldwide climate change. Ambitious targets for GHG reduction require strategies in different production sectors but the proposed actions are not yet effective.

Biogas is considered ‘niche’ among renewable sources of energy but assumes relevant importance in environmental protection. Production of biogas represents a key technology for integrated management of solid and liquid organic wastes, as well as that derived from livestock.

In the United States over one billion tons of manure is produced by livestock annually [8]. Currently, most of this manure is stashed outdoors to decompose. Animal waste stashed in this fashion can release uncomfortable odors, deleterious air pollutants and greenhouse gases. The air pollutants emitted from manure include ammonia, VOCs, hydrogen sulfide and particulate matter, many of which can create health problems in humans [9]. Besides ammonia emissions from manure can contaminate ground water and lead to eutrophication of the soil [10]. Manure also releases methane and nitrous oxide, two potent greenhouse gases. Using the standard developed by Intergovernmental Panel on Climate Change (IPCC), the warming potential of carbon dioxide over a 100 year time span for methane and nitrous oxide are 21 and 310 times respectively [3].

The main environmental benefit of biogas plants is a major contribution to the reduction of air pollutants and GHG emissions in the atmosphere. This is possible through the controlled capture of CH<sub>4</sub> and the saving of fossil fuels by biogas replacement and the CO<sub>2</sub> emissions that are avoided [11].

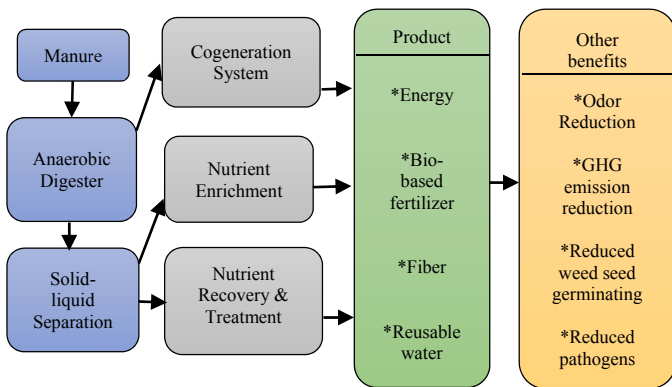


Fig. 4. Environmental relationship aspects [12].

Fig. 4 shows a summary of the environmental relationships in a biogas production system that uses manure as feedstock.

TABLE VI. Emission of greenhouse gases in Bangladesh

Year	2005	2010	2015	2020
CH <sub>4</sub> Emissions in (Tons)	10200	13000	15750	18300
CO <sub>2</sub> Emissions in (Tons)	214000	273000	331000	384000

[Source: wastecon@dhaka.agni.com]

From TABLE VI, we can draw a clustered column that shows methane (CH<sub>4</sub>) and carbon dioxide (CO<sub>2</sub>) emissions from year 2005 to 2020.

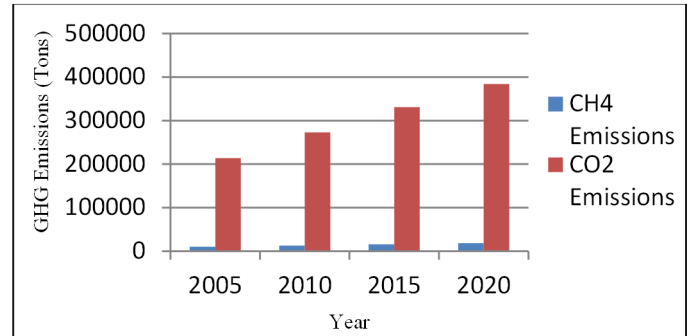


Fig. 5. Projections of greenhouse gas emissions

In rural areas, the most popular energy source of cooking food and generating heat is wood. This leads to deforestation. Implementation of such project will enable people to substitute wood with natural gas; hence preserve forest.

Unbalancing the eco-system is the main cause of natural disasters. Biogas technology can play a powerful role to keep the balance of eco-system as it will encourage farming and reduce deforestation.

### C. Social prospects

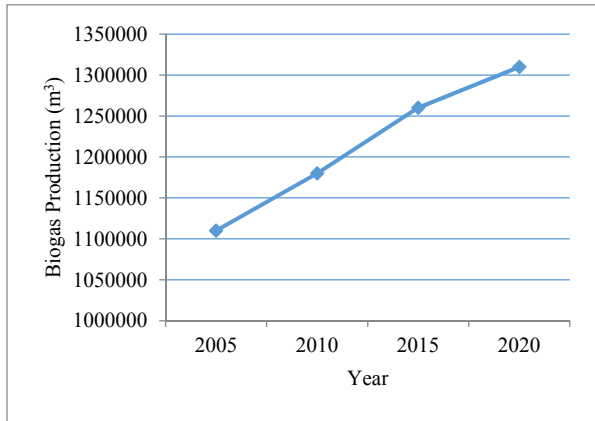
Biogas has a wide variety of social applications. It can be used directly for cooking, lighting, heat generation and electricity production.

Biogas is a clean fuel, thus reducing the levels of indoor air pollution, a major cause of ill-health for those living in poverty. During the conversion process a lot of microorganisms that represents a health risk are killed. The following germs are killed in biogas digester: Paratyphoid, Cholera and dysentery bacteria, Hookworm and bilharzias, Tapeworm and roundworm die completely when the fermented slurry is dried in the sun.

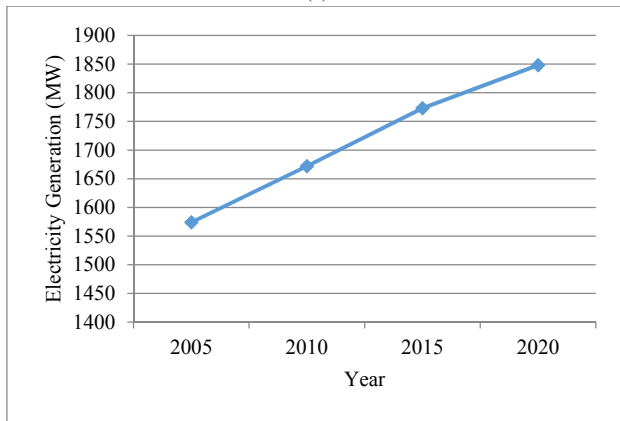
Where biogas is substituted for wood fuel, there are two benefits: reduction in the pressures on the forest and saving time to collect wood usually women and children. This will reduce air pollution, respiratory diseases and infections in eye significantly. Therefore, better lifestyle can be attained by implementing such project.

## VI. FUTURE PROSPECTIVE

Production of biogas from organic waste exposes massive interest in many parts of the world. Biogas production system offers vital environmental benefits over other forms of bioenergy because it provides different final products: a renewable energy source, convertible to electricity and heat or to fuel for the automotive sector, and a good organic fertilizer.



(a)



(b)

Fig. 6. Graphical representation of possibility of (a) biogas production, (b) electricity generation; from 10% of total amount of organic waste in Bangladesh.

Bangladesh has possibility to produce 13100000 cubic meter biogas by utilizing total amount (100%) of organic waste in 2020. If we ensure to utilize at least 10% of it, it will produce 1848 MW electricity which will cover 10.7% of peak electricity demand in 2020. To solve energy crisis in third world countries such as in Bangladesh and save the planet from the effects of climate change and greenhouse gases, we need investments in biogas technologies. In this regard, the developing countries

have the opportunity to leapfrog conventional energy options in favour of cleaner energy alternatives (such as biogas energy) that will drive growth and has economic and social development.

## VII. CONCLUSION

The outcome of this paper expresses that there is substantial scope for Bangladesh to fulfill its future power demand through biogas. Biogas energy sources conferred above can aid Bangladesh to generate more power in order to minimize load-shedding problem. It is high time to work with biogas technology to generate electricity rather than depending entirely on conventional method. Therefore, the government and non-government organizations should work together on biogas and biogas technology to solve energy crisis problem.

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# A Novel Method of Identifying Errors with the Analysis of Alarms in IGW Transmission

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**Abstract**—This paper presents a special method of identifying errors in IGW transmission with the implementation and analysis of alarms. First, different types of alarms and their purposes are described. Then which alarm occurs in which SDH level that is listed. Then the alarm checking methods and the analytical results are shown to explain errors in details. This study would help the operators to identify the errors and problems of the communication system using alarms and take necessary steps to solve those.

**Keywords**—alarms; layers; igw; mux; soft switch; media gateway; signaling gateway; sbc

## I. INTRODUCTION

International Gateways (IGWs) are switching systems through which international voice traffic (VoIP and clear channel) is sent (Outgoing calls) and received (Incoming calls) [1]. Basically IGWs maintain a wired communication through fiber. In this communication system some errors, unwanted events, variation in node parameters, power failure etc can take place which can cause communication failure. However, It is very difficult to identify these kinds of problems manually. Therefore, the system should be designed in such a way so that it gives different alarms for different unexpected issues. Therefore, some alarms are invented. By checking and monitoring those alarms operators can identify the problems easily and take appropriate actions to overcome it. This is one of the most efficient methods to identify and overcome the problems in the shortest possible time.

Without these alarms, finding problems in huge networks would be very difficult and time-consuming. Moreover, the nature and reasons of the problems must be analyzed. The problems are occurring in which parts of the networks that must be identified as well. It is almost impossible for the network operators to identify these kinds of issues in a large network, if the system would not provide appropriate alarms in right time. So the system alarms play a vital and significant role to locate the errors in networks and find the causes and types of the errors.

## II. ALARM AND PERFORMANCE EVENT

In IGWs alarms can be categorized depending on their importance and severity. Such as: Critical alarm, Major alarm,

Minor alarm, Warning alarm. Alarms are color coded as follows [2] [3]:

- Red—Critical alarm
- Orange—Major alarm
- Yellow—Minor alarm
- Blue—Warning alarm
- Green—There is no alarm

Some important alarms, their descriptions and probable causes are discussed below [2] [3].

### A. Alarm Type 1 : R\_LOF

R\_LOF alarm indicates “receive loss of frame”. It is a critical alarm.

Probable causes:

- The received signal attenuation is excessive.
- There is no frame structure in the signal from the opposite station.
- The receiver of the board fails.

### B. Alarm Type 2 : R\_LOS

R\_LOS alarm indicates “receive loss of signal”. It is a critical alarm.

Probable Causes:

- There is a fiber cut.
- The line attenuation is excessive.
- The receiver of the board fails.
- The transmitter of the opposite station or line transmission fails.
- The XCS cards on the opposite station fails or is offline.

### C. Alarm Type 3 : B2\_OVER

B2\_OVER alarm indicates “indication of excessive B2 errors in the multiplex section”. It is a major alarm.

Probable Causes:

- The received signal attenuation is excessive.
- The fiber end is not clean.
- The fiber connector is connected incorrectly.
- The receiver of the local station fails.
- The transmitter of the opposite station fails.

#### D. Alarm Type 4 : MS\_AIS

MS\_AIS alarm indicates “multiplex section alarm indication”. It is a major alarm.

Probable Causes:

- The opposite station transmits the MS\_AIS signal.
- The GXCS, EXCS, UXCS, or XCE of the opposite station fails.
- A fault occurs in the receiver of the board.

#### E. Alarm Type 5 : AU\_AIS

AU\_AIS alarm indicates “AU alarm indication”, which is a major alarm.

Probable Causes:

- The opposite station sends AU\_AIS.
- The transmitter of the opposite station fails.
- The receiver of the local station fails.

#### F. Alarm Type 6 : BD\_STATUS

BD\_STATUS alarm indicates “board offline”. It is a major alarm.

Probable Causes:

- The board is not inserted.
- The board is not fully inserted.

#### G. Alarm Type 7 : APS\_FAIL

APS\_FAIL alarm indicates “APS protection switching failed”, which is a major alarm.

Probable Causes:

- The multiplex section protection (MSP) parameters of the nodes are incorrect.
- The MSP parameters of the nodes are lost.

#### H. Other Alarms

- POWER\_FAIL: Power failure, major alarm.
- MS\_RDI: Multiplex section remote defect indication, minor alarm.
- MS\_REI: Multiplex section remote error indication, warning.
- AU\_LOP: AU loss of pointer, minor alarm.
- HP\_TIM: Higher order path tracking identification mismatch, minor alarm.
- HP\_SLM: Higher order path signal identification mismatch, minor alarm.
- HP\_RDI: Higher order path remote defect indication, minor alarm.
- HP\_REI: Higher order path remote error indication, minor alarm.
- HP\_UNEQ: No loading error in the higher order path, minor alarm.
- IN\_PWR\_ABN: Input power abnormal, major alarm.
- LASER\_SHUT: Laser shut down, major alarm.
- LOOP\_ALM: Loop alarm, minor alarm.
- COMMUN\_FAIL : Board serial port communication failure, major alarm
- COMMUN\_FAIL: Serial port communication failure, major alarm.

- BD\_STATUS: Board not in position alarm, major alarm.

### III. ALARMS AND LAYERS

Previously, telecom networks used PDH (Plesiochronous Digital Hierarchy) for transmission. But now PDH has been replaced by SDH (Synchronous Digital Hierarchy). So, now each alarm is associated with a SDH layer which is shown in the Table 1.

TABLE I. ALARMS AND LAYERS

SDH Layers	Alarms
STM Physical Media Layer	LOS
Regenerator Section Layer	LOF RS-BIP
Multiplexer Section Layer	MS-AIS MS-BIP MS-RDI AU-AIS AU-LOP
Higher Order Path Layer	VC-4 BIP VC-4 REI VC-4 RDI VC-4 LOM
Lower Order Path Layer	VC-12 AIS VC-12 LOP VC-12 BIP VC-12 REI VC-12 RFI VC-12 RDI
PDH Physical Interface Layer	LOS

### IV. IMPLEMENTATION AND ANALYSIS

#### A. Alarm checking for IGW-MUX

Huawei Optix OSN3500 (version V200R011C02) has been used as IGW-MUX and U2000 LCT server system management software has been used for alarm checking purpose. First, U2000 LCT server needs to be started. After 5 minutes U2000 LCT Client needs to be started. Then using access ID and password it can be logged in. After that log in windows will be appeared and the device is ready to check alarm.

There are three different ways to check alarm in IGW-MUX. Such as: NE wise alarm checking, Type wise alarm checking, Card wise alarm checking.

##### 1) NE wise alarm checking

In order to check alarms according to a specific NE (Network Element), I need to browse current alarms for that particular NE from NE Explorer. After that all alarm window of that NE will be opened.

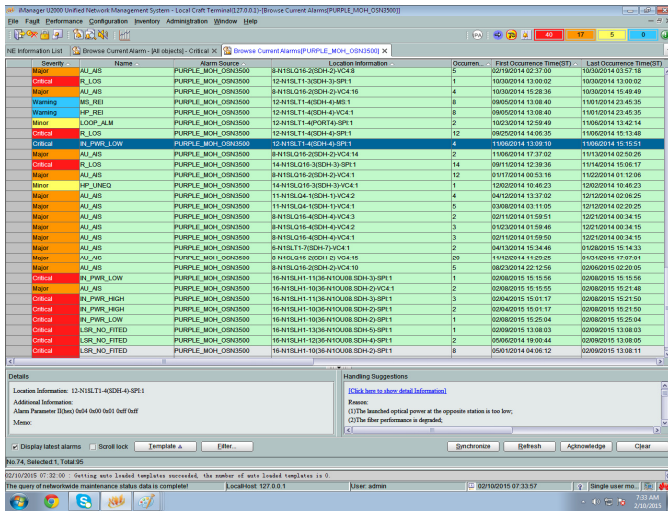


Fig. 1. PURPLE\_MOH\_OSN3500 wise alarm windows.

From Fig. 1, we can see the details of all alarms for a specific NE "PURPLE\_MOH\_OSN3500". For example, when I did this checking, I got a critical "IN\_PWR\_LOW" alarm locating the error in the "12-N1SLT1-4(SDH-4)-SPI:1" card. This error occurred 4 times there. The date and time of that error was also identified. The reasons of that error I got from the analysis are listed below:

- The launched optical power at the opposite station was too low.
- The fiber performance was degraded.
- ✓ **My recommended solutions:** Increasing the capacity of the card or repairing that small portion of fiber.

### 2) Type wise alarm checking

In order to check type wise alarms, I need to choose a particular alarm type (critical, major, minor, warning) from NE list and then that particular type of alarm window will be appeared.

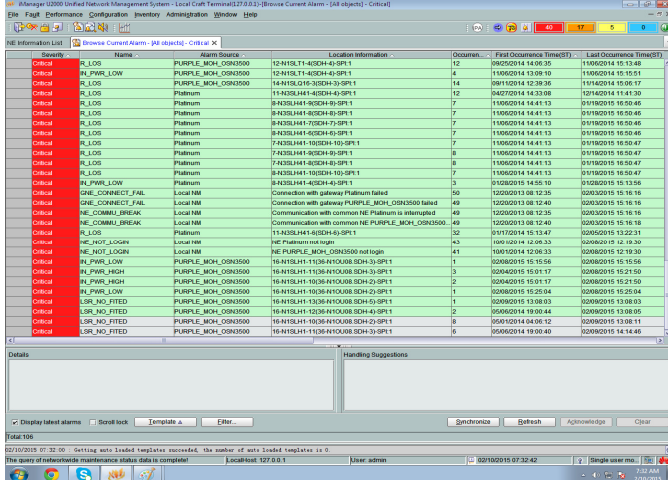


Fig. 2. Critical alarm windows.

From Fig. 2, we can see the details of only critical alarms for different NE(Network Elements). For example, I am describing the analysis for a NE "PURPLE\_MOH\_OSN3500". When I did this checking, I got "R\_LOS", "IN\_PWR\_LOW", "IN\_PWR\_HIGH", "LSR\_NO\_FITED" alarms from "PURPLE\_MOH\_OSN3500". These alarms located errors in following cards:

- "12-N1SLT1-4(SDH-4)-SPI:1"
- "14-N1SLQ16-3(SDH-3)-SPI:1"
- "16-N1SLH1-11(36-N1OU08 SDH-3)-SPI:1"
- "16-N1SLH1-10(36-N1OU08 SDH-2)-SPI:1"
- "16-N1SLH1-13(36-N1OU08 SDH-5)-SPI:1"
- "16-N1SLH1-12(36-N1OU08 SDH-4)-SPI:1"
- ✓ **My recommended solutions:** Informing the opposite station to adjust their receiver board's position or repairing that small portion of fiber.

### 3) Card wise alarm checking

In order to check alarms according to a specific card, I need to browse current alarms for that particular card from a specific NE Explorer. After that all alarm window of that particular card will be opened.

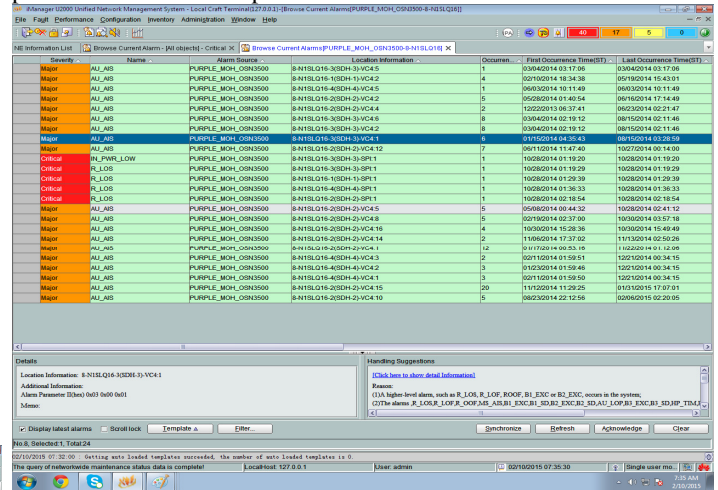


Fig. 3. 8-N1SLQ16 card wise alarm windows.

From Fig. 3, we can see the details of all alarms locating errors in a specific card "8-N1SLQ16". For example, when I did this checking, I got a major "AU\_AIS" alarm from "PURPLE\_MOH\_OSN3500" locating the error in the "8-N1SLQ16-3(SDH-3)-VC4:1" card. This error occurred 6 times there. The date and time of that error was also identified. The main reason of that error I got from the analysis is a higher-level alarm, such as R\_LOS, R\_LOF, ROOF, B1\_EXC or B2\_EXC occurs in the system.

- ✓ **My recommended solutions:** Making the card segmented into more cards.

### B. Alarm checking for soft switch

Here we have considered EMS as the soft switch [5] [6]. First need to be accessed in the EMS server address 10.10.10.10 to enable the console mode of EMS. Being logged



in with the accessing ID and password, I can find the faults of the switching system. From there I need to address the alarms of that switching system which are shown in the Fig. 4.

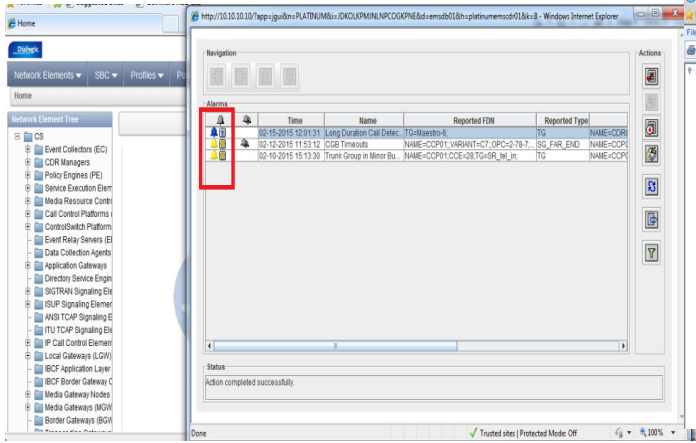


Fig. 4. EMS alarm windows.

From Fig. 4, we can get the detail information of all alarms in the EMS. For example, when I did this checking, I got a “Long Duration Call Detection” alarm . It was a warning alarm which denoted that a call was going on for a long duration in EMS. The date and time of the error was also identified with all other details.

- ✓ **My recommended solutions:** As it is a warning alarm, so it is not that much serious issue. Still it can be prevented by limiting the maximum call duration.

C. Alarm checking for media gateway

Here, Dialogic Media Gateway has been used [7]. We have used XMS media server software for alarm checking purpose [8].Here, I am showing the analysis of alarm checking for Media Gateway DHK-PRO-01 using XMS. First need to be accessed in the server address 10.10.15.100 . Then using access ID and password it can be logged in.

Here, the hardware diagram of Media Gateway DHK-PRO-01 is shown. The equipment type was “I-Gate PRO MG”.

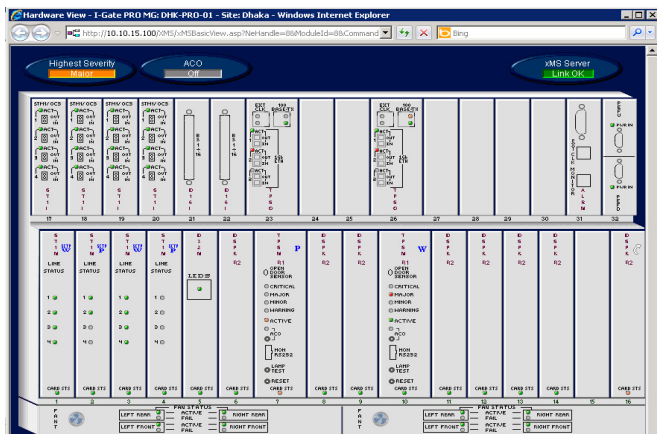


Fig. 5. Hardware view of DHK-PRO-01.

From Fig. 5, we can see that when I did this checking, the highest alarm severity was major. Now searching for the alarm details of DHK-PRO-01 I got 351 alarms.

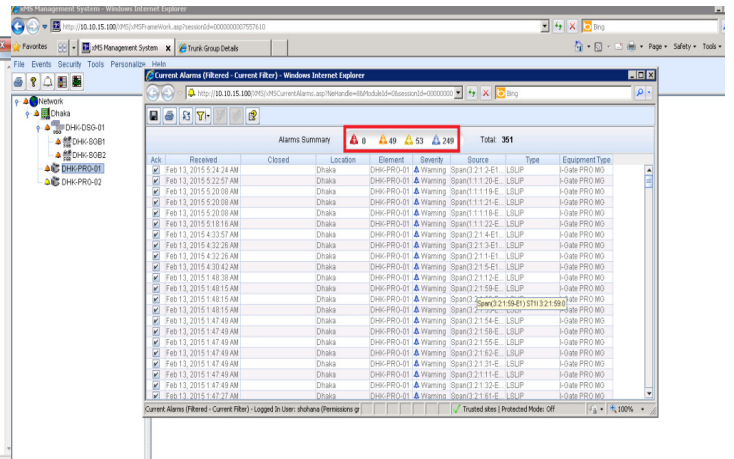


Fig. 6. DHK-PRO-01 alarm windows.

From Fig. 6, we can find that when I did this experiment, total 351 alarms were detected in the Media Gateway DHK-PRO-01. Among them 249 alarms were warning, 53 alarms were minor and 49 alarms were major. For example, the first alarm in the list was an LSLIP warning alarm from “span (3:2:1:2-E1)” card locating the error in Dhaka. The date and time of that error was also identified.

- ✓ **My recommended solutions:** This warning alarm is not that much severe, can be ignored. Still it can be improved by changing the orders of the cards.

D. Alarm checking for signaling gateway

Here, DHK-DSG-01 is the signaling gateway. Fig. 7 shows the analysis of alarm checking for Signaling Gateway DHK-DSG-01 using XMS. The equipment type was “SGB”.

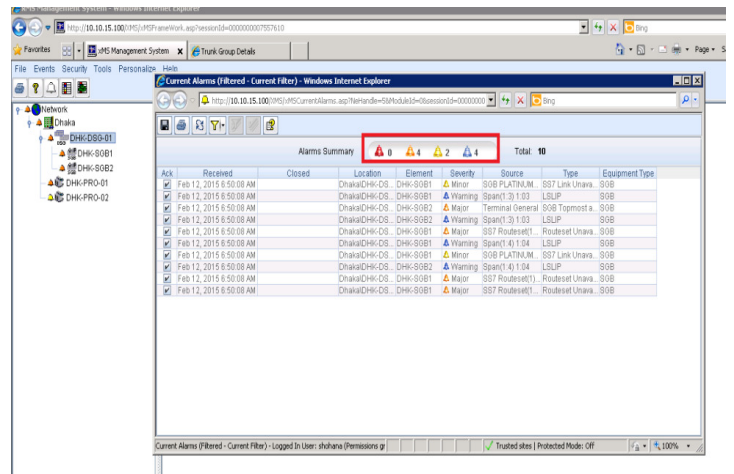


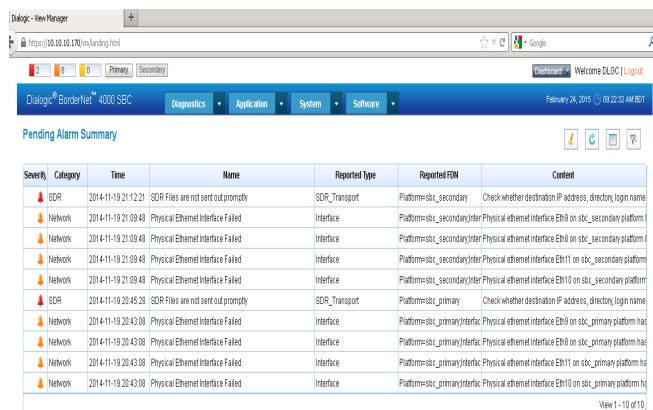
Fig. 7. DHK-DSG-01 alarm windows.

From Fig. 7, we can find that when I did this experiment, total 10 alarms were detected in the Signaling Gateway DHK-DSG-01. Among them 4 alarms were warning, 2 alarms were minor and 4 alarms were major. For example, the first alarm in the list was an SS7 Link Unavailable minor alarm in “DHK-SGB1” from “SGB PLATINUM” locating the error in “Dhaka\DHK-DS”. The date and time of that error was also identified.

- ✓ **My recommended solutions:** Call routing path should be changed to make the SS7 Link available.

### E. Alarm checking for SBC

SBC is Session Border Controller [9]. In order to check alarm for SBC, first need to be accessed in the SBC server address 10.10.10.170. Being logged in with access ID and password, alarm severity can be checked.



Severity	Category	Time	Name	Reported Type	Reported FQDN	Content
Warning	SDR	2014-11-19 21:12:21	SDR Files are not sent out promptly	SDR_Transport	Platform-sbc_secondary	Check whether destination IP address, directory, login name
Major	Network	2014-11-19 21:09:49	Physical Ethernet Interface Failed	Interface	Platform-sbc_secondary/inter	Physical ethernet interface Eth0 on sbc_secondary platform
Major	Network	2014-11-19 21:09:49	Physical Ethernet Interface Failed	Interface	Platform-sbc_secondary/inter	Physical ethernet interface Eth0 on sbc_secondary platform
Major	Network	2014-11-19 21:09:49	Physical Ethernet Interface Failed	Interface	Platform-sbc_secondary/inter	Physical ethernet interface Eth11 on sbc_secondary platform
Major	Network	2014-11-19 21:09:49	Physical Ethernet Interface Failed	Interface	Platform-sbc_secondary/inter	Physical ethernet interface Eth10 on sbc_secondary platform
Warning	SDR	2014-11-19 20:45:28	SDR Files are not sent out promptly	SDR_Transport	Platform-sbc_primary	Check whether destination IP address, directory, login name
Major	Network	2014-11-19 20:43:08	Physical Ethernet Interface Failed	Interface	Platform-sbc_primary/interfac	Physical ethernet interface Eth0 on sbc_primary platform ha
Major	Network	2014-11-19 20:43:08	Physical Ethernet Interface Failed	Interface	Platform-sbc_primary/interfac	Physical ethernet interface Eth0 on sbc_primary platform ha
Major	Network	2014-11-19 20:43:08	Physical Ethernet Interface Failed	Interface	Platform-sbc_primary/interfac	Physical ethernet interface Eth11 on sbc_primary platform ha
Major	Network	2014-11-19 20:43:08	Physical Ethernet Interface Failed	Interface	Platform-sbc_primary/interfac	Physical ethernet interface Eth10 on sbc_primary platform ha

Fig. 8. SBC alarm windows.

From Fig. 8, we can get the detail information of all alarms in the SBC. For example, when I did this checking, I got a “Physical Ethernet Interface Failed” alarm. It was a major alarm which denoted that an ethernet interface in SBC was failed physically. The date and time of the error was also identified with all other details.

- ✓ **My recommended solutions:** Changing the Ethernet Interface or port of SBC.

### V. CONCLUSION

In this paper we have shown the procedure of checking different alarms in IGWs and identifying the errors and problems in the IGW connectivity using different alarms. We have presented a method of identifying the type and area of the errors occurred in IGW communication fast and easily, so that the errors could be corrected by taking appropriate steps. Very often error issues arise due to traffic statistics and

customer complains. These issues need to be solved very fast and commercially. This study will be very helpful for the network operators and telecom society to solve those issues commercially.

### ACKNOWLEDGMENT

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# Rescue Robot

## A dual mode robotic vehicle to locate human victims in structural failure

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**Abstract**—A human life is far more important than a robot. Robots are ideal for use in dangerous rescue operation instead of human rescue workers. This paper describes the design and implementation of a robotic vehicle that can navigate itself through obstacles, simultaneously localizing and moving through the maze to detect and allocate a human body by behavioral execution, which can also be instructed by an android platform to carry out particular commands. Our designed robot can work in catastrophes like building or structure collapse due to earthquake, fire, avalanche, nuclear catastrophe, mine fields, etc.

**Keywords**—Autonomous; Robot; Arduino Microcontroller; GPS; Sensors; Arducam; Android; Bluetooth;

### I. INTRODUCTION

Bangladesh has encountered the deadliest structural failure in human history in 2013 when Rana Plaza collapse on 24<sup>th</sup> April. After the endless search mission of 20 days of clearing the rubbles to find the garments worker, dead or alive, the fire-fighter and volunteers ended with 1129 dead bodies and 2515 injured. Only if there was any faster way of looking for the injured or improved technology to identify their location, maybe the number of dead or injured would have been minimal. Rana Plaza is not the only incident, collapsed or tilted building due to natural and manmade causes is an everyday incident in Bangladesh. This kind of loss can never be reduced to zero but relying only on human based search party is not enough to reduce it to the slightest amount. The introduction of technology is much required. The best there can be is reliable, robust robot that can map its way through rubbles, detect position of human body and let the rescue team know about its finding through GPS, making it less time consuming and more efficient to easily find victims without the hassles of digging piles of debris at random places. To save a human life quickly in the safest way possible has been the main idea and inspiration of this paper.

### II. OBJECTIVE

During catastrophic incidents, only human rescue teams are not capable to search fast enough through the entire area to look for victims. Most cases the victims lay under debris which is impossible to locate. Not only that, the rescuer has to work in life threatening environment. Use of an autonomous rescue robot to map its way to find the victim will be robust, faster,

reliable and time efficient. The robot could be destroyed in this process but the life of a human being is more precious.

There has been a lot of study and researches in building rescue robots for the past couple of years. The robot built by Carnegie Mellon researchers on the USAR team to navigating the difficult terrain of a disaster site is one as such [1]. But it lacks sensors for victim detection. USA used robots during the World Trade Centre disaster in 2001, which used millimeter wave radar and forward looking infra-red camera for vision.

The most recent development is a mechanical roach robot called Cram by the researchers at University of California at Berkeley. Cockroach is able to compress its exoskeleton to around half of its original size. Plan is to be able to make it as cheap as possible and send a swarm of these robots so that they could locate people buried under rubble after earthquakes or other disasters [5].

This project aims to build a robotic vehicle that use PIR sensor for alive human detection, sound sensor to sense a victim calling for help along with camera to know the condition of victim of structural collapse area covered in rubble, trapped in voids, or entombed. This robot has two modes of operation.

- Autonomous mode
- Command mode

An Android based application or any serial terminal can be used as the controller via Bluetooth module. Also it will act as an independent autonomous robot that can navigate itself through obstacles, localizing and moving through the maze to detect a human body by behavioral execution. It is ideal for dangerous environment where sending in human rescue workers are life risk. As the position of any alive human is sensed, the rescue team is notified of the location. The robot can also be commanded by use of an android platform.

The project consists of three main parts:

- First the robot has to map its way through the catastrophic area.
- Secondly to identify any victim by use of its sensors.

- Lastly to notify the human operator about the presence of a victim along with the location of the victim.

### III. SYSTEM DESIGN

The brain of this device is the microcontroller. After a careful consideration we have decided to use an Arduino Mega 2560 R3 and an Arduino Uno R3 microcontrollers. This device has a mobile power supply to power up the microcontrollers. The Rover 5 chassis is analogous to its body. Four dc motors will be attached to the four wheel-drives which will be driven by the motor drivers acting as the leg of the device. As the power supply is switched on the microcontroller initiates the motor drivers that run the dc motors. Ultrasonic proximity sensor is like the eye of the microcontroller.

We have attached a gas sensor to the system to help the human rescuer by detecting any harmful gas or smoke, acting as the nose of the system. PIR and Sound sensor is equivalent to the touch and ears of the system. After a victim is detected the camera is used for taking the picture of the located victim or the location. Then GPS finds the longitude and latitude coordinate of the location. After that using GSM and Bluetooth facility, microcontroller sends all the required information to the control unit. Control unit can be any Android based smartphone connecting via Bluetooth module. This device initiates the rescue mission and human rescue team can take necessary steps to rescue the victim. The “Fig.1” is the basic block diagram of the system.

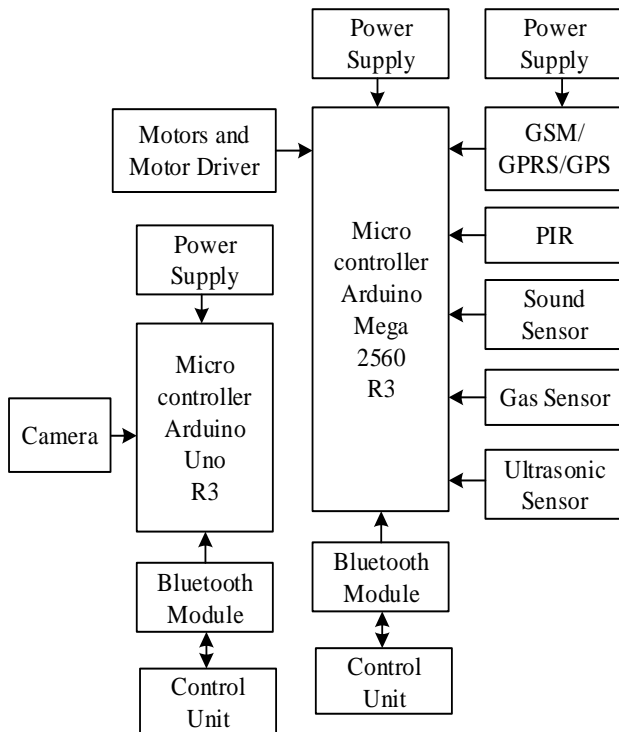


Fig. 1. Block Diagram of the System

### IV. FUNCTION OF THE SYSTEM

When we switch on the power supply of the robotic vehicle, it starts up the microcontroller. Microcontroller first initiates the motor drivers. Motor drivers consuming from its own DC power supply starts moving the DC motors and the servo motor. Microcontroller then activates the Ultrasonic, PIR, Sound and Gas sensor. Ultrasonic sensor helps the device to detect obstacles and measures the distance from itself and the obstacle. When it comes to a certain danger range it moves according to its instruction to avoid the obstacle and map its direction.

Simultaneously by using the PIR motion sensor and sound sensor it keeps looking for injured victims. The moment it locates a victim it checks if there are any dangerous or combustible gas around that area with the help of the gas sensor. Then it will take a photo of that location where victim is detected. It will initiate the GPS navigation to find the location co-ordinates as well. By using the GSM and Bluetooth module it will send the message of its finding and the sensor logs to the control unit.

Control unit will be the Android based mobile devices which are capable of receiving SMS. We are using an android platform mobile phone as there are free applications available which can be used to send commands or control the Arduino microcontroller via Bluetooth module. If the device gets stuck or to bring it back to the control unit. Once it sends of the collected information it will initiate its operation again and find another victim. The device will keep moving until its command to stop and sense a motion or human voice. The “Fig. 2” explains a flow chart of the operation of the device in a simple manner.

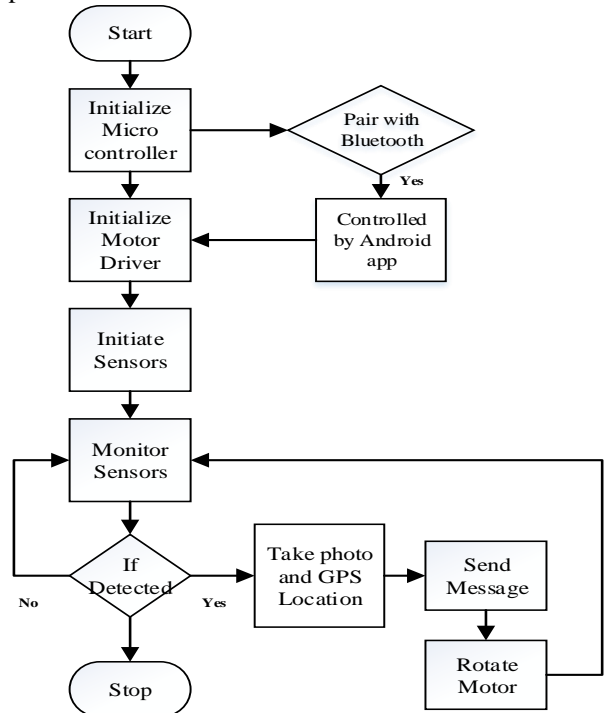


Fig. 2. Flow Chart of the System Operation

## V. COMPONENTS OF THE SYSTEM

### A. Arduino Microcontrollers

Arduino is an open-source physical computing platform based on an Interface Development Environment (IDE) that implements the human language. The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins out of which 15 pins can be used as Pulse Width Modulation (PWM) outputs, 16 analog inputs, 4 UARTs (serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. Using the Arduino IDE the microcontroller can be programmed connecting to a computer via USB cable. The Mega 2560 board is compatible with most shields and requires 7-12 Volts (V) DC power.

### B. Rover 5 Chassis and Motor Driver

Motor driver is the interfacing circuit between the microcontroller and the motor which will be attached with the four wheel drives to move the robot around. DC motor cannot be interfaced to the microcontroller directly because it required much higher voltage and current. Rover 5 motor driver is an ideal motor driver for any small 4-wheel drive. It consists of 4 motor outputs, 4 encoder inputs along with current sensing for each motor. The speed and direction of the chassis can be controlled independently for each four wheels. It can share the power from the microcontroller but for better and proper operation it can use the separate 9 volts (V) power supply. Quadrature encoder mechanism allows configuring clearance of the chassis by adjusting the angle of gear box assemblies better than any other driver.

### C. Bluetooth module

It is a hardware component which provides a wireless communication link with the both microcontrollers. The robotic vehicle is commanded by an Android platform smart device via the Bluetooth module. We are using two Bluetooth modules of model HC-06, both acting as the middleman. We also transfer the picture taken by the ArduCAM to the Control Unit via another Bluetooth module. This control Unit has to be a Computer.

### D. Ultrasonic Proximity Sensor

An ultrasonic proximity sensor uses a piezoelectric transducer to send and detect sound waves. Transducers generate high frequency sound waves and evaluate the echo by the detector which is received back after reflecting off the target. Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to the target. This distance detection allows the vehicle to detect obstacle and choose a different route to proceed. It is acting as an obstacle detector. Ultrasonic proximity sensor has a range of 1cm to 4m and detect obstacle in 30° angle [3].

This sensor is low in price and ease of use. The sensor is sensitive to air condition; also there are some minor problems during echo back if the target has a complex structure. The working process of this sensor is explained with the help of a flow chart in “Fig. 34”.

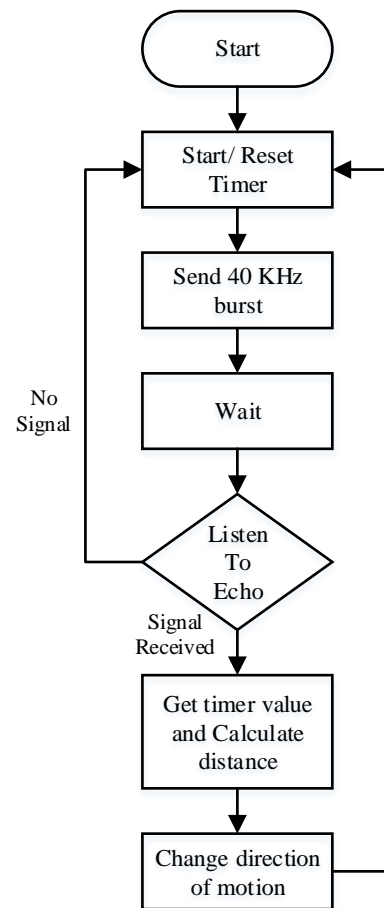


Fig. 3. Working process of Ultrasonic proximity sensor

### E. Sound Sensor

Sound sensor is a small and very easy to use audio sensing board with three different outputs. The Sound detector not only provides an audio output, but also a binary indication of the presence of sound, and an analogy representation of its amplitude.

It becomes very difficult to filter a human sound like a shout especially in a disaster area. It is not possible to keep the area totally silent to be able to hear a shouting victim. But by using the sound sensor we will be able to some victims shouting or groaning noise in this condition. We modified it by filtering out the other frequencies to allow only human range to be detected permitting us to know if a victim is seeking help.

### F. PIR Motion Sensor

Pyroelectric or Passive Infrared (PIR) is a common method of motion detection that measure changes in heat to signal the

change. The basic model is that they take IR (heat) images on two sensors at different times, when they differ, they know something has changed. We are using PIR motion sensor for victim detection purpose. It's very cheap and independent of light condition.

### G. GPS/GPRS/GSM SIM908 module

This shield with a Quad-band GSM/GPRS engine works on frequencies EGSM 900MHz/DCS 1800MHz and GSM850 MHz/PCS 1900MHz. It also supports GPS technology for satellite navigation. It's possible for the robot and the control unit to send messages and call each other using the GSM network. The control unit will be capable to send command to microcontroller by using AT commands. It requires a separate 9-12 volts (V) power supply.

### H. ArduCAM Camera module

ArduCAM modules are specially made for Arduino microcontroller, capable to take high quality and high resolution photos and save them to SD card, or even to publish or send the photos. A free application called ArduCAM\_host v1.0 has been used to receive the picture to the control unit.

We are using a 2MP image sensor with IR sensitive with proper lens combination, supports JPEG compression mode, single and multiple shoot modes, onetime capture multiple read operations, burst read operation, low power mode and etc.

### I. Gas Sensor

The choice of our gas sensor MQ-2, has high sensitivity to LPG, Propane, Carbon Monoxide, Methane, Hydrogen, Smoke, and other combustible steam, it is with low cost and suitable for different application

Sensitive material of MQ-2 is Tin Dioxide (SnO<sub>2</sub>), which is with lower conductivity in clean air. When the target combustible gas exists, the sensors conductivity is higher along with the gas concentration rising.

## VI. RESULTS

When robot will be able to detect a motion using the PIR, it will send distance information along with the message "Motion Detected" and the Latitude and Longitude position detail via serial terminal. When it detects sound it will send "Sound Detected". Gas detection is on all the time and the moment it senses harmful flammable gas it will keep sending "GAS Detected" message to the control unit. We can use serial terminal software in a computer or free applications like Bluetooth terminal in Android platform to control the Bluetooth modules and receive the sensor logs. Microcontroller will first wait for the specific ASCII code from the control unit to decide which mode to choose. Programmed ASCII codes can be sent to control the motion of the robot and to check the sensor activity of the device.

When we send the ASCII code to enable the detection, the sensors will start working and send the activity log to the control units' Bluetooth terminal. The sensor logs from an Android app are shown in "Fig. 4".

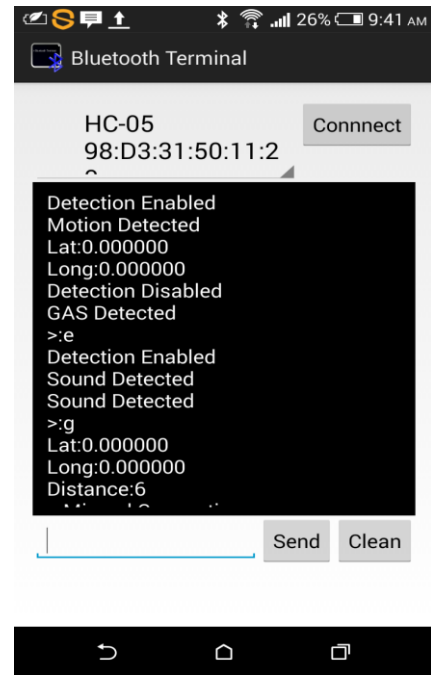


Fig. 4. Sensor logs from an Android app acting as control unit

The device will also send a SMS along with the GPS location using the GSM network with the sim card used in the SIM908 module. We are using AT commands in the source code to generate the SMS with the GPS info, and send it to a desired mobile number. For this purpose, any type of mobile phone with simple text messaging capability will do the work. "Fig. 5" shows the text message received from the SIM908 module.

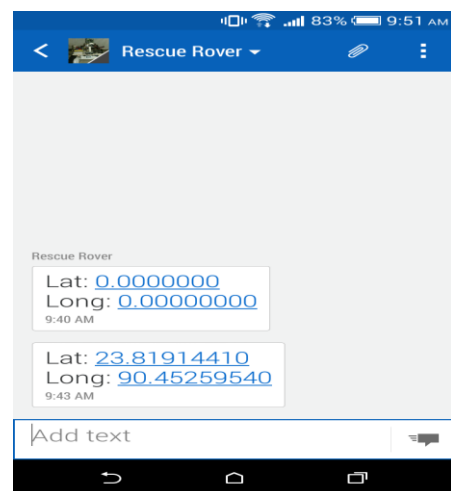


Fig. 5. Text Message from the SIM908 Module with GPS location

Using the second Bluetooth module, control unit will be connected with the ArduCAM via Arduino Uno. The control

unit needs to have the ArduCAM\_host\_v1.0 application to be able to receive the picture taken by the camera within visual range. After the correct COM port is selected in the computer, we have to open the port to get the camera ready to capture. By clicking the capture option in the ArduCAM\_host\_v1.0 we can see the picture taken by the camera shown in the “Fig. 6”.

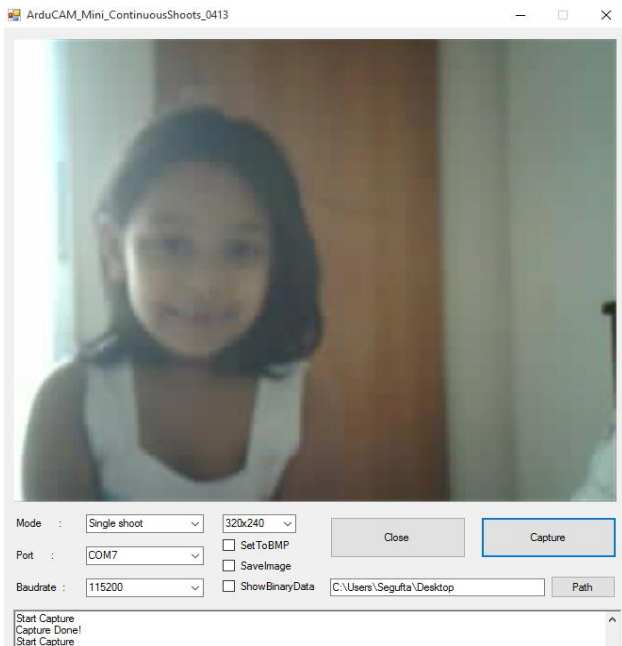


Fig. 6. Photo captured by the ArduCAM using ArduCAM host application

The final setups of all the components are shown below in “Fig. 7”.

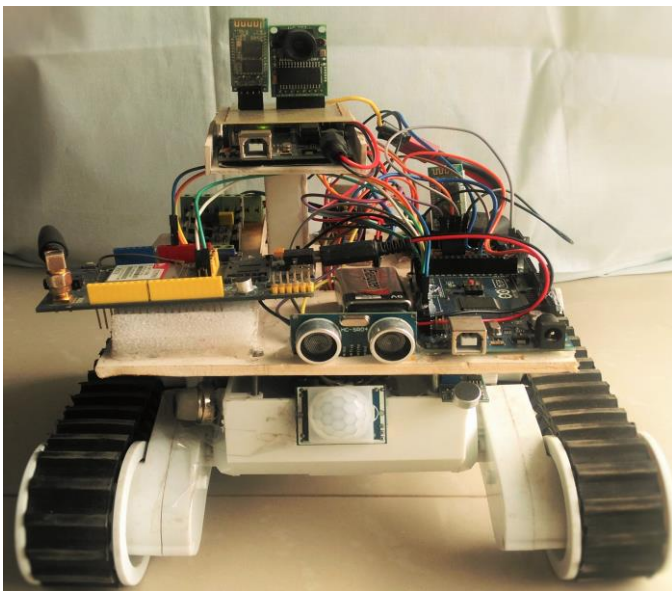


Fig. 7. Front view of Rescue Robot

## VII. DISCUSSION

In this project, the newbie technology and sensors have been used for maximum usefulness of innovation. Getting all the sensors and shields working together as a whole system is the main challenge we faced besides the following challenges.

- Mapping and simultaneous localization
- Target allocation and victim detection
- Path planning and behavioral execution
- Victim detection
- Filtering human sound

Proper power supply for different components is another problem we have faces. Heavy duty alkaline batteries do serve the purpose but it becomes expensive as we cannot recharge or reuse them. We solve this issue by using Lithium-Ion Polymer (LiPo) battery with capacity of 3500mAh as our main power source, Lead-acid battery for GSM/ GPS module and Nickel-Metal Hybrid (NiMH) rechargeable battery for Arduino Uno’s power supply.

Arduino uses sequential programming, so it is not possible to have two simultaneous works at the same time. This turned out to be a huge limitation of our project. The proposed design suggests that the robot will keep sensing using the PIR at the same time it moves around, but due to the concurring limitation of Arduino we had to design the specific task.

Even though we have used the latest technology and sensors, every object has some short come. Some limitation of sensors has been show in “Table. 1”.

TABLE I. LIMITATIONS

Sensors	Function	Range	Angle
PIR	Alive human detection	~7m	<120°
Ultrasonic Proximity Sensor	Obstacle detection	~4m	30°
ArduCAM	Visual	Frontal	0°
Gas/Smoke Sensor	Detect harmful gas and smoke	Wide range indoor	n/a
Bluetooth Module	Connect with Android App to control rover	~100m	n/a

## VIII. FEASIBILITY AND CHOSEN SOLUTION

It is feasible to build this project either with a Raspberry Pi based microcontroller or with an Arduino based microcontroller. It is often assumed these two devices are very similar but the truth is that actually they’re very different [6]. Raspberry pi can be better than Arduino in many cases, but judging the requirements and the ease of the project we choose Arduino mainly due to the following reasons:

- Arduino allows running small programs unlike the Raspberry Pi which runs a full operating system. Interacting with sensors and executing codes are lot faster and easier.
- Arduino uses basic programming language and communication with hardware is for flexible than the Raspberry Pi.
- Raspberry Pi runs on Linux based operating system with huge range of libraries and programming language. It was possible for us to gasp Arduino IDE quicker to get the project up and running in required time. Arduino shields can be added easily to increase the functionality of the board.

## IX. FUTURE IMPROVEMENTS

The victim can lie at any distance away from the robot. The use of a long distance sensor would be helpful to know the accurate position of victim.

An Ethernet or Wireless shield can be added to command the robot to choose its direction if it gets stuck at a place or perform a particular command. An Android or iOS application can be developed to specifically control this device remotely and also see the path of the device through the camera.

Command mode can be improved by using Xbee Shield which allows Arduino board to communicate wirelessly with Zigbee. It uses a mesh network to communicate over longer distance, 100-300 meters outdoor.

In disastrous areas victims bang on stuff, like wall or floor whenever unable to call for help. The robot can be modified to add a function to detect banging sound.

## X. CONCLUSION

The whole project is an approach towards the high speed technology development in relevance to structural failure due to natural or manmade calamities. There has been rescue robot project but none of them was able to cover so many opinions. This project operates in two different modes: command mode and autonomous mode. We have tried to implement all the possible latest sensors and technology in this project to make it exclusive.

This four-wheel drive makes its way through the destructive place, scanning as it moves for a clue of the presence of any victim, and as soon as its sensor receives any positive vibe of a victim, it sends a message to the mobile platform along with the GPS location of the victim. Hence, more lives can be saved in short duration as manual search is both ineffective and time consuming. Also, at times the rescuers lose their lives during the manual search through all those risky places.

Digging upon piles of rubbles without possible outcomes is both physically and mentally pressuring. As the robot detect a body, the human team can go in action without unnecessarily wasting energy at unrequired place.

This device will be able to go to places unreachable by rescue team. Searching throughout the collapsed place is hard for a human, as they can't go through a lot of narrow, contagious or deoxygenated places. This device can be a huge helping hand for the fire-fighters.

This is an effective, safe, reliable and meticulous system to ensure that no human is left behind in a rescue mission regardless of the cost due to all the high range sensors. In fact, cost is not a matter at all when human life is at stake.

## ACKNOWLEDGMENT

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# An Intelligent Traffic Management System for Multi-way Intersections Using Computer Vision Techniques

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**Abstract**—This paper presents the design and implementation of an intelligent and automated traffic control system which takes advantage of computer vision and image processing techniques. This system should help reduce traffic jams and congestion at busy road intersections. It detects the number of vehicles on each road near a node where a node represents an intersection with traffic lights. Depending on the number of vehicles on a specific node and its surrounding nodes, this system assigns optimized amount of waiting time (red signal) and driving time (green signal). It is a fully automated system which replaces the conventional pre-determined fixed-time based traffic system with a dynamic traffic system that auto-adjusts according to the changing road conditions. The designed system should help solve traffic problems in busy cities to a great extent thus saving a significant amount of man-hours that gets lost waiting on jammed roads

**Keywords**—*traffic jam; Computer Vision; image analysis; object recognition;*

## I. INTRODUCTION

“Traffic Jam” is a very common phenomenon of our daily life. Here in Dhaka city this is one of the biggest social problems in our life. In a study, it has been found that, people loses their precious 8.15 million hours, 40 percent of which are working hours –in traffic jam [2]. In Dhaka city we can see that traffic is controlled in two ways, either the lights are changing after a constant interval or traffic police is doing the work manually. Both of them are wasteful process. Sometimes in a junction we can see one side has lower pressure than other side but as the lights are changing maintaining a constant time interval, the road which has higher congestion of traffic increases rapidly. On other hand, in Dhaka most of the traffic polices are ignorant about the terrible traffic situation and it’s also very hard to look at every side of a junction constantly by one person only. That’s why we are proposing a better solution of this problem. Using the power of Artificial Intelligence we can easily build a system which will decide which road needs to be clear rapidly and it will change the time interval accordingly.

## II. RELATED WORK

While working in this research project, we have encountered several research papers which have been

conducted on traffic, analysis of traffic and optimization of traffic. Among these papers, two of them are closely related to our research bourn. Both of them have used Artificial Intelligence to solve the problem.

In one of them, research has been done using the methods of fuzzy logic to solve traffic congestion problem [3]. Fundamentally they have introduced a fuzzy controller system for an isolated four-way junction. The fuzzy controller system takes an input variable arrival which actually represents the number of cars present in the running road in a certain parameter and another input variable queue which represents the number of the cars in the waiting area. The output is basically the extension time of the running road. This total system is quite distinct from us but solves almost same problem but the main difference is they are working on a single isolated junction and calculating the extension time accordingly while we are actually considering other junctions which are directly connected with the certain junction. By doing this we are actually calculating the running time of a single node more precisely according to the neighborhood area. Another difference is, though they are working in a four junction way in their system they are actually considering two situations in their system- Traffic from the north & south and traffic from the east & west. They aren’t considering right and left turns but our designed system will do so. We are considering each road connected to a junction as a single entity and hence arbitrary number of roads can contour a traffic junction. Further

On the other hand, the second research [4] we are referring has used image analysis to solve the problem, which is more close to our research proposal. In this research they have worked on live video streams of roads. Their vehicle detection algorithm is very accurate as they have first identified whether the object is moving or not and after that they have used edge detection on those objects and after that they got the total number of vehicles. In night mode they have used headlights instead of vehicle itself and hence the system is very precise at night as well. Though this algorithm is very good in terms of vehicle counting accuracy but it comes with a good cost of processing power. To run the above algorithm in real time we need a significant amount of processing power to analyze the video feeds of an entire city. Considering that in mind we have only used pattern matching algorithm which is pretty straight forward and less heavier algorithm. We have analyzed single

image for a car count in a given time which is more cost effective as we don't want car count in every second for traffic optimization. As a result, the system is much optimized in terms of processing power and hence the system allows the server to handle more traffic. However, to active this car counting accuracy drops slightly but we can ignore the fact as we doesn't need accurate number of vehicle to provide efficient and effective traffic management system.

### III. MOTIVATION

We intent to make a system that minimizes the waiting and maximizes the running time of traffic lights. The system is intended to identify number of vehicle on each traffic node with computer vision. All the traffic signals are connected to a central server. System considers roads leaving a traffic signal as outgoing edge and roads coming towards a traffic signal as incoming edge. While determining time for a single traffic node, system considers first Childs by default of nodes connected via incoming and outgoing edge to provide better time calculation. By considering number of waiting cars on each road connected to a traffic junction system computes minimal waiting and running time for a specific node.

### IV. THEORY

Primary areas of this research is to optimize time by using the vehicle number on nearby connected traffic signal, identify number of vehicles using computer vision, develop a light intensity varying mechanism to make the vision algorithm to work independent of sounding environment.

#### A. Optimal Time computation:

Initially all node in the system have infinite waiting time and zero running time. System has a starting node predefined in the network. The system also has two thresholds for waiting and running time for a specific junction of nodes where nodes are connected by incoming and outgoing edges. For determining the waiting time for a specific node the system considers nodes connected to the junction with incoming edge and number of waiting cars on those nodes. The system sums up the number of waiting cars and makes a tentative ratio for each node. Finally the system divides the threshold with the assigned ratio for each node connected in the junction and determines waiting time. For running time using the same algorithm for waiting time the system assigns running time for each node connected in the junction. In this case system considers incoming nodes instate of outgoing nodes.

Computation on a junction:

$$\alpha_w < \text{waiting threshold} >$$

$$\alpha_R < \text{running threshold} >$$

$$S_{out} = \sum_i^n C_{out}$$

$$S_{in} = \sum_i^n C_{in}$$

$$T_w = \alpha_w \cdot \frac{W}{S_{out}} \dots \dots \dots (i)$$

$$T_R = \alpha_R \cdot \frac{W}{S_{in}} \dots \dots \dots (ii)$$

Where  $\alpha_w$  waiting time threshold and  $\alpha_R$  is the running time threshold.  $S_{out}$  represents sum of all waiting cars on the outgoing nodes and  $C_{out}$  represents number of waiting cars on each outgoing nodes. Again  $S_{in}$  represents sum of all waiting cars on the incoming nodes and  $C_{in}$  represents number of waiting cars on each incoming nodes.  $W$  is the number of waiting cars on the current node.  $T_w$  is the waiting time for the current node and  $T_R$  is the running time for current node.

#### B. Car detection with Computer Vision:

For car detection, the system takes images of free road on a specified time interval depending on the traffic pattern of the specific road. This suitable time interval is need to be predefined during the system setup. To identify car on a given time the system takes a snapshot of the road with vehicles and subtract it with the image of empty road. If absolute of subtracted is compared with a small threshold value pixels congaing cars is identified. Afterwards if we consider connected comments of the image individual cars on the image is identified. Finally total number of cars on a given image can be identified by counting individual cars.

$$[d] = [\text{Image without cars}] - [\text{Image with cars}]$$

$$[\eta, c] = \text{connectedComponents}([d])$$

$$T = \sum_{i=1}^n 1$$

Here square brackets represents matrix.  $\eta$ , represents number of connected components and  $c$  represents all the identified connectedcomponent as a matrix. We are considering "connectedComponents([d])" as a function that take matrix as input and cluster out the connected regions and returns a matrix with a one degree greater detention containing each cluster.

#### C. Light intency varing Image detection algorithm:

To identify vehicles, image of empty road is needed for our algorithm but it is not possible to achieve empty road image on every signal event. Instate of taking images on every signal event, image of empty road is taken on a specific interval, then adjusted and finally is used in the car computation. Signal nodes have light sensors. Measuring the presence of light of the original image and current time system will adjust the image of no vehicles.

In the low light condition where vehicle is barely visible, instead of identifying vehicles itself system identifies headlights of cars and count those and dividing the total number of lights by 2 gives a tentative measurement of vehicles on the traffic node

In the situation of light intensity change during the day time system takes small slice of the empty road image and take similar region from the new road image with vehicles and by subtracting these two we get the intensity change. Using this value we adjust the intensity of the subtracted image.

### V. SYSTEM DESIGN

There are two major components of the system. Small embedded device to control the traffic lights and capture images from the road. Another component to process images and performs time optimization centrally. We have considered the embedded device as traffic node and distant central component as server.

We have designed the system such a way that the image processing is done on the server and the processing the image on the embedded devices will increase the cost of the node and hence will increase the cost of the entire system in a broad scale. Processing the image on the server makes the system cost efficient and at the same time this will allow the system to process more images simultaneously with a lesser amount of time. To build the network between server and the node we have used http protocol and network techniques as it has well defined communication protocols for images and other data as well. To reduce the power consumption of each node, instate of allowing direct wireless communication with the server the nodes in a junction is be connected with a single router and that router communicates with the server wirelessly or via wire.

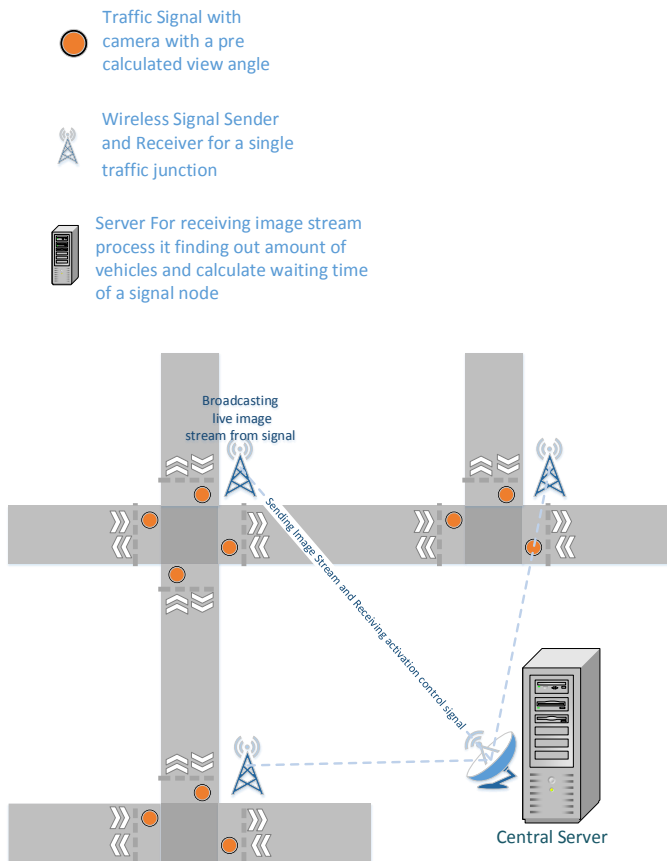


Fig. 1. System Design

A traffic node contains four different components. They are one camera, three signal lights, an Ethernet interface and a microcontroller and a junction has an additional component, a router. Our system counts car by analyzing images of street and to do so we need a component capture images and hence we need cameras. In our system design we have used VC0706 cameras. Cameras capture images depending on the instructions provided by the server. The cameras in a node are connected to a microcontroller. The microcontroller acts as the single platform on which, the traffic node is designed. As microcontroller we prefer to use ATmega328P microcontroller which has 14 input-output pins. Using these pins, a camera is communicates with the microcontroller. Arduino UNO has this

microcontroller integrated in it. So we have used Arduino UNO as microcontroller platform. We have chosen Arduino over other microcontrollers because we need a controller which can command the camera shield to capture an image and sent it to the server. We doesn't need powerful microcontroller for our purpose. Hence Using Arduino is energy and cost effective. An Ethernet interface is used to connect the microcontroller with the internet through the router. For this purpose, we have used W5100 Ethernet Shield which is an Arduino compatible Ethernet module. The Router connects all of the nodes around a junction. It establishes a connection between the server and the traffic junction using http protocol. Signal lights of three different colors remains on or off during the time interval provided by the software, which is calculated using the Optimal Time Calculation algorithm. We are using LED lights as signal lights.

Each road connected to a traffic junction has its traffic controller. Each junction has a wireless transmitter to broadcast images to server. Server has a graph of the traffic system. Each listed node on the graph has their location info and associated MAC\IP address. Initially controller device is set to red light. Server software requests for live image to traffic controller on certain time division via its IP. On request traffic controller returns live image feed to the IP/PORT from which the request was sent. On receiving image server processes it compute number of vehicles and forward to traffic management section of the software which computes optimal time for the traffic. Software sets clock for the specific node and send red light signal to controller device. Traffic controller device will set the light indicated by the server and holds its state until further instruction from the server. After the computed time elapse server sends controller device to set green light. Figure 1, describes the system, its components and its actions.

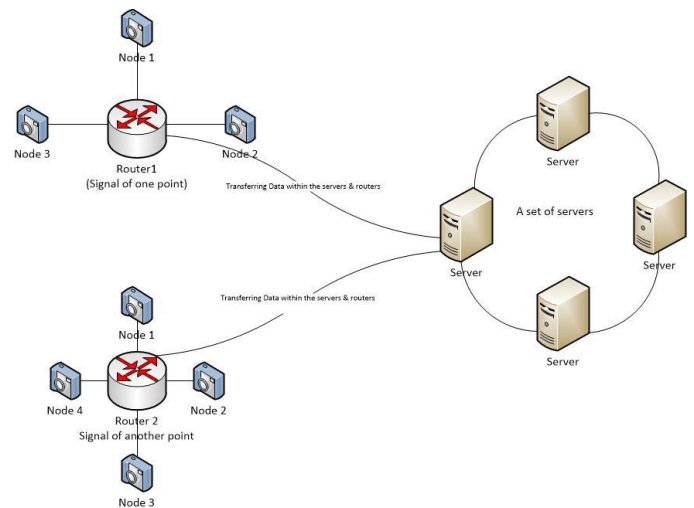


Fig. 2. Network Diagram

All the traffic nodes are connected to a server. Server takes all the decision and commends the traffic nodes. Server has software to manage the system. The Server software is based on Java platform. We are using MATLAB for image processing. Server device is connected to the network and communicates with the traffic nodes on TCP/IP port. In the server all the traffic nodes need to be registered and mapped in

its memory. Server will identify each node uniquely by their MAC address. To instruct a specific node server will use its MAC address to get the IP address from the data map and using that IP address server will communicate with the embedded device. When the system starts up, initially it command all the connected nodes to light up red light. Upon calculating optimized waiting time and running time server can command specific node to perform specific task. Instead of using only one server grid of server we can use where every server is connected with its adjacent server and makes a server web. In figure 2, we can see that instead of using any one server we are using a grid of servers.

### VI. SOFTWARE DESIGN

Two separate programs have been constructed to design the system. An embedded program has been written for the microcontroller. This program is written in C++. This software uses standard interfacing libraries to interface the components with the microcontroller. Embedded software opens a socket in TCP/IP port and creates a socket server which listens on the port for instruction. A separate program runs the server. Server software is the heart of the system. It is designed to process the images and calculated the optimal time for several junction at the same time. It can serve multiple nodes at the same time on different IP ports.

System is implemented with object oriented software design. Every traffic node is represented as an object in the software. Road to road connection is represented as directed edge. Three or four node combined together will form a junction.

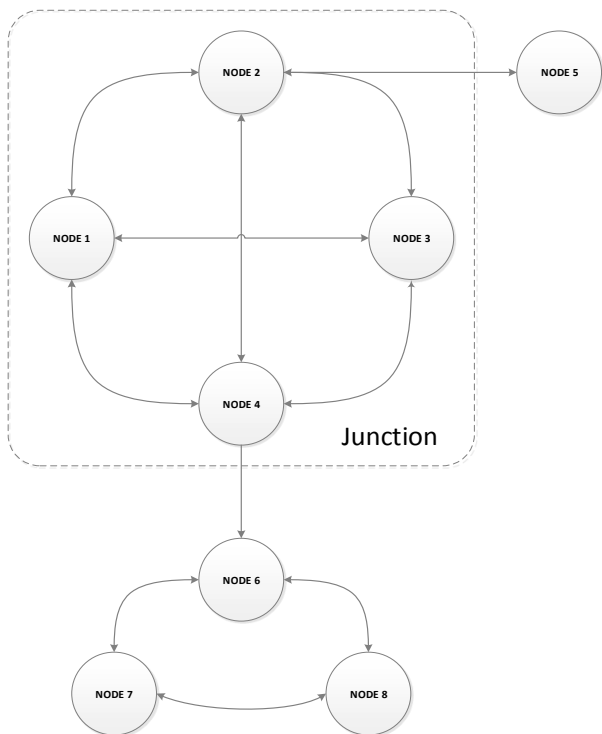


Fig. 3. Graph Representation of nodes

For example if there is a junction where 4 roads are connected then we can say that a single node on the junction can go to 3 different road and it is represented by 3 different edge. So for 4 roads there are 12 directed edges. Every incoming node has at least 1 incoming edge and at least 1 outgoing edge. All the objects and edges are represented as a graph in the system. Fig 3 describes the software representation of the system. Dashed Square is in the figure represents a 4 road connecting junction.

The software has two sections. One Section is to retrieve image, process it drive vehicle count and optimized time computation section to compute waiting time for each signal controller. These two run on different threads.

Image of Empty Street is subtracted from the image from the input stream to reduce unnecessary information. Use pattern matching algorithm to identify all rectangle shaped patterns on the image. Rectangles between specific thresholds can be considered as vehicles. Count number of vehicles and send it to the optimize time calculation section of the software to compute waiting time.

Time calculation section seeks nearby node's waiting vehicles for a given node and makes a ratio of cars. Default time slice is multiplied with the ratio and assigns time for the given node. This calculation will be further researched for further optimizing.

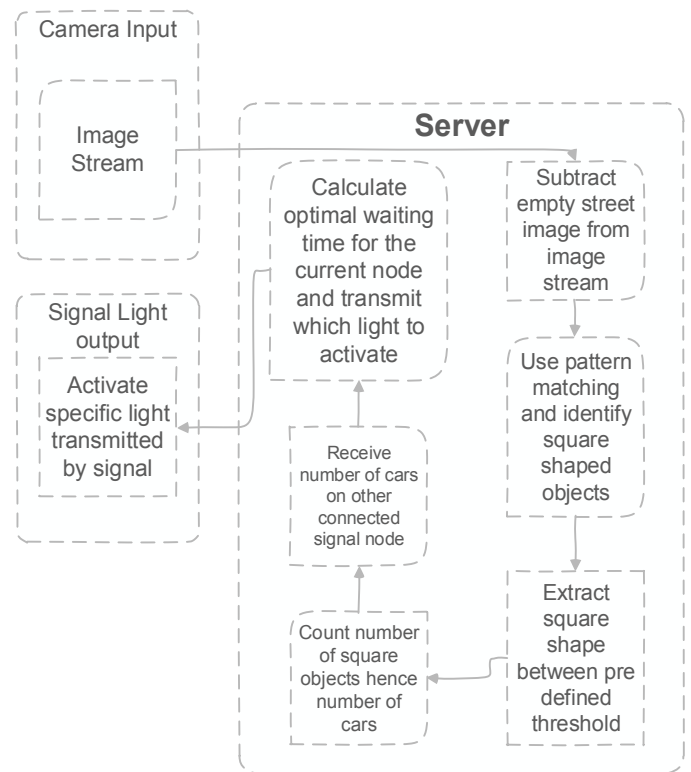


Fig. 4. Processing Software Diagram

Processing flow of the system is represented in Figure 4. From the figure we can see that incoming image as input signal and each stage it passes through the system to acquire vehicle

count to optimized time computation and finally provide light activation signal as output.

### VII. COMPONENTS AND ASSEMBLY OR SETUP

We need a system where we can capture live image from the traffic signal and that can be sent to the server over a wireless transmission.

In our research we have used the below components to construct the signal nodes:

- Arduino
- Ethernet Shield
- Camera Shield
- Router

The connections between the devices are given in figure 5.

As the Arduino board and the components Ethernet board and the camera board all three of them are directly pluggable we have just stack them on top another and attached their pins. Manufacturers of these boards provide necessary library and schematics. This is one of the reasons for selecting these boards over others. Finally two led lights have been attached on pin 5, 6, 7.

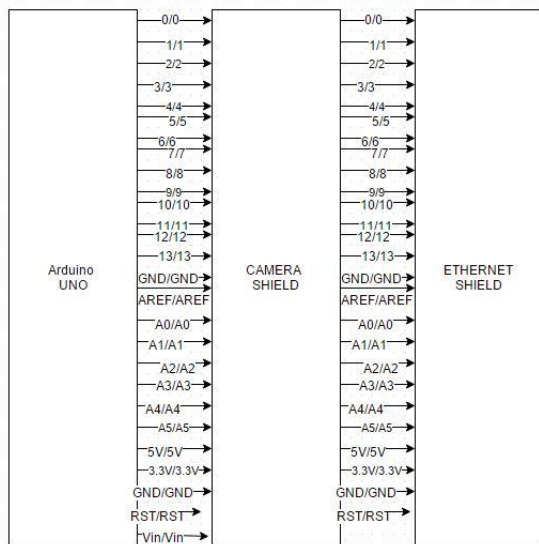


Fig. 5. Components and assembly diagram

Ether shield has an onboard Ethernet port, what has been connected to a router. As in our research we have implemented two junctions we have used two routers. We have connected nodes Ethernet port with associated router's Ethernet port. As there can be only be 3 or 4 nodes connect to a single node a router having 4 Ethernet port is good enough for this purpose. To keep the development setup simple we build the system by using wireless routers and connect those routers to a wireless Ethernet network. Regarding these facts we have used TP-Link WR740N router which a 5 port Wi-Fi router. This router communicates with the server over Wi-Fi network.

We are using simple wired Ethernet lines from the nodes to the router of a junction. It's because in a junction the nodes won't be much far away from each other and we can easily connect it to the router and as we are using Ethernet cables to connect, image passing will be both cost effective and time saving.

Least but the major component of the system, Server, is connected with the system by its onboard Wi-Fi card and we have complete system where all the components are connected in the network.

### VIII. OPERATION OF THE SYSTEM

In the previous section we have discussed about the components of our system. The total operation can be divided into three stages which are explained below.

#### A. Fetching Images Data:

Each road connected to a traffic junction has its traffic controller(nodes). Each node has a camera to capture images and has access to wireless transmitter to broadcast images to the server. But to allow the server to command the embedded device a predefined instruction is need. To acive this purpose the host socket in node listens to requests and has a defined set of instruction as system commands. Node interpretes /getImage request as capture image command. When this request is received Arduino controls the devices and capture images and sends that image back as a response to that request. Each node or traffic device has its own location information and MAC/IP address through which the server can identify the particular node. Now when the server requests an image to any node like, "http://xxx.xxx.xxx.xxx/getImage" ,the node will respond to the server. Here we are using TCP/IP protocol to send the image. Here "xxx.xxx.xxx.xxx" the IP address of the node. The image is sent to the server via wireless connection from the wireless transmitter.

#### B. Receiving and Analysis of the Image on the Sever:

This is the main part of our research work. We have explained briefly in the system design section how the image analysis process actually works. On the iterating process of calculating optimal time server will request a specific node to provide street image for the time calculation of that specific node. At the end of the request server will receive image of road and pass it to its computation section to process the image and compute optimal time. After computing optimal time server will provide light command to node.

#### C. Sending Signal to The Traffic Lights:

Just like capture images to allow the server to light up a specific light on a specific node a set of instruction is required. Node software interprets /red, /grn, /yhl request as light command and up on receiving one of this request software will light up the respective signal light. Here /red request turns on red light, /grn turns on green light /yhl turns on yellow light. Initially server turns all the traffic lights to red. Now after getting the time period for a certain signal of a junction, the server sends signal to that particular node through TCP/IP connection. Server will command to turn the traffic light green from red like "http://xxx.xxx.xxx.xxx/grn" and server counts down the time period which has been calculated by the server.

When the countdown is done server commands the traffic light to turn red again.

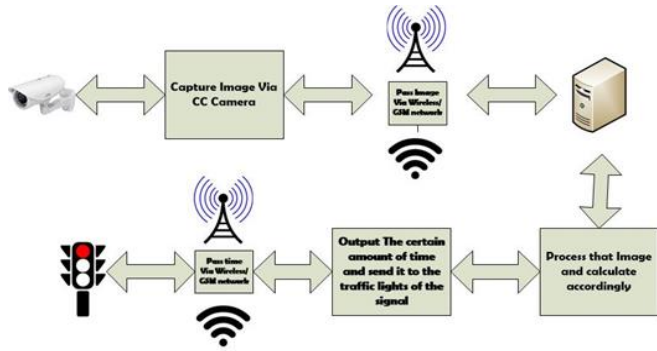


Fig. 6. Input Output signal

In this section, we have discussed about the operation of the system and in figure 6 we have shown communication the process for better understanding. The discussion was based on one junction but this process will be going on in every junction.

### IX. RESULTS AND DISCUSSIONS

This research is conducted in a replicated environment and in that environment significant evidence of time optimization was measured. In this replicated environment there were in total 9 cars but by using the image analysis we got 12 cars in total. So the accuracy is about 75%. The system got 4 cars in road 1, 5 cars in road 2 and finally 3 cars in road 3. After that the system counted the running time for each road using the algorithm that the system has been provided with. By doing this the running times for the three roads were 20s, 25s and 15s accordingly. In figure 7 the analyzed images have been shown serially and in table I the results have been given.

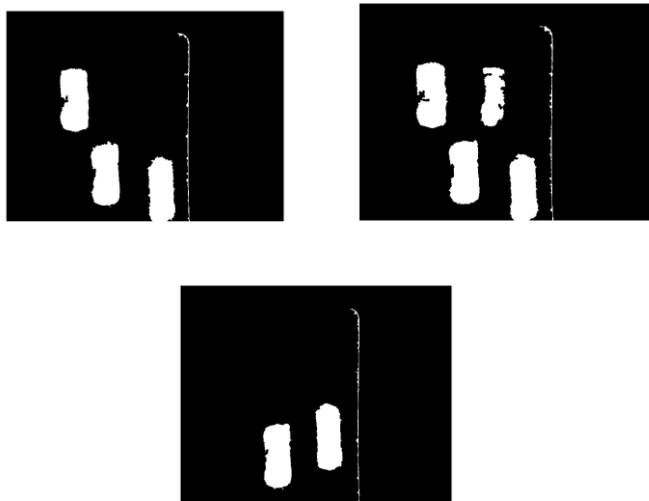


Fig. 7. Replicated situation's analyzed images for the three roads

Table I. Replicated situation's results

Fields	Number of Cars	Running time(s)	Waiting time (s)
Road1	4	20	40
Road 2	5	25	35
Road 3	3	15	45

### X. FUTURE WORK

Currently the system uses fixed or predefined thresholds depending on road to measure number of vehicles. System will be enhanced with machine learning abilities so that system itself can identify those thresholds. Currently the system runs on a single server for individual network. System can be developed such a way so that system can run on a grid of server so that multiple network can be supported under a single system. Currently the components on the road runs on external power and to optimize time and resources we have provide extra electricity. Devices on the traffic nodes can be powered by solar cell to increase power efficiency.

### ACKNOWLEDGMENT

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# A Unified Online Survey and Quizzing System

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**Abstract**—Knowledge and skills are two of the crucial parts for all living beings in this world to propagate and survive. Among all species, in humans these two things are dependent on education which has made us to come along all the way from beginning to the present world we are living in. Undoubtedly education is the secret key for our success and the root of education lies beneath competition. Throughout many ways to arrange competitive exam, MCQ type quizzes serves the main purpose of competition as they make assessment more reliable and make marking far less labor-intensive. On the other hand, Surveys help to gather quantitative information. Many companies and research institution performs surveys regarding a product or their subject of research. In order to make Quizzes and online surveys more appealing, we in this paper has proposed and implemented an online survey-quiz solution to make the work process of quiz and survey easier.

**Keywords**—Multiple Choice Questions (MCQ), Quiz, Survey, Cloud Computing, MySQL, PHP, Bootstrap

## I. INTRODUCTION

Our main objective is to design an online system where survey and quiz questionnaire can be created and shared. We believe this will help to transform the traditional paper centric process of doing survey and quizzes in Bangladesh and also all across the world. In this modern world due to ruthless aggression of Cloud Computing, it is quite easy and secure to keep data's online. Driven to take this advantage we tried to design a system that will minimize paper consumption, sudden loss of valuable papers, report making times, energy and cost.

Educational Institution spend a lot of money each year on buying and printing papers. Also big companies keep a huge amount of money in their budget for performing survey. So using the proposed system both the educational institute and companies can save a lot of money.

The system is capable of computing results of quizzes and surveys instantly as it gets responses of a question which is more efficient then the paper centric process of calculating results. Also no need of any manpower to calculate or analyze the result. Not only it computes the results of quiz and surveys in a matter of second it also represents the result in various graphical representation for simpler understanding.

In educational institute professors or teachers spend a stressful amount of time while making different set of questions for quizzes using our system they will be hugely benefited. The student will also see the result of their quizzes as soon as they finish the quiz. The professors do not have to check any quiz

papers and also all the marks will be recorded automatically by the system.

Some researchers hire interviewers to conduct their surveys. According to [1], a hired interviewer might falsify a result which may lead to inaccurate result. This may hamper the work of the researcher. But using our system are researcher do not need to hire an extra person to conduct a survey. As a result, there will be no falsification of result which will lead the researcher to an accurate result.

To understand the market response of a product and customer satisfaction companies tend to do survey [2]. Sometimes they do survey on many departments inside their company to get a better understanding of the performance of a department. This helps a company to increase their productivity and income.

## II. RELATED WORKS

In [3] the authors proposed a way they can find eligible responders to answer questions in Q&A sites. This will make the site more efficient and person who post a question will get the answer more quickly and correctly. The system first find the respondent by checking his previous answers reviews which the system record as factors. By analyzing the factor score the system determine the respondent who will be matched with the posted question.

Checking exam papers and assignment is a very tedious process for professors if they have lot of students in a class. So keeping that in mind, [4] designed a web based system which will help the professors easily check and grade assignments of their students. The proposed system is for checking Java Programming Language assignment and automatically generate the score after checking. The authors already tested the system in an Introductory Java Programming course in authors university and was highly appreciated by the students and professors. Student can submit their assignment from anywhere as the system is web based and get feedbacks in a very short time after submitting. They can also re submit an assignment after making changes according to feedback given by the system after checking their assignment.

The main goal of [5] is to gather knowledge in form of relationship data and the author thinks that computer based survey is the best option to collect relationship data than pen centric surveys. The authors talked about many advantages of computer based survey system. They also used example of a team consisting of eight members where each member can relate

his knowledge sharing with every other member of the team using the system.

### III. EXISTING SYSTEMS

There are couple of popular existing system available in the world wide web for creating survey and quiz questionnaire: SurveyMonkey and Google Form. We designed our system keeping in mind the limitation of the existing system. SurveyMonkey has limitation of creating only 10 questions [7] in a question set for free users whereas google form does not let the users download the graphical results of a survey or quiz. Though SurveyMonkey offers Unlimited Questions for pro users but the package is quite expensive for countries like Bangladesh.

So seeing these limitations we planned to offer unlimited question creation and easy download of survey or quiz results (graphical form).

### IV. OVERVIEW OF THE SYSTEM

Our system is a web based application for taking and creating quizzes or surveys online. It is a better version of take-home quiz with many twists as question order as well as option order will be shuffled so that cheating anxiety will be greatly avoided. The survey question could be made without any numerical limit and can be sent to individuals at their respective emails.

A user first creates an account in the system so that the system can keep track of his data. Then user can create a survey or quiz questionnaire and share it via email or other social media sites to get answers of his questions. Every time a respondent completes a survey or quiz, the creator of the questionnaire gets an email notification and can see the current result. The user can also set deadline for the survey and specific time for a quiz.

The survey questionnaire may consist of many type of questions e.g.

Location	★★★★★☆☆☆☆☆	12. Select all the beverages you consume during the following meal times:
Room	★★★★★☆☆☆☆☆	water <input type="checkbox"/> juice <input type="checkbox"/> soda <input type="checkbox"/> coffee <input type="checkbox"/> tea <input type="checkbox"/>
Restaurant	★★★★★☆☆☆☆☆	breakfast <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Gym	★★★★★☆☆☆☆☆	lunch <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Pool	★★★★★☆☆☆☆☆	dinner <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
<p>1. CSS Stands for...</p> <p><input type="radio"/> A) Computer Styled Sections</p> <p><input type="radio"/> B) Cascading Style Sheets</p> <p><input checked="" type="radio"/> C) Crazy Solid Shapes</p> <p><input type="radio"/> D) None of the above</p>		
<p>Zoho CRM has a user friendly interface</p> <p><input type="radio"/> 1) Strongly Agree</p> <p><input type="radio"/> 2) Agree</p> <p><input type="radio"/> 3) Neutral</p> <p><input type="radio"/> 4) Disagree</p> <p><input type="radio"/> 5) Strongly Disagree</p>		

Fig. 1. Type of survey question pattern

Fig. 1. Shows the type of questions a user can use to make a survey questionnaire. The first type is the rating, by which one can rate a particular product on a scale that will be provided by the questionnaire maker. Second type is the checkbox option where one can answer one or multiple times. Third is the radio button which offers only one answer, one can select. Finally, creating questions based on Level of Measurement.

Quiz question type will only consist of MCQ's where one can give one or multiple answers. The answer of the Quiz

Question will be preset in the database so that when one completes a quiz the system can instantly check and deliver the result. Also Quiz questions and answered will be shuffled based on the number of pupil it is shared on.

There are two main important part in our system structure. One is the frontend and other one is the backend. Frontend is a interface that directly communicate with the user where backend directly communicate with the database. For Frontend we have use Bootstrap [6]. Bootstrap is framework which helps a website more attractive and responsive. One of the main reason we use bootstrap is that it automatically adjusts the design of the web content according to the devices a user is using. So if a user is using the system from mobile devices he will have no problem using the system. The bootstrap has inbuilt JavaScript function which also helped us to design a responsive system webpage.

To communicate with database (i.e. backend) we used Php programming language. And for managing our database we used MySQL which is a Relational Database Management System (RDMS).

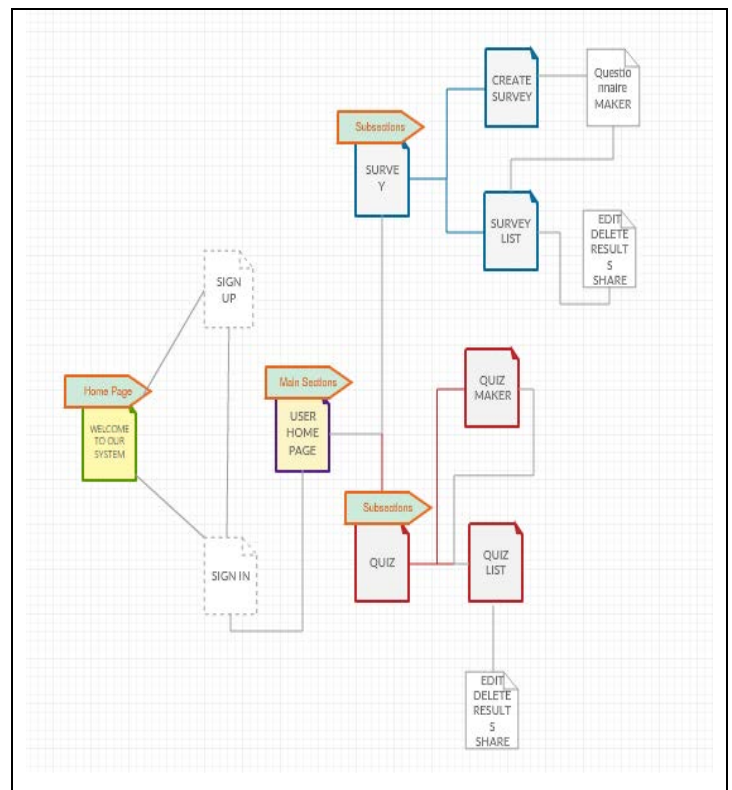


Fig. 2. System Structure

Fig. 2. Show the system structure of our website. When the user first enters the URL in the browser he/she will be greet first at the homepage. Homepage will tell the user all he/she needs to about the system and it's features. Next the user needs to register to get pass the Homepage and if a user is already registered he/she can directly move to sign in page.

After a successful login the user will be greeted with his personal homepage which will contain the history of all his recent work on the system, also can see announcement of system



admin. User can modify all his profile setting from this page and also can see or write message to other users of the system.

In the same page user will found two more subsections: Survey and Quiz. By going to the Survey section user can create, take, edit, delete and share a survey. Similarly, in the quiz section user there are two more subsections the quiz maker and quiz list. A user can create a quiz question using the quiz maker and the in the list he can edit, take, delete or share a survey. A user can only edit/delete his own created survey/quiz.

The system will represent the results of surveys in graphical form (pie chart, bar graph) whereas the quiz results will be shown in tabular form with student name and marks achieved. Results of both the survey and quiz can also be downloaded in pdf format for printing purposes.

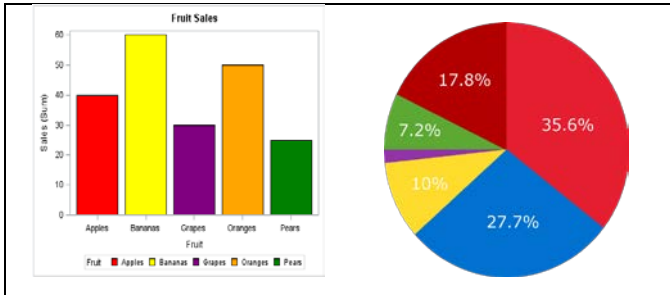


Fig. 3. Representation of Survey Results in graphical form

Obtained Marks		Scored By Students (%)	
33	100	50	50

Student	Quiz	Marks(%)	Taken On
Haidi Mursaleen	Gk on Thailand	100	2019-03-10 12:20:34
Halla Iniaz	Gk on Thailand	33	2019-03-10 12:22:18

Fig. 4. Representation of Quiz Results in tabular form

### A. Database Relational Model Design

In order to create an accurate system or website a database structure needed to be constructed that would result in a perfect relation among the variables from each data table. The Xampp software has been used to create such a database. The idea is to store all the user information, questionnaires and results. Designing good database design makes a website fast and highly demanded by users.

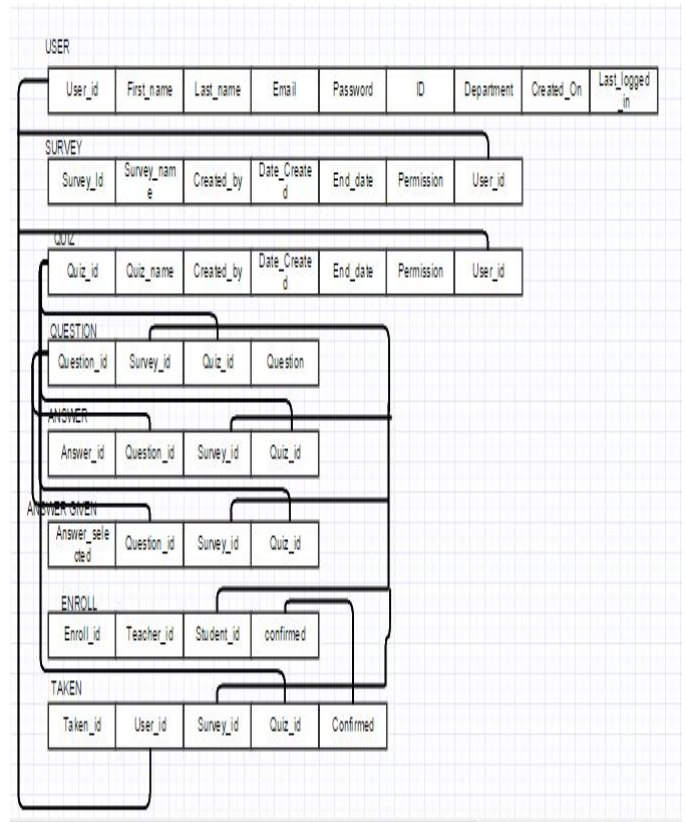


Fig. 5. Relational Model

Relational Model diagram shown in fig. 3 shows 8 table each consisting of different attributes. The attribute is where all the data's will be stored.

### B. System Equations

We have created our quiz maker in such a way so that, it will assign some weight with each questions that we will get from the teacher. We have named the weight of each question as "importance". Our goal is to generate all possible combination of questions regarding their marks so that the importance of the set of question is maximized. For example, let's say we have 4 different questions with different markings. Each question has individual importance of its own.

Marks	1	2	3	4
Importance	1	3	4	5

Now if we want to generate a question set of total marks 4 the possible ways to arrange question sets that will have a total mark of 4 are:

- Question with marks: 4, in this case total importance is: 5
- Question with marks: 1 - 1 - 1 - 1, in this case total importance is: 4.
- Question with marks: 1-1-2, in this case total importance is: 5.
- Question with marks: 2-2, in this case total importance is: 6.
- Question with marks: 3-1, in this case total importance is: 5.

As we can see, if we take two questions with marks 2 each, we will get a question set with maximum importance, so we will choose questions with marks 2 each. Now, at this point, many combination of questions with marks 2 can be generated, so, we created question sets based on each of the combinations and also we kept an option for our teacher if he has any personal preferences for questions. We were inspired by the Rod Cutting Problem of Dynamic programming to create our quiz question maker. We built an algorithm for that purpose and we named it QQM. The working mechanism of QQM is quite straightforward yet efficient; it tries to find the maximum amount of importance iteratively by considering all possible question marks given by the user. In order to achieve our goal, we used recursion to make our code short and easy to understand. Our proposed algorithm for QQM is given below in fig. 4.

---

**Algorithm 1: Quiz Question Maker (QQM)**

---

1. QQM (marks, total\_marks)
  2. if total\_marks = 0 then
  3. return 0
  4. end if
  5. importance = MinInt
  6. for i in 1 .. total\_marks loop
  7. importance=max(importance,marks(i)+QQM(marks,total\_marks-i))
  8. end loop
  9. return importance
- 

Fig. 6. Algorithm of Quiz Question Maker

**C. Performance Analysis**

The performance of the website was evaluated by testing main aspects of the website i.e. the time it took to load the webpage. Since the webpage, which is 38.9MB in size, was intended to be accessed through various devices, test was run by recording loading time for both desktop and smartphones.

Test No.	Time Taken (s)
1	21.11
2	10.12
3	8.63
4	10.44
5	10.85
6	10.95
7	11.03
8	10.66
9	9.7
10	10.78
Average	11.427

Fig. 7. Time taken to load the webpage first time on desktop

Test No.	Time Taken (s)
1	8.2
2	6.24
3	6.4
4	6.15
5	6.36
6	5.98
7	6.78
8	6.87
9	6.23
10	5.78
Average	6.499

Fig. 8. Time Taken for webpages to load on a smartphone device

The performance analysis was done to see type of benchmark the website has achieved so that users can be relieved about the anxiety of the site before they embark on the journey to utilize their goal. The various performance parameters have clearly shown that the website can be reliably pay the users off for their time and effort.

**V. TECHNOLOGY USED**

‘JetBrains PhpStorm’ software has been used for our coding platform. It is a cross platform IDE which provides an editor for programming languages PHP, HTML, CSS and JavaScript. Php scripting is required in order to access data table created in the XAMPP server and it is also helps that PhpStorm comes with a built in SQL editor. All the programming for designing our system has been done using PhpStorm.

XAMPP for our server purposes. Xampp is one of the most popular free and open source cross platform web server solution stack packages. It enables users to create a local web server in order to test database connections in website using the Apache HTTP server as a server application and also allows the creation of MySQL databases. These features allowed for the testing of our system on a local workstation before moving the website online to an ISP Hosting service. As most the components of XAMPP are similar to actual web server deployment applications, it also makes the transition of the system from the local to a live web server much easier and requires less modifications.

**VI. FUTURE WORK**

Our designed system is a unique system that will be one of a kind when introduced in Bangladesh. In future it can be used for government projects and private offices to develop a digital Bangladesh. We plan to create an API (Application Interface) in future to integrate our system with other’s existing system. It will help universities and companies to avail our feature inside their own system. Also we plan to make our system available for every platform like android, windows and IOS.

**VII. CONCLUSION**

After spending months on building and designing we are able to achieve the primary goals set at the beginning of the project. Even though a lot of complications were faced in the

programming phase of the website, the end results were achieved with great success. Hopefully it will be accepted by the users and they can come forward from the traditional process of pen and paper.

#### ACKNOWLEDGMENT

First and foremost, we would like to thank our honorable faculty advisor Dr. Hasan U. Zaman, whose vast knowledge and insightful guidance helped us design this system. We would like to thank him for always finding time to meet us despite his busy schedule. We truly appreciate his patience and encouragement that allowed us to become more and more passionate about our project.

Lastly we would like to thank our parents for giving us constant support in both mentally and financially to complete this work.

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# A Cost-effective SMS Based Tracking System Using GPS-GSM-GPRS Modules with Arduino and Smartphone

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**Abstract**—An efficient tracking system can track the location of any object or person from any location at any time. Tracking can help monitor people, vehicle, and valuable objects on the move as well as prevent theft, loss, etc. It also ensures security. This paper discusses about a short message service (SMS) based location finding and tracking system. The designed system makes good use of simple and user friendly technologies that include a smart-phone, an Arduino microcontroller and a GSM-GPS-GPRS module. This proposed system is inexpensive and easy to implement compared to other systems available in the market. The design works using Global Positioning System (GPS) and Global System for Mobile Communication / General Packet Radio Service (GSM/GPRS) technology. The device is lightweight and easily concealable. It can provide real-time location of its carrier object. When a command message is sent from a user phone to the tracking device which is installed on an object or vehicle, a return text message containing the location coordinates is sent back to the phone.

**Keywords**— *Real-time Tracking, Arduino, Microcontroller, GSM/GPS/GPRS technology, Sim908-C, Google maps API, formatting.*

## I. INTRODUCTION

It is observed that the world is experiencing accelerated growth in smart-phone ownership. As a result, smart-phone users are now more prevalent within the overall population than owners of basic mobile phones. As smart-phones become more familiar to people and finding use in the day to day lives, their influence on society continues to grow. To meet the needs of their various apps/products/services are developed. The Location Tracker management system ensures substantial productivity and gains, including greater efficiency of fleet operations, higher field workforce productivity, lower fleet operating costs and better customer service. People want everything mobility and ease of access. Uncertainty and tension grow in their mind while they are somewhere else and their belongings, or any known person is out of their sight. These days, with technology growing at a fast pace, locating system can help in a variety of ways to track and display locations in real-time. This paper proposes tracking system using GPS/GSM/GPRS technology and short message service to provide better service and cost-effective solution for users. The system aims at improving the quality and efficiency of the

industry and humanity. Missing objects, transportation and person can be found in real-time on a map. If any accident or unwanted event occurs, this tracker can be a useful tool for later solution, as well to prevent theft of belongings and keep track of vehicle's movements. GPS is usually used to find a path to any location and route anyone to their destination. In addition, vehicle monitoring service is provided by some companies but they have to rely on a call center and that is expensive too. .

## II. BACKGROUND AND MOTIVATION

Problems like not being able to know exactly when a person is in danger of theft, murder, loss of direction, or when a vehicle is going to face an accident can happen in our daily lives. These problems give us a strong motivation to develop an efficient tracking system with SMS control that can be of huge benefits for safety purposes. The proposed tracking system has features of location tracking, knowing the latitude and longitude of the place being tracked, 2d mapping of the danger and sensing accident before those occurrences.

For a practical example, recently in Bangladesh there are many murder cases being attempted around the country for several political, personal, and professional reasons. There are also many cases where people are murdered by the hijackers disguised as CNG drivers by taking them in distant solidly places because of the victims refusing them to give them money. Bangladesh is also familiar with cases where many accidents occur continuously in some highways and places due to poor infrastructure or rough driving like in Comilla and some villages. These accidents lead to several lives being lost every day.

If we build a less costly GPS tracker with SMS control for tracking and use a sensor to sense the vibration after the accident and will send an SMS the location of the accident to a pre referred person. It can be of great help in the rescue of many lives. They can be used as the initiative to save people from any kind of danger where they are simply helpless.

## III. RELATED WORK

Different papers have been published on the development of vehicle tracking system using GPS and GSM Modem[3][4][5][6][7]. In [8], differential GPS algorithm that is

capable of providing real-time near PPP service is presented. A web application and a mobile application related to vehicle tracking are presented in [9]. An effective method of vehicle tracking using wireless sensor technology and passive sensors is presented in [10]. In [11], development of real-time visual tracking system for vehicle safety applications and the concept of focus of expansion (FOE) is introduced. A low cost real time tracking system providing accurate localizations of the tracked vehicle is demonstrated in [12]. Even child based tracking systems also have been worked upon, which is mainly designed to save the children which is described in [13].

Different papers displayed the utilization of GPS/GPRS for tracking people or vehicles. However, our system is a more cost-effective method for tracking or sensing accidents using both SMS and panic button control which is easier and able to be used by anyone widely without any complications of using the proposed system.

#### IV. POSSIBLE SOLUTIONS

Two possible methods of solutions were considered for the proposed tracking system. Those two methods are:

##### A. Solution 1

A mobile, real-time GPS tracker can be made with integrated Google Maps and integrating all the different pieces of hardware and software. The GPS chip outputs the positioning information which is then transferred over a GPRS link to the mobile operator's GGSN (Gateway GPRS Support Node) and then to a remote server over a TCP connection. The TCP server stores the incoming positional data in a database. When a user clicks on the tracking page, it pops up an HTML page with an embedded JavaScript code. The JavaScript would run in the user's browser that has instructions to retrieve the positional information from the database every second. It then integrates this information into Google Maps through Google Maps API which displays the position on a map.

##### B. Solution 2

A Geo-location tracker can be made by integrating SIM908-C module which works with both GPRS and GPS technologies and allows achieving real-time tracking. Here the GPS coordinates (longitude and latitude) are read by the GPS satellite and are sent by using an HTTP request to a web server. Then a browser will load the PHP web page using Google maps to show the location in real-time. All the code, including the PHP scripts and the Arduino program can be downloaded and released with an open source license.

#### V. SOLUTION ADOPTED

For our project, we implemented "Method 2" as a mean to solve the real-time tracking problem out of the only possible two solutions. SIM908-C is integrated with a high performance GSM/GPRS engine and a GPS engine. The GSM/GPRS engine is a quad-band GSM/GPRS module that works on frequencies GSM 850MHz, EGSM 900MHz, DCS 1800MHz and PCS 1900MHz. SIM908-C features GPRS multi-slot class 10/ class 8 (optional) and supports the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4. The GPS solution offers best-in-class acquisition and tracking sensitivity, Time-To-First-Fix (TTFF) and accuracy. SIM908-C is a power saving technology as in

sleep mode, and required current is as low as 1.0mA with the GPS engine powered down. This integrates TCP/IP protocol and extended TCP/IP AT commands which are very useful for data transfer applications. The power supply range of SIM908-C is from 3.2V to 4.8V. Thus, tracking would be simpler since by sending an SMS to the locator; it will send back its location to the receiver, making it more user-friendly and easy to implement.

#### V. MAJOR HARDWARE USED

For implementing the proposed tracking system, we used the following hardware and also followed various software development and designing techniques to develop the required programs for our project

##### A. Arduino Microcontroller

The Arduino UNO R3 microcontroller is used as the brain of the tracking system where Arduino shields are used for the GPS and the GSM/GPRS modules. A software program to control them saved into the microcontroller's flash memory. Arduino can be used to develop various interactive objects. It can use input from a wide range of switches or sensors and can control several items such as lights, motors or any kind of hardware.

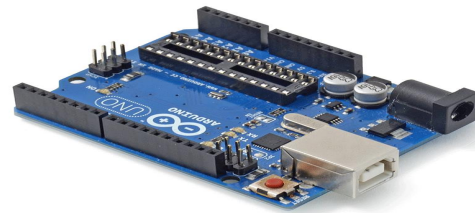


Fig.1. Arduino UNO Microcontroller

##### B. GPS Module

The Global Positioning System in tracking method is commonly used to provide users with location coordinates anywhere on Earth. The GPS module has the GPS receiver with antenna. Rx and Tx in the GPS module will be connected to microcontroller. However, if UART is selected, while trying to upload program code to the Arduino, users will see an error message in the microcontroller because the UART uses the same pin numbers that are used for programming, but nothing should get damaged. For these reasons, the GPS module should select the switch in the UART position after the source code is uploaded.

##### C. GSM/GPRS Module

The GSM/GPRS modules are responsible for establishing connections between the locating device and a remote server for transmitting the object's or person's location information using TCP/IP connection through the GSM/GPRS network.

##### D. Panic Button

The Panic button is carried by the person in danger to as a remote device to act as real time alert and sent a text or mail to the tracker.

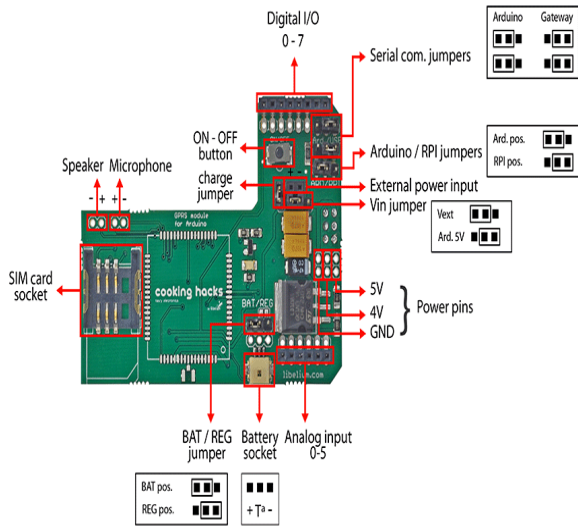


Fig.2. SIM908 with GPS and GSM/GPRS module

### E. Vibration Sensor

It is a piezoelectric sensor with a high voltage output to detect position where accident takes place and by sensing this vibration the GSM system in the vehicle sends SMS to the tracker.



Fig. 3. Vibration Sensor

### F. SIM908-C

SIM908-C is integrated with a high performance GSM/GPRS engine and a GPS engine. The GSM/GPRS engine is a quad-band GSM/GPRS module that works on frequencies GSM 850MHz, EGSM 900MHz, DCS1800MHz and PCS 1900MHz. SIM908-C features GPRS multi-shot class 10/ class 8 (optional) and supports the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4. The GPS solution offers the best-in-class acquisition and tracking sensitivity, Time-To-First-Fix (TTFF) and accuracy.

With a tiny configuration of 50mm x 33mm x 8.8mm, SIM908-C is able to meet almost all the space requirements in user applications, such as M2M, smart phone, PDA, tracker and other mobile devices.

The followings are some of the important attributes of SIM908-C:

- Serial port and debug port helps user to easily develop users' applications.
- GPS Serial port.
- Two audio channels are two audio inputs and two audio outputs that are configured by AT commands.
- Charging interface is available.
- Programmable general purpose input and output.

- The keypad and SPI display interfaces serves users to develop customized applications.
- RF connector interface.

## VI. HARDWARE ASSEMBLY AND IMPLEMENTATION

For successful functioning of our system, we assembled all the major hardware according to the following methods and implemented it by following the steps described below.

### A. Hardware Assembly

In this system, we use an Arduino UNO with the GPRS+GPS (SIM908) shield to send GPS coordinates to a mobile with an SMS and through HTTP when you call to the module designated to a specific number. When you call to the module and your phone number is correct, the GPS obtains longitude and latitude, sends an SMS with the position and send the GPS data through the Internet to the phone user.

In the first step, Arduino is connected with SIM 908C and then the GPRS+GPS shield is assembled with the antennas where the SIM card is installed inside the module. For the GPRS+GPS to connect to the cellular data network, the SIM card installed must be able to use date connectivity, thus, APN must be defined by default.

In the second step, when the GPS fix the GPS satellites, the GPRS+GPS shield will connect to the network and it will send the GPS data through the Internet. However, for our system to be efficient and less power consuming, we will not auto update the location every minute and store it somewhere, rather we will only search and locate when an SMS command is send to the device and it reads the SMS and then will send back the location coordinates if the command is correct. Block diagram of connections made are in Fig. 4.

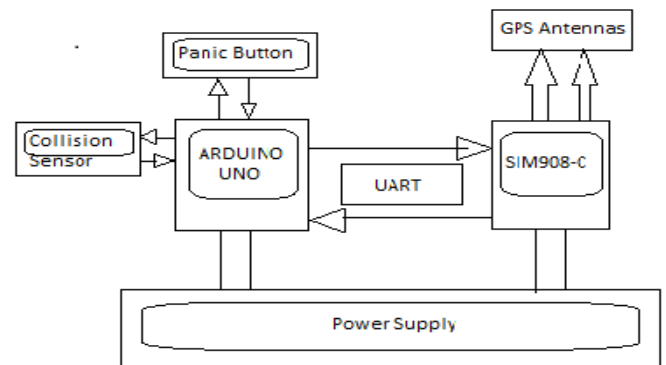


Fig. 4. Block-diagram of the connections made

### B. Implementation of the System

Arduino program is used to design the code and working mechanism of the locator, the predefined code is stored along with how and what to respond to the following possible commands and reply and send denied SMS when the command is unknown or doesn't match.

SIM908 module identifies the phone number when we call it and if it is correct, the GPS fix the GPS satellites. The GPRS+GPS shield will connect to the network and send the GPS data through HTTP request after which the position of the device is displayed using Google Maps API.

In a nutshell, it is very simple: a GPS module for position data and the 3G module that sends the HTTP request with the coordinates of any object we are tracking.

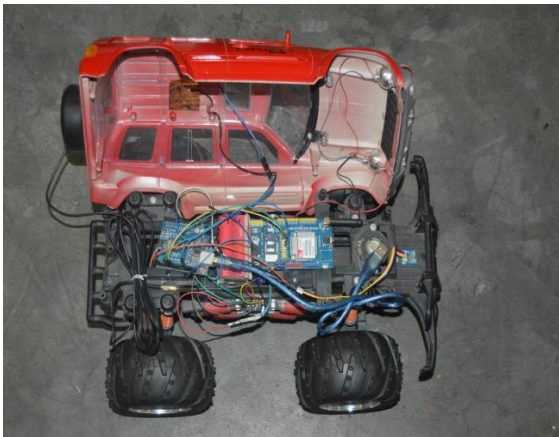


Fig. 5. System setup

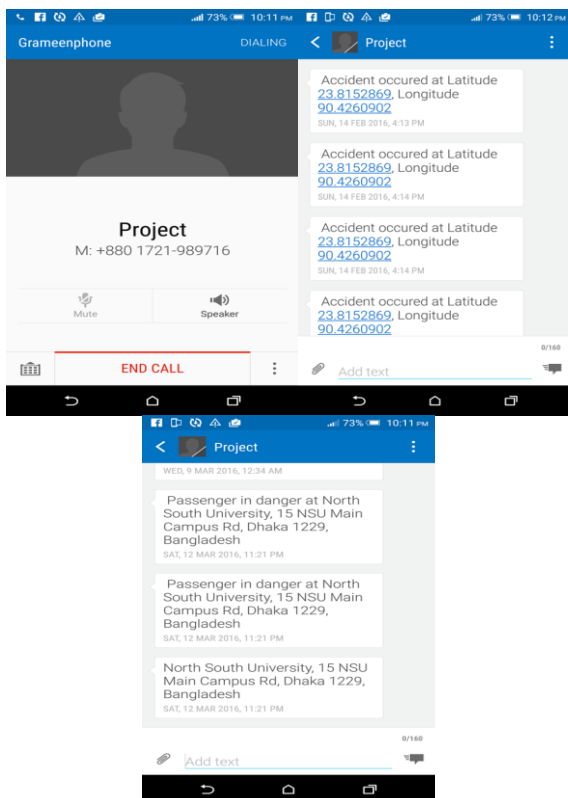


Fig. 6. SMS Control

### VII. ADVANTAGES OF THE IMPLEMENTED SYSTEM

The system is very easy and inexpensive to operate. Only an SMS should be sent containing the appropriate commands to the tracking device. The device reads the command and replies back the latitude, longitude, which the user can view on Google map and have a clear view and an idea of the location. No special skills or dependency is required to operate the system

We also designed the tracker keeping in mind the situation after any accident has already taken place. If the cellular phone is an Android Smartphone or an iPhone, the link received in the SMS can open Google Maps directly on the area where the device is situated. In the other cases, the message contains the coordinates and other data which can be used to determine the device's location separately.

### VIII. RESULTS

We developed and tested the tracking system to track the exact location of a moving or stationary object/ person in real-time. We used Arduino and SIM908 of simcom (GPS/GSM/GPRS module) and a Smartphone to remotely locate the position. We also turned this location monitoring device into a precaution or early notification system. A panic button was set on the device so that it could send the current location with one click, thus it didn't have to depend and wait for users' SMS command and then send the location coordinates. Also a shock sensor was used on our project with a car, which could sense the vibration of any accident and send SMS to the tracker. Thus tracking becomes easier and can be done anytime from anywhere.

Furthermore, our implementation is low-cost that is based on easily accessible off-the-shelf electronic modules. However, a few precautions are, SIM card should not be pin protected, credit should be available on SIM in order to operate and lastly the locator device needs power to run, thus if the battery runs out the device will not be able to send any coordinates to track.

### IX. FUTURE WORK

We also plan to include cameras on the system so that exact picture of the required location can be sent to the locator, Geo-fencing and use sensors on the GSM module on the vehicle so that it can sense the temperature and automatically send a SMS of the location if any calamity like fire is blazing.

### X. CONCLUSION

We have achieved our goal of developing and testing a tracking system to track the exact location of a moving or stationary object/ person in real-time, sensing accidents and track the location of the accident and using a panic button to send SMS to the person in danger to trace its location. Thus the tracking becomes easier and it can be used from anywhere anytime. Multiple ways have been found to implement the project, but the best and cost effective method has been chosen, where the main objective was to make a better and more useful tracking system in a cost effective way.

### ACKNOWLEDGMENTS

The project was done as an undergraduate research capstone project under the department of electrical and computer engineering, North South university. We are thankful to our honorable faculty Dr. Hasan U. Zaman, Associate Professor, for guiding and helping us in our project. The project was on sms based GPS tracking, with a prototype built for a proof of concept..

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# Cost Effective Home Automation

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**Abstract**—This paper describes the design and prototype implementation of a cost effective home automation system, where several sensor nodes such as temperature sensors, humidity sensors, gas/smoke sensors, sound sensors, water leakage sensors are connected to the microcontroller. A wireless transceiver is also connected to that microcontroller. There is an additional microcontroller, on top of which there is an Ethernet shield installed. Further this setup is extended by attaching another wireless transceiver. This microcontroller is attached to the Ethernet to get access to internet. The other feature of this system is that the user can access this system to control their home appliances remotely from anywhere. There is a web interface and a mobile app in this system as well. The user can use them to easily login to the system and control their home appliances.

**Keywords**—Home Automation; Internet of Things (IoT); Micro Controllers; Arduino

## I. INTRODUCTION

In the today's world home automation systems are used more and more. The benefit of home automation is it increases comfort especially when employed in a private home. But the home automation can be extended to the commercial buildings. This not only increase comfort but also allow centralized control of heating, ventilation, air condition and lighting. Hence, they contribute to an overall cost reduction and also to energy saving which is certainly a main issue today.

There are lots of existing home automation systems. Some are built on wire based, some are based on wireless, some are open source, and some are proprietary.

Wired based home automation include a controller using a mobile phone via USB cable [1]. Wireless based home automations include Zigbee network [2] and using WiFi shield [5]. The problem of these system is, they are either short in range, complex to setup or expensive.

Many companies are in 'Home Automation' business now. Companies like Nest and Philips are mentionable. The company Nest makes devices like thermostat, smoke detection and security camera to make people's life easier. The products of Philips hue help people to automate their household lighting system, control the lights from anywhere or automate the lights.

Philips Hue system comes with apps, switches and other switches to control the lights. [7]

But our approach is build a Home Automation system which is easy to setup, easy to use, user friendly UI and most importantly cost effective.

## II. RELATED WORK

So far we have researched in this field, we found that there is no such system like us as cost effective and easy to use by the end user.

D. Javale, M. Mohsin, and S. Nandanwar [1] make their home automation using Android Accessory Development Kit. Their main objective to help handicapped and old aged people by enabling them to control home appliances and alert system in critical situation. Their actions performed by the Android device which is connected with an embedded device via USB port. The main problem of this system is, it is limited to use on one type of device i.e. Android. And it should be connected to the embedded system through a USB port.

M. Varchola and M. Drutarovsky [2] initiated to make home automation system using ZigBee. In their ZigBee radios, there are three typical ZigBee network and those are Zigbee coordinator, ZigBee router, Zigbee end devices. But the limitation of this solution is that ZigBee works in local area network. Their approximate operation range is 30 – 100 m. And their approximate bit rate is 250 kbps.

S. I. Azid and S. Kumar [3] devised a home automation system which is extended to a security system. Their solution is SMS based. Which is, in turn, costly. You need to pay each time of your request. Their GSM experiment showed that it took 8-10s for the security system to respond the occupant and relevant civil authorities in case of emergency. And it took about 18-22s for the occupant to switch and monitor lights and appliances and then get feedback from home depending upon the network traffic. So in the one side it is costly and in the other side it is time consuming solution. In this current world where users want responses with in a fraction of a second and should be cost effective, this solution is way unacceptable for this present world.

A. E. Shafee and K. A. Hamed [6] proposed a design and prototype implementation of home automation system that uses WiFi technology as a network infrastructure connecting its parts.

Their system consists of three main modules, the server, the hardware interface module, and the software package. Their proposed system's function is similar to us. For example, they include temperature and humidity sensor, motion detection, fire and smoke detection, light level etc. The main problem of this solution is that they used WiFi shield for each and every sensor node. Where are using wireless transceiver for each node sensor and which is much cheaper solution than WiFi shield.

### III. THEORY

Our home automation system is comprised with several sensors, micro-controllers, and wireless transceivers. Sensor nodes are attached on a micro-controller. There is also a transceiver connected to that micro-controller. On other side of our system, there is another micro-controller and top of that, there is an Ethernet shield. That Ethernet shield connected to a router to get access to the Internet as well as Local Area Network (LAN). On this system we also attach another wireless transceiver. So the sensor nodes' micro-controller sends information via wireless (RF) transceiver. That information will be received by another end's wireless (RF) transceiver which attached to the Ethernet shield. Since the Ethernet shield is connected to the router it is able to send information to a PC, MAC, Raspberry Pi, as well as to any mobile phone (Android/iOS/Windows) which has access to the Internet or to that particular network. Through that PC, MAC, Raspberry Pi or mobile phone end user can access to their home appliances and they can turn on and off their light, fan, air-condition etc. They can also monitor the house's room temperature, humidity, any smoke detection, and even water leakage.

### IV. SYSTEM DESIGN

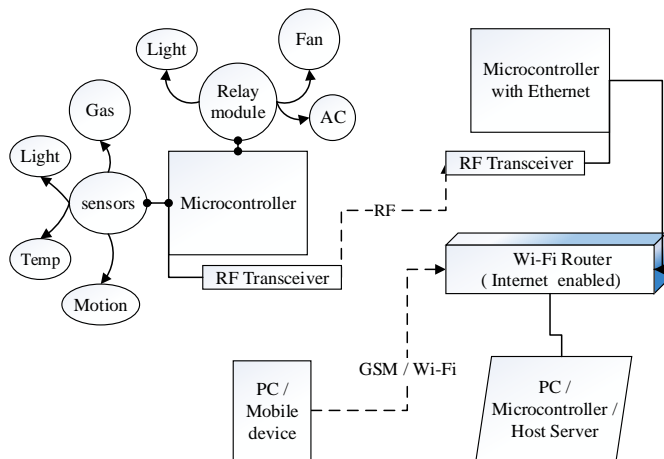


Fig. 1. Block Diagram of the System

This is our main system design showed in Fig. 1. On the left side of the diagram there is a microcontroller. On that microcontroller, there is a sensor node like gas sensor, light sensor, temperature sensor, humidity sensor, motion sensor etc. On the other hand of this microcontroller, there is a relay

module. We can attach multiple relay module if we wish as well. Relay module is necessary to connect alternative current's (AC) appliance. On this relay module we can attach our connections of light, fan, air-condition and other any home appliance.

On the left side of the system on Fig. 1 there is another microcontroller. But on this microcontroller we attach an Ethernet shield. Both microcontrollers (right side and left side) are equipped with RF transceiver. This RF transceiver is 433 MHz and has range up to one kilometer in open space.

Sensor node's RF transceiver receive data from sensor node via the microcontroller that attach to it. Then the RF transceiver sends those data to another RF transceiver that attach on the microcontroller with Ethernet shield. When microcontroller with Ethernet shield's transceiver get the data, it will send those data using the Ethernet gateway to the router. Then router will send the data to the server. Then it will available to the clients.

### V. COMPONENTS AND SETUP

In this diagram on Fig. 2, we show our components and its setup. Here we have an Arduino UNO. Arduino UNO has several pin configurations. Where D<sub>0</sub> to D<sub>13</sub> is used for digital pin, A<sub>0</sub> to A<sub>5</sub> is for analog pin. GND for ground connection. There is also a 3.3V connection, 5V connection and a V<sub>in</sub> connection. There are also other pins like ioref, Aref, reset, those are not important here.

For this setup, we use A<sub>0</sub> pin for temperature sensor. Temperature sensor is on top middle in our Fig. 2. Temperature sensor also has several pin. And those are V<sub>cc</sub> for voltage in. GND for ground, and out for its output. So here we connect V<sub>cc</sub> to the 5V of the Arduino UNO board. Out pin connected to the A<sub>0</sub>, and GND connect to the ground of the Arduino UNO board.

We use A<sub>1</sub> pin of the Arduino UNO for the light sensor. Light sensor has very simple connection setup. One is connected to A<sub>1</sub> and its GND is connected to the ground on Arduino UNO board.

We use A<sub>2</sub> pin of the Arduino UNO for the gas sensor. Gas sensor's pin configuration is B<sub>1</sub> connected to the GND of the Arduino UNO board, H<sub>2</sub> connected to the A<sub>2</sub> of the Arduino UNO board, A<sub>1</sub> of the gas sensor's pin connected to the V<sub>cc</sub> of the relay module. And H<sub>1</sub> pin connected to the 5V of the Arduino UNO board.

We use D<sub>0</sub> and D<sub>1</sub> of the Arduino UNO on our wireless transceiver's TXD and RXD pin respectively. And GND of the wireless transceiver is connected to the ground of the Arduino UNO board.

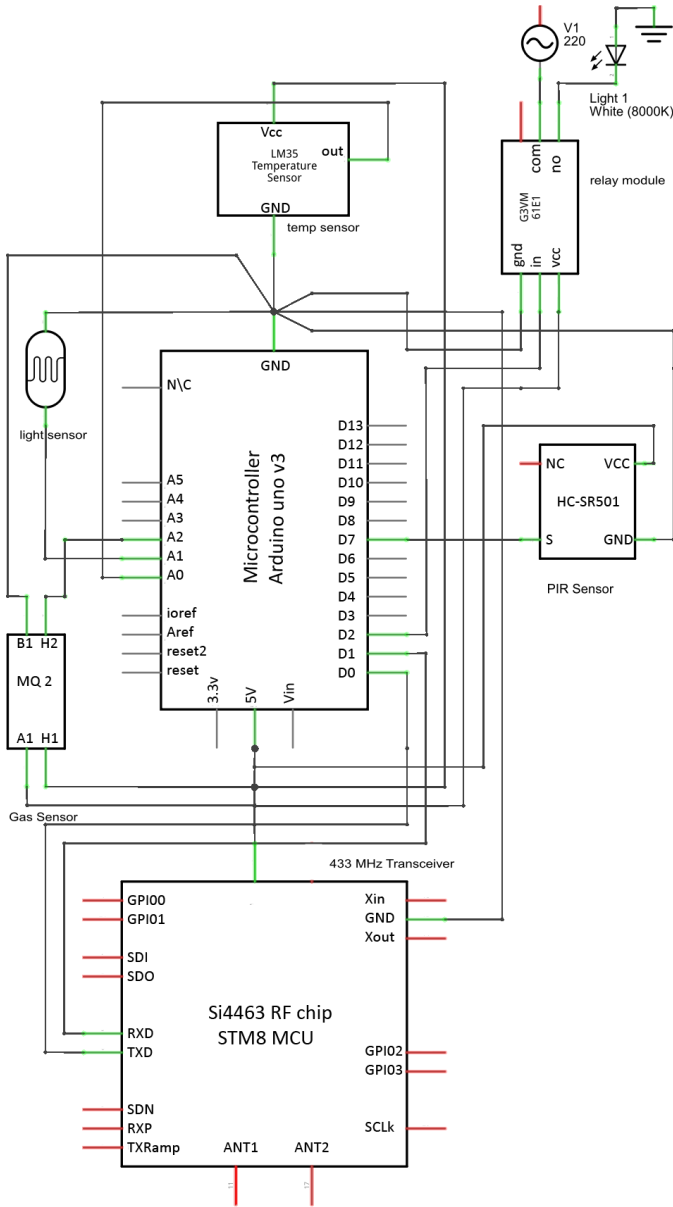


Fig. 2. Components' Connection Diagram

For PIR sensor, we use D<sub>7</sub> of the Arduino UNO and it is connected to the S pin of the PIR sensor. PIR sensor's V<sub>cc</sub> goes to the 5V connection of the Arduino UNO and GND goes to the ground connection.

For the relay module, GND pin goes to the ground connection. In pin goes to the D<sub>2</sub> of the Arduino UNO board. COM connection of the relay board goes to line of AC (220V). And NO connection goes to any appliance's input and other side of that connection should be grounded.

## VI. PRINCIPLE OF OPERATION

Our system has basically three parts. Namely, sensor node, Ethernet gateway, and end user's PC, Mac, Raspberry Pi or any Mobile phone with access of internet connection.

Sensor node is a system which build with a micro-controller i.e. Arduino UNO and some sensors like temperature, humidity, sound, gas/smoke, water leakage detecting sensors. Then we attached a wireless (RF 433 MHz) transceiver on this system. The main function of this wireless transceiver is to collect data from sensors and send to the other part of our system which is Ethernet gateway.

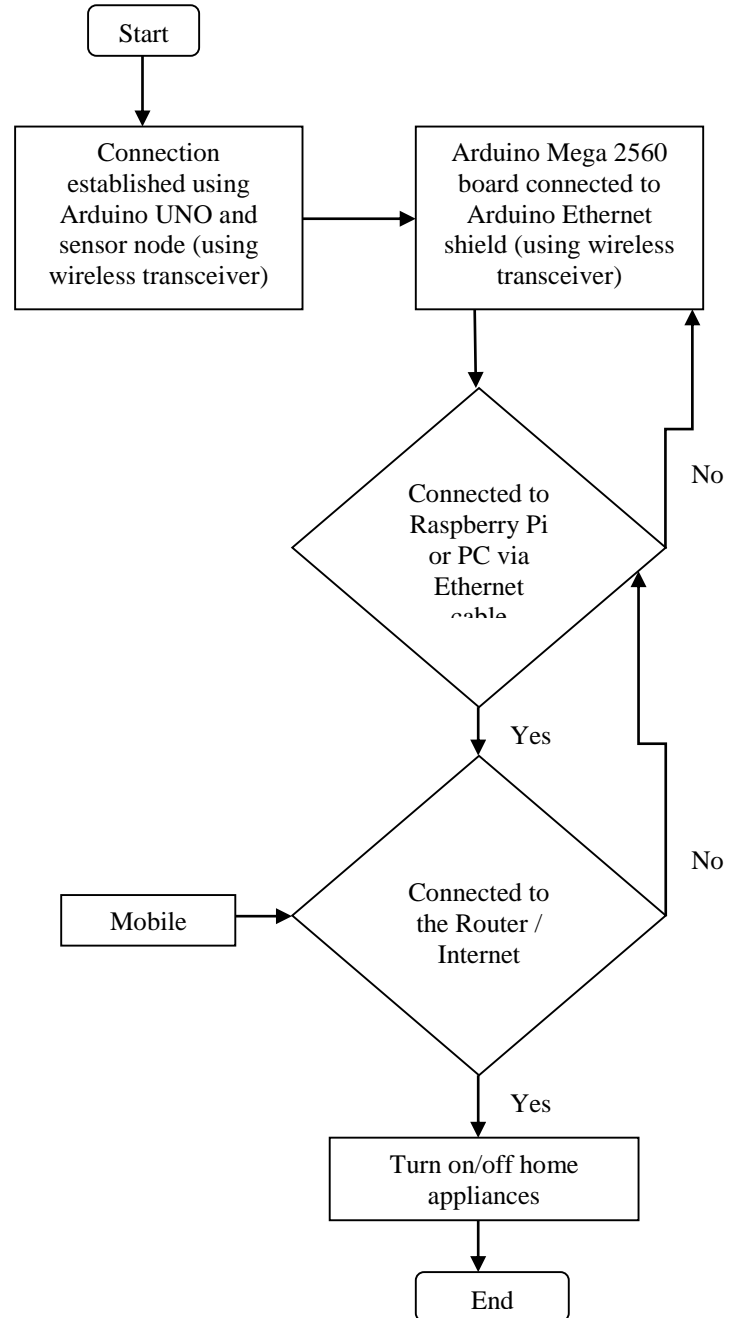


Fig. 3. Flow chart of the system

Ethernet gateway comprise of a microcontroller, in this case we used Arduino Mega 2560, on top of that we installed Arduino Ethernet shield. Then we attached another wireless (RF 433 MHz) transceiver on this system. The main function of this transceiver is to collect data wirelessly from other part where our sensors are attached. By collecting those sensor data, it passes to the Ethernet gateway to the PC or Mac or Raspberry Pi where a server has hosted to distribute those data to the clients. The client could be any kind of computer or mobile. It could be a PC, Linux machine, MAC, or even Raspberry Pi as well as any kind of Android, iOS, or windows mobile.

## VII. RESULT AND DISCUSSIONS

So far we have tested our home automation system is well responsive and accurate. There is almost zero latency in operation. For example, unlike other system [3], when you press light on button, you don't need to wait for a second or few to lit the light. It has executed in real time whenever you pressed the button. Like other system we don't have network traffic [3] issue, since it is operating through Ethernet connection on your own home network.

Our system is efficient because you don't need any especial port or cable [1] like USB port in our system. Ease on your hand. You may operate the whole home automation system using any kind of computer and mobile. It has wide one kilometer range for the wireless transceiver and can be access through mobile or computer from anywhere.

When it comes to wireless data transmission, we have a concern of security issue. Because wireless transmission can be invaded by the intruder if there is no security apply on the system. We use a special type of wireless transceiver which has Silab's SI4463 RF chip and STM8 MCU [4]. It has enhanced encryption and decryption methodology. So when we send and receive information through these transceiver, it has passed secure encrypted data from one transceiver to the other transceiver. After receiving the data only that particular transceiver is able to decrypt the transferred data. There is no way to invade into the system to alter the data.

Its wireless working frequency band is 433.4 – 473.0 MHz, multiple channels can be set, with the stepping of 400 KHz, and there are totally 100 channels. The maximum transmitting power of module is 100mW (20dBm), the receiving sensitivity is -117dBm at baud rate of 5,000bps in the air, and the communication distance is 1,000 m (1 Km) in open space (600 meters indoor).

## VIII. FUTURE WORK

Our current home automation system has flexibility. It is easy to use and easy to customize. Our user interface is also user friendly and secure. But innovation and improved features are not stop here. We have plan to extend this project in a greater extend. We are planning to setup a dedicated server to handle

all the requests and act accordingly. That server will have database implementation and we will use artificial intelligence and machine learning algorithm to enhance user experiences. We will develop this automation to the industrial level. Where offices and factories can save their electricity bill and enhance their working places' environment. We have also a plan to extend this home automation to provide security system for both home and offices. For example, if any unauthorized person enters in the house or office, the system will detect that face and notify to the home owner or office's manager to take appropriate action.

## IX. CONCLUSION

Home automation is automation of the home, housework or household activity. Our home automation able to automate your house's light, fan, air-condition and other home appliances. It can also detect any person's movement. It is able to sense house's temperature and humidity. It is also able to detect sound and even water leakage.

Our design is simple and easy to use. It has a nice user interface from where user can control their house's appliances. It is easy to setup and also customizable. If any user wants different setup for different floor or room, we can also able to support such demand.

## ACKNOWLEDGMENT

We acknowledge all the great work by the experts who have done their home automation and teach us how to approach to a such journey. We acknowledge our project's supervisor who has dedicated his helping hand and extends his valuable advice to us. We also thankful to the Internet from where we find our various resources for our work.

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# Universal MP controller

## A web-platform for controlling microprocessors

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**Abstract**—Everything now a days are being accessed through internet. There are even sites which are used as cloud operating systems for computers. We have studied and applied a technology which will allow anyone to control their microprocessors via internet. Our goal is to make a platform through which everyone in this world will be able to access their microprocessor from anywhere. Anybody can already do that individually. But our platform is unique because it is a common ground for all. So, a user do not need to go through all the hassles of making a server of user's own. It is already provided by us. Web platform is an effective technology for controlling microprocessor energy and performance.

**Keywords**—low cost diy; microprocessor, controlling via internet;

### I. INTRODUCTION

A microprocessor is a computer processor that incorporates the functions of a computer's central processing unit (CPU) on a single integrated circuit (IC), or at most a few integrated circuits. The microprocessor is a multitasking, programmable device that takes digital data as input, processes it according to instructions which will be stored in its memory, and provides results as output. It is the one kind of sequential digital logic because it doesn't have any internal memory. Microprocessors operate on numbers and symbols represented in the binary numeral system.

Previously, there is also a noticeable work on Dynamic voltage and frequency scaling (DVFS) which is also an effective technique for controlling microprocessor energy and performance. Recent DVFS techniques are primarily based on hardware; OS based time-interrupts, or static-compiler techniques. However, substantially greater gains can be realized when control opportunities are also explored in a dynamic compilation environment. But when it is time for more userfriendly features, then the web platform comes first.

If we could throw a question, is there any way that anybody can control their microprocessor from distance? Yes, there are some technologies like Bluetooth, NFC, via internet etc. But for that we have to make our own server. Then buy a domain. And then connect one processor with that domain. A control system is a system which is a collection of components

working together under the directions of some machine intelligence. In most cases, electronic circuits provide the intelligence, and the electromechanical components such as sensors and motors provide the interface to the physical world. In yesterday's world, so-called automatic machines or processes were controlled either by analog electronic circuits, or circuits using switches, relays, and timers. Since the advent of the inexpensive microprocessor, more and more devices and systems are being redesigned to incorporate a microprocessor controller. Basically, for a web platform controlling a microprocessor, we are using motor which will be connecting with the ARDUINO UNO with Ethernet shield.

This paper presents a design framework of web platform that control microprocessor. We have to follow the following steps Firstly, connect ARDUINO UNO with Ethernet shield. Secondly, connect and install the ARDUINO to the server computer and download and install the Ethernet library. Thirdly connect the motor to the ARDUINO with Ethernet shield. Fourthly, go to the website and register and login for the microprocessor. Thirdly, select the correct microprocessor through the website from computers or mobiles. We can also use Raspberry Pi, but we prefer ARDUINO UNO here. Because Raspberry Pi is an individual operating systems (OS) but Raspberry Pi isn't. Moreover, ARDUINO UNO is faster than Raspberry Pi. So, ARDUINO is more user friendly than Raspberry Pi is in this procedure. However, there are a couple of things we have to bear in mind. The most common Ethernet shields are basically SPI based whereas the WIFI is UART based. And The ARDUINO GSM Shield connects ARDUINO to the internet using the GPRS wireless network. But in controlling microprocessor through web platform, we are using wire connection with Ethernet shield.

There is a problem with controlling microprocessor from very distance. For example, we have to program a server. For which we need to know server side language. We figured whoever is working with a microprocessor should not spend extra time to learn the language and then buy a domain and operate. That takes valuable time and money. So, our platform will serve as a platform where you will just need to just create a new profile and register your microprocessor and you are done.

The concept of using our site is simple. If anybody registers a microprocessor and define its model then from our database we will give them a page with the pin layout. The pin layouts will be as buttons in the site and there will be a text file created in the name of the user in the browser. Our concept is the user has to add a line of code to the microprocessor program which will consist of the url of the text file in the server.

Whenever the user clicks a pin number button in the browser the pin number will be written in the text file. And the microprocessor will simply read the text file and see which number is the last one there and give output in that respective pin.

Ethernet with an ARDUINO (it could be either WIFI or Wired) is very limited. Because, in the purpose it has the lack of RAM. If you want to explore Internet connected devices, the best choice is Raspberry Pi. But ARDUINO is more faster and simpler and lack of RAM is not a big issue in here. The ARDUINO Ethernet Shield connects the ARDUINO to the internet in a very short time. We shall just have to plug this module onto our ARDUINO board, connecting it to the network with cable and following a few simple instructions. Then we'll be able to start controlling your world through the internet. As always with ARDUINO, every element of the platform – hardware, software and documentation – is freely available and open-source.

The ARDUINO Ethernet Shield needs an ARDUINO board to connect to the internet. It is mainly on the WIZNET Ethernet chip. The WIZNET provides a network stack capable of both the TCP and UDP. It supports up to four simultaneous socket connections. Use the Ethernet library to write sketches which connect to the internet using the shield. The Ethernet shield connects to an ARDUINO board using long wire-wrap headers which extend through the shield. This keeps the pin layout intact and allows another shield to be stacked on top.

## II. THEORY

The theory behind it is simple. The server provide a text file. The microprocessor reads the file. The file will only consist of a number of the pin that the user wants to send signal to. And the layout page of the website will consist of the buttons named the pins of the respective microprocessor.

To use our website a user must have access to the internet. The microprocessor must have an internet module attached to it. And we provide the user with the basic code they need to add with their existing code. If all of these is set then a user can use our site to make their microprocessor work from distance.

We are using PHP for server side maintenance and for frontend we used HTML and CSS and also Javascript. And because this is a web platform it can be used from any operating system.

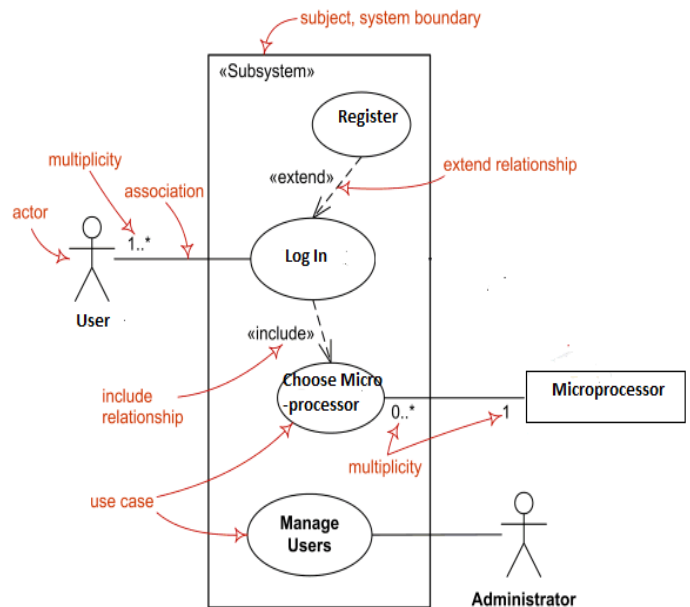


FIGURE 1: USE CASE DIAGRAM.

## III. SYSTEM DESIGN

The overall architecture is a complex hierarchical structure. Interconnected virtualized data centers with high scalability and availability are the crucial parts of the server.

The architecture consists of a server pc, a controlling device (A computer, laptop, smart phone etc), a microprocessor with internet module.

In a shield, hardware is managed in such a way that it will always connect to the particular pins. There's a trick to fr this procedure. Place Ethernet shield on the ARDUINO. Ethernet's respective pin will always connect to ARDUINO's pin .

So to solve this problem, we have to follow some steps. We don't have to place Ethernet shield directly to ARDUINO. Instead we have to connect this with the jumpers externally and change the pin 4 by the programming.

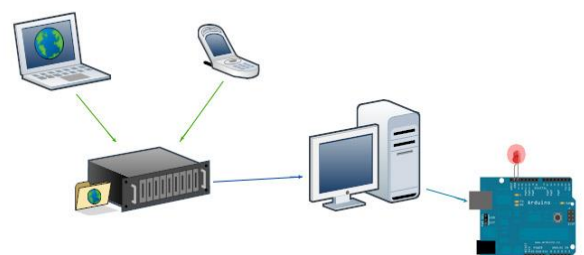


Figure 2: Proposed DIY world Architecture

#### IV. COMPONENTS AND ASSEMBLY

For the our project we have considered 2 microprocessors Label them each according to their configuration in a descending order MP A to MP B as can be seen in Table 1.

Table 1: Configuration of Microprocessors

Microprocessor label	Microprocessor Name	Operating System	RAM
MP A	ARDUINO Uno R3	ARDOS	35KB
MP B	Raspberry Pi B+ (Quad core CPU)	Linux	1 GB

Table 2 shows the ARDUINO UNO R3's technical specs.

Table 2: Technical Specs of ARDUINO UNO R3

Microcontroller	ATmega328p
Operating Voltage	5V
Input Voltage	7-12V
Input Voltage(Limit)	6-20V
Digital I/O pins	14
PWM digital I/O pins	6
Analog input pins	6
DC current per I/O pins	20mA
DC current for 3.3V pins	50mA
Flash memory	32KB
SRAM	2KB
EEPROM	1KB
Clock Speed	16MHz
Length	68.6mm
Width	53.4mm
Weight	25g

Table 3 shows the Raspberry pi's technical specs.

Table 3: Technical Specs of Raspberry pi B+

CPU	900 MHz quad core ARM cortex-A7 CPU
RAM	1GB
USB ports	4

GPIO pins	40
Full HDMI port	Yes
Ethernet port	Yes
Audio Jack and Composite video	3.5mm
Camera interface	Yes
Display interface	Yes
MicroSD card slot	Yes
Graphics core	Videocore IV 3D graphics core

#### V. PRINCIPLE OF OPERATION

We have considered two different configurations for our evaluation purpose and the details are presented in Table 3.

- **ARDUINO Ethernet Shield Configuration:** 1 ARDUINO UNO R3 and Ethernet Shield
- **Raspberry pi Configuration:** 1 Raspberry pi and Ethernet cable.

Table 3: Costs of Various Nodes

Components	Cost
<b>ARDUINO UNO R3</b>	\$15.45
<b>EthernetShield</b>	\$7.25
<b>Raspberry pi B+</b>	\$39.45

#### VI. RESULTS AND DISCUSSIONS

We have tested our devices with the web platform for different places. And if the internet connection is fine then nothing else is a problem.

But our main goal was to find out that how much time and money can be save for the developers.

To upload a site in the web with domain can cost \$9.0 yearly and learning the server side will take a fair amount of time. So, our common platform takes care of that. And also through our site a user can control multiple microprocessors.

#### VII. FUTURE WORK

It is interesting to find out how our work is related to many different streams of work in different ways. The site would still be better and much faster if instead of PHP in the server side NodeJS is used and also a noSQL database like

mongoDB is used. But noSQL's security issue and big data handling issue needs to be studied first.

## VIII. CONCLUSION

In the end we would like to call this project a success. Even though it could be much better but it is step in the right direction. And hopefully this is a big step towards making all the complexities into simplest blocks. At least this is a pioneer step towards the efficient path.

## IX. ACKNOWLEDGEMENT

First of all our appreciation goes to the faculty member DR.Hasan Uz Zaman for his undivided attention and helps to achieve this milestone. He has kept his door open the entire way for us. And also our gratefulness is divine for the North South University ECE dept for providing us a course such as 499A in which we could really work on this project.

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# Transformation of Bangla to English Word/Sentences for Proficient Net-Searching

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**Abstract:** Over 245 million peoples are using Bangla to converse and gigantic number of them use internet for their preferred information. A problem is seen that, lots of people do not know English as well, especially when they need information from internet by search engines. Some does get appropriate results for their deplorable understanding in English. To overcome this downside this interface is developed to easy conversation of bangle to English using search engines [8].

**Keywords:** Bangla Net-Searching, Browser apps, Language Converter.

## I. INTRODUCTION

In this age of Information Technology, at present we have to used search engines or web browser to find our aspirated information for all purposes of communication. In fact we cannot think a day without using search have done over internet, and to used internet we need to have a search engine and web browser (including Internet Explorer, Mozilla Firefox, Google Chrome, etc)[8]. People with lacking of English knowledge very often suffer to search in internet. So we are trying to give some additional facilities to user through an interface in web-browser, so that they can drive a search by using Bangla alphabet (have to used Bijoy or Avro keyboard to write Bangla alphabet [5] or Bangla word written in English alphabet or in the regular language[6][7], which is English. Whatever, every time the search result is appear in English.

The main idea behind developing this interface is to provide the capability of using search engines to those users who use search engines everyday in their life, but do not have too much knowledge of using vocabulary to write search request correctly to find approximate search information. These people can use our interface to do browsing easily by themselves, because people like them can search information by written in Bangla alphabet (i.e. বাংলাদেশ ইতিহাস) or Bangla written in English alphabet (Bangladesh etihias) or if someone enable in browsing, then he can search in English (Bangladesh history) also. As a result, lack of inefficiency in language, one can find his desire information by using any of these above formats.

## II. DESIGN METHODOLOGY

We have provided a database which connected with our developed interface. This database contains a table called 'bangla\_english', which holds data that can be used for Bangla to English conversion. This database is like English to Bengali conversion dictionary. The main differences between this

database and typical dictionary are in conversion process. In a typical dictionary only words can be translated. But in our developed database system it can convert whole sentence with prior grammatical knowledge. When someone search any information by writing in Bangla, like “বাংলাদেশ ইতিহাস”, at first these Bangla word's send to the database to check whether it is available in the database. If so, then there are some necessary grammatical rules will be applied for appropriate conversion and finally the converted English sentence “Bangladesh history”, is send to the search engine as it's parameter. After getting this parameter, the default browser (which user currently using) will display the relevant search result.

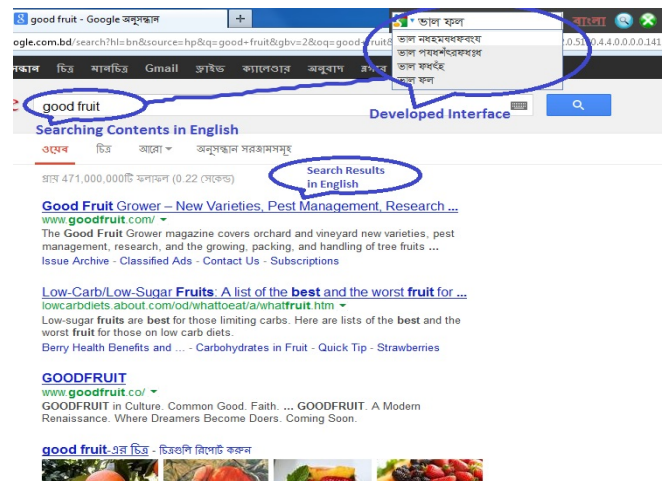


Fig. 1: Developed Search engine converter

The important feature and characteristic of this interface is following:

- The developed interface can be used without the prior concern of opening a web-browser. It automatically open the browser when enter button is pressed.
- Desired contents can be written in Bengali, In Bengali pronounced (using English alphabet) or English are allowed here.
- Targeted search result always in English.
- Drag and drop search engine selection (i.e. Google, Yahoo, Bing) are available.
- The interface can be used as a Bengali to English dictionary.
- Word and sentence suggestions are available when typing in the text box.

- When users click on the exit button of this interface, it goes to the taskbar as taskbar icon. To exit permanently click right button of mouse and click on exit.
- If someone double click on that icon or click right button of mouse and click on open, it show again on top.

### III. WORKING PRINCIPLE

In the figure-2 Bangla words are stored in database with information of English word, tense (if word is verb), parts of speech and person (if word is noun or pronoun or other pronoun). During translation all data of words are taken from database.

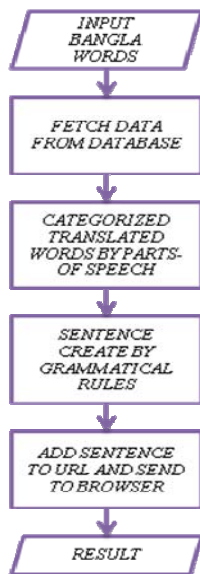


Fig. 2: Converter working Procedures

Bangla sentence can be written by Bangla Unicode or English alphabet as input, by changing language selection option. If someone types a bangla word our application search for equivalent English word in to database. If it is available into database it fetches the data. If not it remains same. If there are more than one word is being typed it checks for proper grammatical rules then convert the whole bangla word into corresponding English sentences.

### IV. GRAMMATICAL RULES FOR WORD CONVERSION

Translated words are classified into some categories depending on parts of speech.

**Noun Words:** Nouns are part of speech typically denoting a person, place, thing, animal or idea [3].

Words, which are declared into database as noun, are used as noun.

Noun Word= Word {Noun}

Example: boi -> book

Which word does not have any information of parts of speech or not found in database, those will also consider as noun.

Noun Word= Word {null}

Example: Raju -> Raju, রাজু -> Raju.

**Prepositional Words:** Prepositions show the relationship between a noun or a pronoun and some other word in the rest of the sentence. Example: of, for, at, in, under, towards, before, about, above as, as far as, as of, etc [2].

If given sentence contain any preposition words it will check next.

**Rule 1.1:** If not found any word after preposition word, words before preposition are exchange with words after preposition and words are considered as same portion after concatenation.

Prepositional Word=word {Preposition} + words {before preposition}

Example: desh ar -> of country, boi ar -> of book, bisshobiddaloy ar -> of university.

**Rule 1.2:** If found any word without adjective, an exchange will occur between word before preposition and word after preposition. That mean, words before preposition treat as words after preposition and words after preposition are treat as words before preposition.

Prepositional Word=Word {after preposition} + Word {preposition} + Word {before Preposition}

Example: desh ar boi -> book of country, Bisshobiddaloy ar chatro -> student of university

**Rule 1.3:** If found any Adjective word after preposition, adjective rules are applied. After applying adjective rules, resulting words are set to left of preposition word and words at the left of the preposition are set to right of preposition.

Prepositional Word=Words {After Preposition (From adjective rule)} + Word {Preposition} + Words {Before Preposition}

Example: bisshobiddaloy ar valo chatro -> good student of university

**Adjective Words:** Adjectives are one of the traditional eight English parts of speech. Adjectives describe or qualifying (or adding something to) the meaning of a noun or pronoun [2]. Example: good, small, dark, yellow, etc.

If any adjective word is found, it will check next word.

**Rule 2.1:** If next word not found, single adjective words will be stored as adjective.

Adjective Word=Word {adjective}

Example: valo -> good

**Rule 2.2:** If found any word without preposition, two words are considered as single portion.

Adjective Word=Word {adjective} + Word {Next}

Example: valo bisshobiddaloy -> good university

**Rule 2.3:** If found any prepositional word after adjective or there is another word after adjective, and after that found preposition, in this situation rules of preposition are effected and words will considered as prepositional words. Adjective word and word after adjective (if have) will consider as same portion of before preposition.

Example: valo bisshobiddaloy ar -> of good university

**Other Pronoun:** Unless Personal Pronoun, all other types of pronouns (including relative, demonstrative, indefinite, reflexive, intensive, interrogative, possessive pronoun) is considered as other-pronoun.

When other pronoun is found, next word is checked.

**Rule 3.1:** If not found any word after Other Pronoun, that single word is considered as Other Pronoun

Other Pronoun Word=Word {Other Pronoun}

Example: amar -> my, আমার-> my.

**Rule 3.2:** If found any word and that word is adjective, then adjective rules are applied. If adjective rules 2.1 & 2.2 are applied, those words are concatenation with other pronoun.

Other Pronoun Word=Word [Other pronoun] + Word {From Adjective rules 2.1 & 2.2}

Example: amar valo -> my good ; amar valo bisshobiddaloy -> my good university

If Adjective rule 2.3 is applied then words will be considered as prepositional words.

Example: amar valo bisshobiddaloy ar

**Rule 3.3:** If second or third word after other pronoun will appear as prepositional word, then prepositional rules will applied and words will considered as prepositional words.

Example: amar valo bisshobiddaloy ar → for my better university

**Pronoun Words:** We know that a pronoun is a word that takes the place of a noun or noun phrase. Examples: he, she, I [2]. That means only personal pronoun is considered as pronoun words.

Words, which are declared into database as Pronoun, are used as Pronoun.

Pronoun Word= Word {Pronoun}

Example: ami -> I, tumi -> you

**Questionable Words:** Words which are used to ask some questions, is known as Questionable word. Example: who, what, which, when, where, how, etc.

Words, which are declared into database as Questionable, are used as Questionable Words.

Questionable Word= Word {Questionable}

Example: ki-> what, konti-> which

**Verb:** A verb is a word that expresses an action or a state of being [4]. Example: study, read, writes, shopping, etc

Words which are assigned as verb in database are considered as verb.

Verb Word= Word {Verb}

**Subject:** First categorized words are mentioned as subject with some additional information (person and category).

Subject Word= Word {First Categorized word}

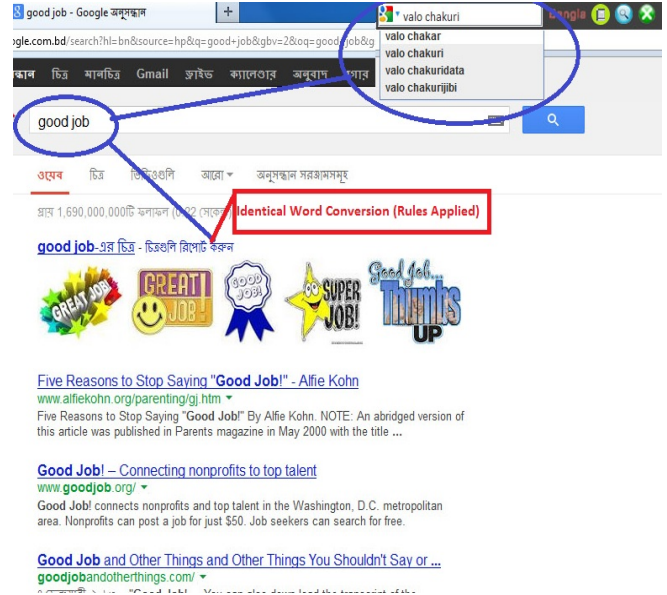


Fig. 3: Identical word Conversion using rules

## V. CREATION OF SENTENCES BY GRAMMATICAL RULES

After categorized, all words are sequenced by some grammatical rules to create a sentence.

**Auxiliary verb:** An auxiliary verb is a verb that adds functional or grammatical meaning to the clause in which it appears. It used to express tense, aspect, modality, voice, emphasis, etc [2].

Example: am, is, are, were, have, has, will, etc.

**Rule 1:** Auxiliary verbs are found out by using person of subject and tense of verb.

Example: am, is, are, have, has, was, were, etc

**Rule 2:** If Verb is not used, tense are considered as present and be verb is found out by Rule 1.

**Rule 4:** If questionable word is used and have not any verb, find out person of subject and concatenation auxiliary verb after questionable word.

Questionable Word =Word {Question} + Auxiliary verb

Example: tader bisshobiddaloy ar naam ki ? -> What is the name of their university?

**Rule 5:** If both questionable and verb words are present, find out be verb by *Rule 1*, Auxiliary verb is used instead of questionable word.

Questionable Word =Auxiliary verb

Example: chatro ki boi porche -> is student reading book

**Rule 6:** If have other pronoun and questionable word but not have any verb, auxiliary verb is defined by *Rule 2* and added before Other Pronoun.

Other Pronoun Word = Word {Question} + Auxiliary verb+ Word {Other Pronoun}

Example: tar naam ki -> what is his name

**Rule 7:** If have adjective and questionable word but not have verb, auxiliary verb is taken from *Rule 2* and added before adjective words.

Adjective Word= Word {Question} + Auxiliary verb+ Word {Adjective}

Example: valo boi konti-> which is good book

**Rule 8:** If have verb but not used questionable word, auxiliary verb identify by *Rule 1* and added before verb.

Verb Word =Auxiliary verb+ Word {Verb}

Example: sey porche -> he is reading

**Rule 9:** If have prepositional word but not have verb, *Rule 2* will effect and find out auxiliary verb. That auxiliary verb will be added before prepositional word.

Prepositional Word= auxiliary verb+ Word {prepositional word}

Example: boi ar naam ki->what is the name of the book

**Rule 10:** If have noun and subject but not verb and any other, then auxiliary verb are identify by *Rule 2* and added before noun.

Noun Word =Auxiliary verb + word {Noun}

Example: sey chatro-> he is a student

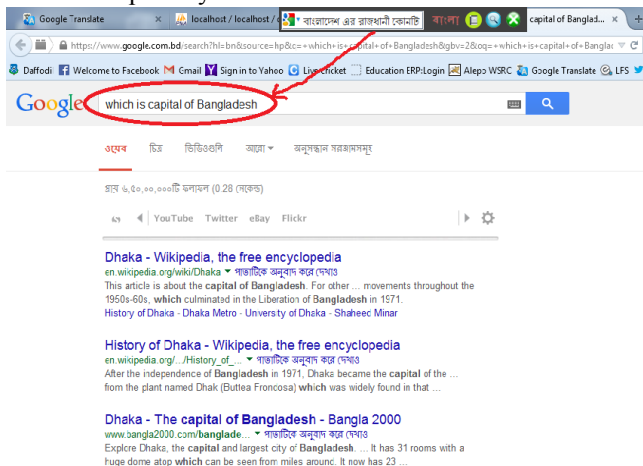


Fig.4: Conversion of Complete sentences by Rule

After generate a complete sentence, it sends to the selected search engine. Then results are displayed by selected search engine in web browser.

Example: amra valo bisshobiddaloy ar chatro -> we are the students of good university.

## VI. CONCLUSION

For enhanced use of search engine with the fundamental knowledge of writing this was our main aphorism when we developed this research work. This interface really performs a better outcome whether it is used in individual conversion. We tried to make it optimistic. In future we want to facilitate the search option considering more grammatical rules. We are planning to enhance the database by bearing in mind of all complex Bengali words. We will extend this interface for android devices. We will provide our own Bangla keyboard for typing that will reduce the clumsy of Bangla type.

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# Optimization of Pest Detection Algorithm using Feature Analysis and Image Segmentation

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**Abstract—** With the increase of agricultural production worldwide, the economic importance of early detection of crop pests is more evident than ever before. The purpose of this study is to improve the performance of an existing pest detection algorithm by using image processing techniques. This study combines the object extraction and feature extraction methods and classifies a particular crop pest species using the SVM classifier. The end point of this study is to improve the performance of the existing algorithm while preserving its accuracy.

**Index Terms—** Image Processing, Image Segmentation, Feature Extraction, Pest Detection, Feature Analysis, Object Extraction, SVM Classifier, Performance Optimization

## I. INTRODUCTION

Most of the third world countries in the world today rely heavily on agriculture. About 75 percent of the world's population living under the poverty line reside in rural areas, choosing farming as their profession [1]. But in order to attain the best production out their crops these people invariably need to protect them from various kinds of plant pests. In recent times, many researches have focused on detecting pests in agricultural crops. Crops infected by pests must be detected at an early stage in order to facilitate direct action against further infection. There are many existing manual methods to detect pests in crops but they all tend to be time consuming. With the recent advancements in image processing research and the rise of new technologies, a more efficient system for early detection of pests can be developed. Hi-Resolution cameras can be used to capture the image of crop leaves, which are then observed and analyzed using automated and specialized image processing algorithms to determine the presence of pests.

Pesticides are one of the preventive measures taken against pest occurrence, but its long-term usage is not sustainable in many ways because of the adverse effects it causes on both the environment and the animals that come in contact to the plants. Furthermore, usage of pesticides reduces nitrogen fixation and thus decreases the production of crops [2]. Therefore, digital means of pest detection can serve as a feasible alternative to pesticides. With its help, early detection of crop pests can play a huge role in achieving better economic productivity in the field of agriculture.

In this study, the primary objective is to study the existing pest detection algorithms, and attempt to optimize them by applying latest processing techniques and improve their performance through feature analysis.

## II. LITERATURE REVIEW

Insect detection using static images method was first given by Paul Boissard, Sabine Moisan. [3] Their image acquisition method involved scanning the insects directly, which turned out to be a slow process. The actual algorithm computation took hours, and the slow scanning process included risks of pests flying away from the crops, resulting in a faulty image database.

The method of acquiring images using sticky traps was given by Vincent Martin, Sabine Moisan, Bruno Paris and Olivier Nicolas. This method is used to attract pest to the crops and try to get them trapped. But the method attracted a lot of pests to crops which defeats the purpose of pest detection for early prevention of plant losses.

Another study conducted by Sandip P. Bhamare and Samadhan C. Kulkarni [4] used shape and texture extraction methods for detecting Black Sigatoka insect in banana trees. Their algorithm showed promise, but lacked a viable image database. It also lacks a detection accuracy rate. In another study conducted by Goutham and Tejaswini, detects pests in tomato plants by extracting Region of Interest (ROI) from tomato plant images.

Usage of pan tilt camera to acquire images in a greenhouse was introduced by Rupesh G. Mundada and Dr. V. V. Gohokar. [5] Their algorithm is automated and shows a 100% accurate detection rate, but is not optimized. This study primarily focuses on the Mundada-Gohokar detection algorithm and seeks to optimize its performance and accuracy.

## III. OVERVIEW & ANALYSIS OF EXISTING ALGORITHM

The existing algorithm for detection and classification of pests in greenhouse is given by Rupesh G. Mundada and Dr. V. V. Gohokar [5]. Their study focuses on whiteflies as early detection of this pest is crucial for effective intervention. Image database for their study was acquired through pan tilt camera with zoom within the boundaries of a greenhouse. For this study the same image database was chosen as the image quality is optimal. A portion of the acquired image database for is shown in Fig.1.

The algorithm proposed by Mundada & Gohokar use several stages of image processing techniques. Their methodology, consists of three main working stages, namely: pre-processing, detection and classification. The elaborate steps of this algorithm are displayed in Fig. 2.

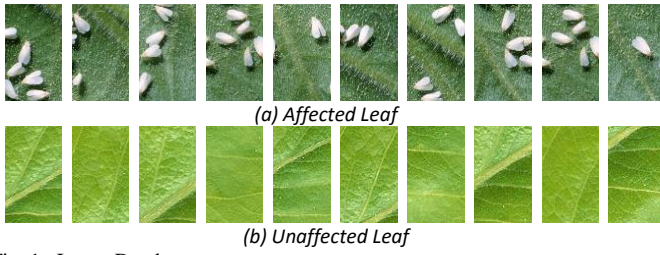


Fig. 1. Image Database

This study takes a more in-depth look at the features used in the Mundada-Gohokar algorithm and determine the effect the features have on the accuracy of the detection algorithm. The purpose of this study is to determine if all the features used in the previous study were actually significant to the actual detection of pests. This study also aims make the Mundada-Gohokar algorithm more efficient by reducing the number of features used in the study. The importance of feature reduction for improving classifier performance is briefly described below.

#### A. Importance of Feature Reduction

According to a study made by Andreas G. K. Janecek and Wilfried N. Gansterer [6] in application fields where the search for the optimal feature set is still a topic of active research, it can be observed that the accuracy of classification achieved with a reduced feature set is often significantly better than using a full feature set. In an active field such as image processing and computer vision, the search for the perfect feature set is continually progressing. With that in mind it is reducing the size of the feature set can make classifier algorithms more accurate.

Another facet of the importance of feature reduction is again made clear by Janecek & Gansterer as they state that the time needed for the full execution of the classification algorithm decreases with a smaller feature set. This reduction in execution time can be significant in terms of application. For instance, if detection algorithms are to be applied to devices with lower processing capabilities (portable devices such as cell phones and tablet computers), this reduction in runtime can mean higher performance rate and thus making the algorithm optimal for consumer usage.

#### B. Features Analysis of the Mundada-Gohokar algorithm

As stated in the previous section, the feature set used by Mundada-Gohokar for the detection of whiteflies in leaves consists of six primary features: Entropy, Mean, Standard Deviation, Contrast, Correlation and Eccentricity [7][8].

After taking a brief look at this feature set, we can immediately decide to rule out either one of the features Standard Deviation and Contrast. The reason behind this conclusion becomes clear as we study the definition of the two features:

$$RMS\ Contrast = \left[ \frac{1}{n-1} \sum_{i=1}^n (x - \bar{x})^2 \right]^{\frac{1}{2}} \quad SD = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}}$$

Standard deviation is the quantifiable measure of variation between data values in a set [8], whereas the contrast of an image, as defined by Eli Peli [9], states that it is the standard deviation between the pixel intensities. Therefore, in the

context of a grayscale image, standard deviation and contrast as essentially the same feature. Contrast can thus be eliminated as an extra feature and use only standard deviation by itself.

#### C. Percentage of Variation

In order to understand how the detection algorithm given by Mundada & Gohokar was affected by the aforementioned features, a simple experiment is conducted. At first, the image database that was used in the Mundada-Gohokar algorithm is obtained. Then the images are converted to grayscale, resized and filtered according to the specifications mentioned in the previous study. Then the seven features are extracted from the image and prepared into a simple feature vector. By repeating this process, a feature vector for each of the sample images in Fig.1. is obtained.

A portion of the sample feature vector set obtained through this method is shown in Table 1. Note that since the current concern is with training images, it is already known which data are from images affected with whitefly and which are empty leaf data. The feature set for the whitefly affected leaves is given in Table 1a and the feature set for empty leaves is given in Table 1b.

Now for each of the columns in Table 1a and 1b, the mean of the features is calculated. After the mean is calculated their variation with respect to one another is obtained. The formula for calculating this variance is given below:

$$Variation_k = \frac{|\mu_{ak} - \mu_{ek}|}{\max(\mu_1, \mu_2)} \times 100$$

Where,

- $\mu_a$  = Mean data of affected leaf
- $\mu_e$  = Mean data of empty leaf
- $k$  =  $k^{th}$  feature in the feature set

TABLE I  
FEATURE SET FOR SAMPLE IMAGES

	Entropy	Standard Deviation	Contrast	Mean	Correlation	Euler Number	Eccentricity
	7.3803	51.942	51.942	110.17	0.99668	78	0.5918
	7.3504	46.056	46.056	126.58	0.99556	121	0.6452
	6.963	33.666	33.666	108.48	0.99075	199	0.69273
	7.1334	43.296	43.296	118.91	0.99535	49	0.54657
	6.9486	37.231	37.231	106.56	0.99417	101	0.66372
	7.1385	40.904	40.904	121.46	0.99488	107	0.56102
	7.1221	43.344	43.344	121.01	0.99483	84	0.6187
	6.5884	28.999	28.999	122.46	0.98892	213	0.6486
	7.0988	40.127	40.127	127.06	0.99418	105	0.63682
	6.6421	28.735	28.735	122.99	0.99032	208	0.66292
Mean	<b>7.03656</b>	<b>39.43</b>	<b>39.43</b>	<b>118.568</b>	<b>0.993564</b>	<b>126.5</b>	<b>0.626808</b>

a) For Affected Images

	Entropy	Standard Deviation	Contrast	Mean	Correlation	Euler Number	Eccentricity
	5.4556	11.94	11.94	147.76	0.95978	92	0.61338
	5.5588	12.674	12.674	143.25	0.961	1	0.86603
	6.0448	17.31	17.31	147.71	0.97499	133	0.68753
	6.4417	21.716	21.716	149.81	0.98329	1	0.86603
	6.6703	24.807	24.807	145.36	0.98702	55	0.68813
	6.4218	20.884	20.884	142.16	0.98215	81	0.7262
	6.618	25.721	25.721	154.9	0.987	10	0.78578
	6.903	31.958	31.958	142.13	0.9919	43	0.77838
	6.7352	27.689	27.689	136.81	0.98968	79	0.67525
	6.4034	20.657	20.657	150.06	0.98463	91	0.67251
Mean	<b>6.3252</b>	<b>21.5356</b>	<b>21.535</b>	<b>145.99</b>	<b>0.980144</b>	<b>58.6</b>	<b>0.735922</b>

b) For unaffected images

That is, the percentage of variation is defined by the ratio of the difference between two means and the highest value of mean among the two data. This percentage provides a basic idea about which feature varies more in an image for a leaf affected with whitefly versus an empty leaf. The higher the percentage of variation, the more viable that feature is in terms of significance to whitefly detection.

#### D. Result of Analysis

The results obtained through the calculation of percentage of variation are shown in Fig. 3. Note that the bar for standard deviation and contrast have the same exact percentage of variance. This is consistent with the earlier conclusion that contrast and standard deviation are essentially the same data feature in an image.

It is also noted that the percentage of variance is surprisingly low for the features correlation and entropy. With the percentage of variance being under 10% these two features can be eliminated from the feature set for their insignificance to pest detection.

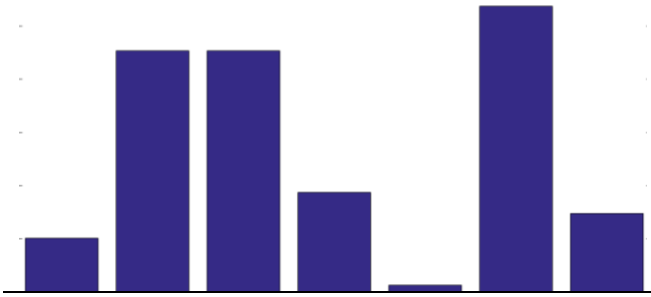


Fig. 3. Percentage of variance for affected images vs Unaffected Images. Here, y-axis represents the percentage (ranging from 0 to 100) and x-axis represents the following features: (from left) Entropy, Standard Deviation, Contrast, Mean, Correlation, Euler Number and Eccentricity.

So in conclusion to this analysis, it is noted that the features contrast, entropy and correlation do not vary much between affected and unaffected images, and as such, can be eliminated from the optimized feature vector. This study will now aim to discover new significant feature extraction methods to optimize the existing algorithm.

#### IV. PROPOSED ALGORITHM

In image processing, there are two principal techniques for object detection in images. One of them is the aforementioned feature extraction method, the other method is known as image segmentation, or object extraction. While feature detection deals with extracting data points from an image based on some of its property, object extraction takes a more physical approach to the image and focuses on detecting actual edges and other visible characteristics in the image.

Image segmentation is the process of dividing a digital image into multiple segments. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. [11] Unlike other greenhouse pests, whiteflies are visually significant. For this reason image segmentation and object extraction is a feasible technique for detecting whiteflies in leaf images.

Therefore, with the aim of improving the existing Mundada-Gohokar detection algorithm, this study aims to combine the two principal image processing techniques of image segmentation and feature extraction. The proposed

algorithm, uses the blob extraction method of image segmentation, obtaining physical characteristics data from the image.

#### A. Image Acquisition

This study uses the same image database as the Mundada-Gohokar algorithm. This is to maintain the integrity of optimization. This image database, as depicted in Fig.1 is of .jpeg format and consists of two classes of images: a) Affected with whitefly, and b) Healthy, unaffected leaf

#### B. Image Pre-processing

In order to make the images ready for being taken as input to the detection algorithm, this work follow similar pre-processing steps as Mundada & Gohokar. The images are converted to grayscale, resized and then smoothed to eliminate background noise. The pre-processing steps are discussed in detail here:

##### 1) Resize

Different sample images can be of different sizes. It is needed to bring uniformity to the images so that computation and image processing can be same for all images. For this purpose all the images are resized to 512x720px at the very beginning of processing.

##### 2) RGB to Grayscale Conversion

Digital images are classified in four main types according to its format of pixel: binary images, grayscale images, indexed images, and true color images. [12] In binary images the value of a pixel is one of two possible values, true or false. In grayscale images the value of a pixel is a scalar who represents an intensity or gray level within some range. The value of a pixel in indexed images is a scalar who represents an index. It indicates the color of the pixel in a color map. In true color images the value of a pixel is a vector. This vector indicates the color of the pixel according to some color space (e.g. RGB, CMYK).

A grayscale image is composed of different shades of grey colour. A true colour image can be converted to a grayscale image by eliminating the hue and saturation information while retaining the luminance. The RGB image is a combination of Red, Blue and Green colours. The RGB image is 3 dimensional, while a grayscale image is 2 dimensional.

The formula used to convert RGB images to grayscale in this study is as follows:

$$I(x, y) = (0.2989 \times Red) + (0.5870 \times Green) + (0.1140 \times Blue) \quad [13]$$

##### 3) Filtering

The image is filtered to get rid of the environmental noises, which helps to detect the objects. There are many methods of noise reduction. Such as low pass filters, high pass filters, median filters etc. The low pass filters are smoothing filters whereas the high pass filters are sharpening filters. The traditional median filters are used to reduce salt-paper noise. Smoothing filters are used for smoothing of the edges and sharpening filters are used for enhancing the edges of the image. In this study smoothing filter is used to reduce noise and to improve the visual quality of the image. The simplest smoothing filter is average filter which consists of a 3x3 matrix of 1 and is divided by 9.

### C. Image Analysis

In this stage of the algorithm two different image processing techniques are followed to obtain a significant and optimized feature vector. For image segmentation, the blob detection method is applied for detecting the region containing whitefly in images.

### D. Blob Detection

In computer vision, blob detection methods detect regions in a digital image that differ in visual properties like brightness and colour in comparison to its background or surrounding regions. Informally, a blob is a region of an image in which some properties are constant or approximately constant; all the points in a blob can be considered in some sense to be similar to each other. [14]

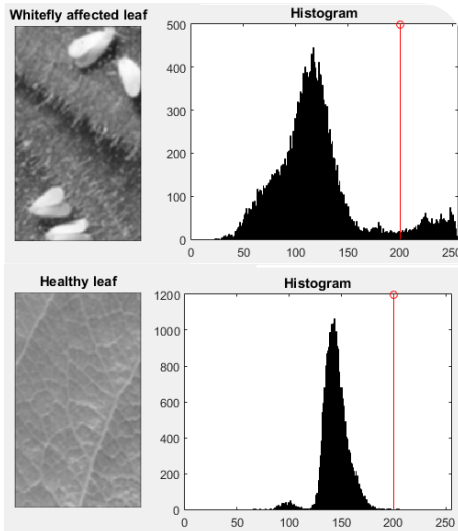


Fig. 4. Histogram of sample images

After the sample images have been put through the aforementioned pre-processing procedures, the resultant images are fixed-size, grayscale and have minimum noise. The images are now analysed by drawing a histogram using the intensities of the grayscale image. A histogram is a graphical representation of the distribution of numerical data. It is an estimate of the probability distribution of a continuous variable and was first introduced by Karl Pearson [15]. The histogram of an affected image vs an empty leaf image, as demonstrated in Fig. 4, provides an interesting insight to the distribution of the pixels in the image.

In case of the whitefly affected leaf image, the histogram demonstrates a clear disparity between intensity of the background of the leaf and foreground of the pest. This forms two peaks in the histogram. The greater peak culminating at intensity level 100 and the smaller peak occurring near 220-250 intensity level. The boundary of this disparity is used as a threshold value, which in the case of Fig.5 is marked near 200. The threshold value in turn is used to convert the grayscale images to binary images. The result of this conversion is shown in Fig.6. It is observed that with the proper use of thresholding, the whitefly affected regions have been almost accurately segmented out of the image. The segmented region of interests, or more informally ‘blobs’ can now be studied for further physical features.

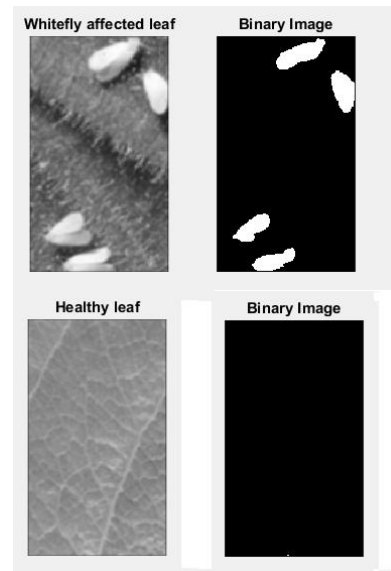


Fig. 5. Conversion to binary image

### E. Blob Property Extraction

Now that the outlines of the whiteflies have been detected, mathematical analysis to measure their diameter, centroid and area can be performed. These data provide insight to the measurement of the pests, as well as the total affected area. These data can be significant in application of a pest-detection program because it is important to know how much a crop leaf has been affected by a pest for consideration of possible treatment methods.

TABLE II  
FEATURES OBTAINED FROM IMAGE SEGMENTATION

Probable Pest Number	Mean Intensity	Affected Pixel Area	Pest Diameter
14	230.37	2437	40.518
12	231.27	2492	44.883
7	230.2	470	19.214
7	233.68	2296	44.796
3	236.12	1254	24.482
6	231.35	1390	32.495
7	234.63	2165	27.194
3	234.99	870	24.597
5	234.36	2026	36.984
1	234.03	785	31.615

Probable Pest Number	Mean Intensity	Affected Pixel Area	Pest Diameter
1	228.5	2	1.5958
0	0	2	0
1	226	1	1.1284
1	227	1	1.1284
3	226.67	3	1.5595
2	230	2	1.3621
4	228.19	10	2.778
5	229.15	14	3.0668
3	229.92	12	3.119
1	228	4	2.2568

a) For Affected Leaf

b) For Empty Leaf

The data extracted from the sample images using image segmentation is displayed in Table 2. Fig. 6 demonstrates a demo application that can count the number of whiteflies affecting the crop and the total affected area using image segmentation. This application gives a measure of how much area is affected by the pest. If the pixel density of the captured image, the focal length, and the camera distance is known then the real world affected area in mm<sup>2</sup> can be calculated.

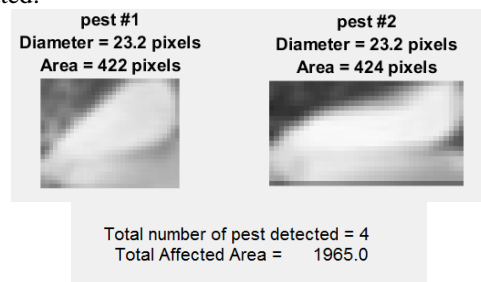


Fig. 6. Application of Blob Detection



## F. Feature Optimization & Classification

The purpose of this study is to optimize and improve the Mundada-Gohokar detection algorithm. As described in the previous section, the algorithm optimization is done by reducing the size of the feature set used in the previous study. After elimination of features who had little to no effect on the classifier's performance, the features that have been selected for the optimized feature set are: Mean, Standard Deviation, Euler number and Eccentricity. These are the features that are provided to a SVM classifier for classification and identification of whitefly in images.

In the field of machine learning, support vector machines are learning models which are supervised through training. It is interfaced with learning algorithms that are able to analyze data and detect known patterns. [16] This is used for classification. If given a set of training examples, where each entry is labeled to belong to a particular class, an SVM classifier builds a model that assigns new test data to one category or the other, making it a non-probabilistic binary linear classifier. An SVM model is a representation of the training data as points in an n-dimensional space, drawn so that the members of separate classes are divided by a defined boundary that is as wide as possible. New test data samples are then mapped into that same space and predicted to belong to a category based on which side of the decision boundary they fall on.

In addition to linear classification, SVMs can efficiently perform a non-linear classification using what is called the kernel trick. This trick consists of implicitly mapping training and test data into higher-dimensional feature spaces, when data is not linearly separable. This study makes use of a binary SVM classifier which takes as training input the reduced feature sets.

## V. RESULTS

The results of the SVM classifier for the reduced feature sets are shown in Table 3 and Table 4. Note that the feature 'Blob Diameter' has been added to the feature set. It is found that the SVM has been able to classify all test datasets successfully using these features. So the accuracy rate is 100%. And when both the Mundada-Gohokar algorithm and the new revised algorithm were run in 30 attempts, their run times varied significantly, as shown in Fig.8. The average difference between the runtime of the two algorithms is approximately 2.32 seconds, which is a 36.14% performance improvement.

TABLE III  
SVM TRAIN SET

Standard Deviation	Mean	Euler Number	Eccentricity	Diameter	Labels
51.942	110.17	14	0.68268	40.518	Whitefly
46.056	126.58	12	0.81433	44.883	Whitefly
33.666	108.48	7	0.50458	19.214	Whitefly
43.296	118.91	7	0.72846	44.796	Whitefly
37.231	106.56	3	0.94435	24.482	Whitefly
40.904	121.46	6	0.69777	32.495	Whitefly
43.344	121.01	7	0.89161	27.194	Whitefly
28.999	122.46	3	0.97309	24.597	Whitefly
11.94	147.76	1	0.86603	1.5958	Empty
12.674	143.25	0	0	0	Empty
17.31	147.71	1	0	1.1284	Empty
21.716	149.81	1	0	1.1284	Empty
24.807	145.36	3	0	1.5595	Empty
20.884	142.16	2	0	1.3621	Empty
25.721	154.9	4	0.18298	2.778	Empty

31.958	142.13	5	0.32047	3.0668	Empty
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TABLE IV  
SVM TEST SET AND RESULT

Standard Deviation	Mean	Euler Number	Eccentricity	Diameter	Result
40.127	127.06	5	0.89505	36.984	Whitefly
28.735	122.99	1	0.89132	31.615	Whitefly
27.689	136.81	3	0.88947	3.119	Empty
20.657	150.06	1	0	2.2568	Empty

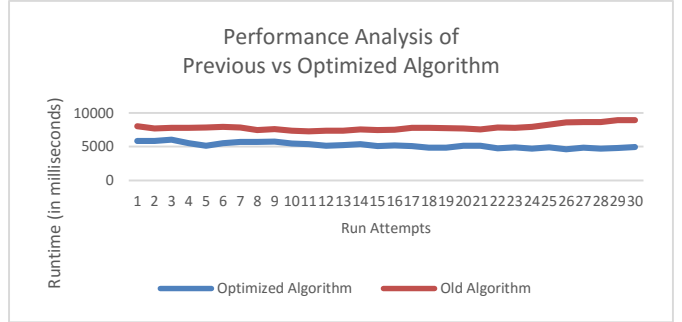


Fig. 7. Performance analysis chart

## VI. FUTURE SCOPE

The importance of a fast and reliable solution that can effectively detect crop pests is undeniable. With that in mind, the optimization of detection algorithms is crucial. In order to implement detection algorithms in feasible user applications, the algorithm needs to be runtime efficient. The goal of this study is to achieve such optimization that allows portable devices like cell phones with working camera implement these pest detection algorithms. So the future scope of this study will include further optimization using other non-linear classifiers, and to apply these algorithms into feasible mobile applications, so that the general user can benefit from modern day image processing researches.

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# An Automated System for Converting Bengali Simple Valid Sentence into UNL

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**Abstract**—Internet is the largest platform for communication among the people worldwide. English is the most used language in internet. The comfortable and easiest way for most non-English speakers like Bangladeshi is to use one's own mother language in internet. Universal Networking Language (UNL) is a computer understandable language that allows people to use their mother language for communication to others. This paper mainly focuses on En-conversion rules to convert Bengali into UNL automatically using shift-reduce parser. This paper describes a four modules system that converts the syntactically and semantically valid Bengali sentence into UNL.

**Keywords**- *Universal Networking Language; Bengali Subject Verb Relation; Shift - Reduce Parser; En-converter.*

## I. INTRODUCTION

English is the most common language used for communication worldwide. Although English is a popular language for communication, billions of people worldwide do not have the resources for learning English [1]. So a gap exists in communication for non-English speakers like Bangladeshi. Mother language is the easiest and best way for communication to others.

Many attempts had been taken to break the language barrier. One of the significant developments is computer translation systems. But most of the times the users need to edit the output document which is difficult especially for the user with poor language knowledge. Universal Networking Language (UNL) is an electronic language for computer that represents the natural language through logical expressions [2]. UNL is an intermediate language that allows communication among different language speakers through their mother language.

Bengali (or Bangla) is one of the Indo-Iranian languages [3]. Bengali came from Sanskrit language is world ranked four in terms of the number of people speaking in all over the world[4]. Research on Bengali still in developing step as compare to other languages like English [5]. Many theoretical researches had done on Bengali to connect UNL [2][6][7] [8], but these methods were designed manually. But there is no significant practical development on Bengali to connect UNL as compare to theoretical researches.

In this paper, we present a practical development for converting Bengali simple sentence into UNL expression using shift-reduce parser. From the best of our knowledge there was no such work in Bengali. Bengali sentence structure is very complex. For simplicity we proposed a four modules system which allows only syntactically and semantically valid Bengali sentences.

## II. THE SYSTEM MODULES

Bengali sentence structure is very complex [9]. We use exact grammatically structure for reducing complexity. Our proposed system consists of four modules. The first three module used for checking the sentence structure and fourth module convert the Bengali sentence into UNL expression.

### A. Syntax Module

Syntax module checks whether the sentence is grammatically correct or not. In this paper we present the analysis of following grammatical rule of Bengali sentence.

Sentence  $\leftarrow$  [Subject] [Object] [Verb]

Bengali: “আমি মাছ খাই”  
English: “I eat fish”

Where “আমি” (I) is subject, “মাছ” (fish) is object and “খাই” (eat) is verb.

Some other analysis also done in syntax module discussed in Section III.

### B. Semantic Module

The semantic module checks whether the verb in the sentence is in correct form for a certain subject. For example the syntax module returns true for the sentence “আমি মাছ খাও”. But according to Bengali grammar “খাও” is not semantically valid for subject “আমি”. The verb should be “খাই” for present indefinite tense.

For checking subject verb relation we create some relationship tables (RT). The relationship table defines relation between Bengali person and verbal inflection.

For example RT [First person][ই] is predefined true relation in relationship table. For a particular sentence the system finds out the person of the subject and verbal inflection of verb and checks the relation between them.

### C. Quality Module

Quality module finds out the statistical probability using statistical N-gram language modeling. Here we use Trigram model (N=3) [10]. The computed probability is compare to a threshold value. The system will produce UNL expression if the probability of sentence is larger than predefined threshold value.

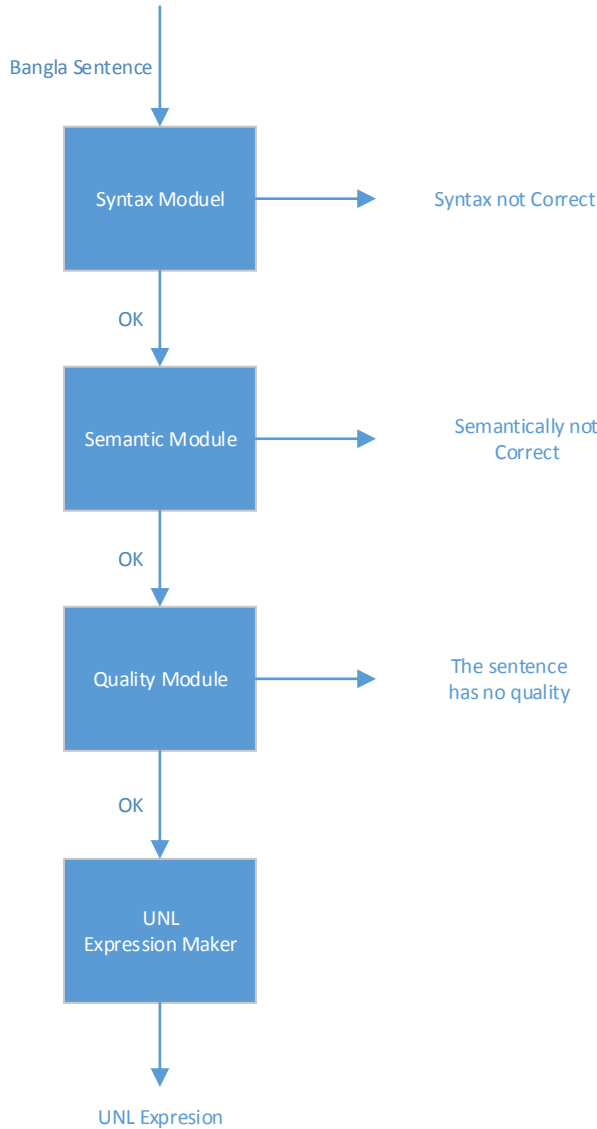


Figure 1. The system diagram

### D. UNL Module

UNL module produces UNL expression of input sentence. In this paper we use shift-reduce parser to create UNL expression which scans the input sentence from left to right. We use Stack (S) which is LIFO data structure for shift-reduce parser.

At each step the program wants to create UNL binary relation between Top(S) and Next-To-Top(S) of Stack which are called analysis window. Binary relations are made up of a relation and two universal words (UWs). The program POP (reduce) the Next-To-Top(S) when a binary relation possible by preserving the verb till end of procedure. Otherwise, it PUSH a token into Stack from input sentence.

### III. UNL REPRESENTATION OF BENGALI SENTENCE

The System of converting the natural language into UNL expression is called En-converter. En-converter is a software that automatically converts the natural language text into UNL [1]. Our proposed system is an En-converter. During analysis of a sentence in syntax module the system tokenize the sentence and represents the sentence in a specific format along with attribute of each word.

For example, “মানুষগুলি মাছ খাইতেছে” is a sentence where “মানুষগুলি” defines is the plural of subject “মানুষ”. “খাইতেছে” is a verb that consists of verb root (“খা”) and verbal inflection (“ইতেছে”) [2]. The verbal inflection “ইতেছে” defines present continues tense. Each Token of “মানুষগুলি মাছ খাইতেছে” represented in UNL dictionary as follows.

- [মানুষ] {} “man(icl>person)” (N, ANI) <B,0,0>
- [গুলি] {} “” (PL, 3P, SUF) <B,0,0>
- [মাছ] {} “fish(icl>animal)” (N, ANI) <B,0,0>
- [খা] {} “eat (icl>do)” (V, ROOT) <B,0,0>
- [ইতেছে] {} “” (PRESENT, PROGRESS, VI) <B,0,0>

The sentence is tokenize and represented as {“মানুষ”, “মাছ”, “খা”} and attribute of each token represented as {“.@pl”, “”, “.@present .@progress”} in particular memory location and cleared from memory after each sentence processing. The system use shift-reduce parser to represent the sentence into UNL according to following procedure.

Step 1: Stack takes first two token of the input sentence. The program checks whether the UNL binary relation possible between TOP(S) and Next –To-Top(S).

Stack, S : 

মানুষ	মাছ
-------	-----

TOP(S) = “মাছ” which is Noun

Next –To-Top(S) = “মানুষ” which is Noun

Here both token are Noun. So, binary relation is not possible. Program needs to scan the next token.

Step 2: “খা” is shifted into Stack.

Stack, S: 

মানুষ	মাছ	খা
-------	-----	----

TOP(S) = “খা” which is Verb (actually verb root)  
Next –To-Top(S) = “মাছ” which is Noun and Object in input sentence.

Relation between Noun and Verb is possible. The “obj” relation will introduce between the universal word (UW) of TOP(S) and UW of Next –To-Top(S). Next –To-Top(S) which is “মাছ” deleted from Stack.

Stack, S : 

মানুষ	খা
-------	----

Step 3:

TOP(S) = “খা” which is Verb  
Next –To-Top(S) = “মানুষ” which is Noun and Subject in the input sentence.

Relation between Noun and Verb is possible. The “agt” relation will introduce between the UW of TOP(S) and UW of Next –To-Top(S). Next –To-Top(S) which is “মানুষ” deleted from the Stack.

Stack, S: 

খা
----

The system already read all tokens and only the verb “খা” is remaining in the Stack which is the main predicate of the sentence. Procedure is stopped and @entry attribute is added to UW of “খা”.

The system uses another Stack namely ‘A’ along with Stack ‘S’ to retrieve attribute of each token of sentence. When a token is shifted or reduced from Stack ‘S’, the same operation also done in Stack ‘A’.

{unl}
obj(eat(icl>do).@entry.@present.@progress, fish(icl>animal))
agt(eat(icl>do).@entry.@present.@progress, man(icl>person) .@pl)
{\unl}

Figure 2. UNL representation of “মানুষগুলি মাছ খাইতেছে”

Fig. 2 shows the UNL representation of Bengali sentence “মানুষগুলি মাছ খাইতেছে” and Fig. 3 shows the UNL representation of Bengali sentence “আমি স্কুলে যাই”. In Input sentence “আমি স্কুলে যাই”, the token “স্কুল” is a type of place and verb is “যাই”. so “plt” relation is introduced.

{unl}
plt(go(icl>do).@entry.@present, school(icl>place))
agt(go(icl>do).@entry.@present, I(icl>person))
{\unl}

Figure 3. UNL representation of “আমি স্কুলে যাই”

#### IV. EXPERIMENTAL RESULT

Bengali sentence structure is very complicated. We proposed four modules system to reduce complexity. We developed our research practically as a part of our research on Bengali. We tested the proposed system with 550 sentences at the Laboratory of United International University. The system produced accurate result for 548 sentences. The accuracy of the system was 99.63% during testing.

#### V. CONCLUSION

In this paper we have presented the analysis rules for converting Bengali simple sentence into UNL expression. For this analysis we proposed a four modules system. We also present sample data for analysis which shows that our designed system works perfectly for Bengali simple sentences. We hope that our proposed system will be valuable for Bengali to connect UNL.

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# Laplacian and Priority Based Naïve Bayesian Algorithm

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**Abstract**—Naïve Bayesian is a well-established classification algorithm used largely in prediction and classification. Due to zero-value situation, result may be void or may show wrong outcomes. A well-known solution is to use Laplacian correction, mostly which is used if a zero -value effect is found. In this paper, a different approach of Laplacian correction is introduced for avoiding the situation. Also, a priority based correction methodology is introduced which doesn't require to change any value, rather the algorithm works by prioritizing classes for classification or prediction. Both methodologies are well-tested and efficient for using in real-life implementation.

**Keywords**-Naïve Bayesian algorithm; Laplacian Correction; priority; classification; prediction; probabilities.

## I. INTRODUCTION

Naïve Bayesian classification algorithm is a well-known and well-established algorithm mostly used for prediction and classification in large data mining implementation. For any types of prediction or classification, zero value may indicate some erroneous outcome. Different research has been done on implementing Naïve Bayesian algorithm. Disease prediction [1], predicting heart disease and breast cancer [3] are mostly done with the algorithm. Pat Langley, Stephanie Sage showed why Naïve Bayesian algorithm is the most accurate among the Bayes classifications [4]. Though Naïve Bayesian is well-established, but, zero-value effect can be a cumbersome stone. Even, due to this effect, there may arise a situation where no class can be classified or predicted. There are some methodologies for overcoming the effect. One is known as Laplacian correction. It alters the data for avoiding zero-value effect. The method is applied when there is a zero-value situation. In this paper, a different approach is introduced for implementing Laplacian correction. The approach is performed considering that, there will be a zero-value effect. So, without waiting for a zero-value situation, the algorithm alters the values of the probabilities, and add one to the attribute occurrence, so there will be no zero value effect in the process. In this paper, also a priority based algorithm introduced which is also capable of over-coming the zero-value effect. The algorithm gives priorities to the classes having maximum occurrence or probabilities with the attributes. There may rise a situation, where more than one class have the same priority. The algorithm also overcomes the situation by applying probability of classes for detecting the desired class. Both algorithms are well-tested and checked with good amount

of data. It is seen, both algorithms are fast and able to show same result.

## II. NAÏVE BAYESIAN ALGORITHM

### A. Naïve Bayesian Algorithm

The most straightforward and widely tested method for probabilistic induction is known as Naïve Bayesian algorithm. This schema represents each class with a single probabilistic summary. It is a supervised learning technique. The algorithm learns from a stored data set. When, some attributes are given to the algorithm without class, as class is to be found out, the algorithm first calculates the probabilities of the classes. Then, probabilities of the attributes against the classes are calculated. After that, the probabilities of the classes and the attribute's probabilities against the classes are multiplied respectively. The class having the maximum value is the predicted class. The process is shown below.

#### Algorithm: Naïve Bayesian Algorithm

```
1. for  $i=1$  to  $n$ : begin
2.    $PC_i = \frac{\text{count}(C_i)}{\text{count}(T_t)}$ ;
3. end for;
4. for  $i=1$  to  $n$ : begin
5.   for  $j=1$  to  $m$ : begin
6.      $PC_j = PC_j * \frac{\text{count}(Ag_i, C_j)}{PC_j}$ ;
7.   end for
8. end for
Predicted class:  $C_{(\text{index of } \max(PC_i))}$ 
```

In the algorithm, from line 1 to line 3, we count the probability of classes against the total dataset ( $T_t$ ). The probabilities are stored in PC array. From line 4 to line 8, we count the occurrence of the attributes with the classes, against the class occurrence. The probabilities are multiplied with the classes. This is done at line 6. We then find out the maximum value of the PC array, and with the index of the maximum value, we get

the predicted class, as class is also stored in an array and the array index will indicate the class.

### B. Zero-value effect

Let's examine the situation with the following example.

TABLE 1

Age	Sgpt	Sgot	Class
Young	Normal	Normal	classA
Middle	Normal	High	classB
Old	High	High	classC

Let us think that, table1 is our database. We are given following attributes.

TABLE 2

Age	Sgpt	Sgot	Class
Young	High	Normal	?

Table 2: Attributes without class

We have to find out the class for the table 2 attributes. First, we calculate the probabilities of the classes.

$$P(\text{classA})=1/3=0.333$$

$$P(\text{classB})=1/3=0.333$$

$$P(\text{classC})=1/3=0.333$$

Now, we check the probability of the attribute values against the occurrence of classes.

$$O(\text{classA}) = 1 \text{ (occurrence of classA in the database)}$$

$$O(\text{classB}) = 1$$

$$O(\text{classC}) = 1$$

For (age, class):

$$P(\text{(young, classA)}/O(\text{classA}))= 1$$

$$P(\text{(young, classB)}/O(\text{classB}))= 0$$

$$P(\text{(young, classC)}/O(\text{classC}))= 0$$

For (sgpt, class):

$$P(\text{(high, classA)}/O(\text{classA}))=0$$

$$P(\text{(high, classB)}/O(\text{classB}))=0$$

$$P(\text{(high, classC)}/O(\text{classC}))=1$$

For (sgot, class):

$$P(\text{(normal, classA)}/O(\text{classA}))=1$$

$$P(\text{(normal, classB)}/O(\text{classB}))=0$$

$$P(\text{(normal, classC)}/O(\text{classC}))=0$$

Now, we multiply all the probabilities of the classes.

$$P(\text{classA} | \text{Attributes})= 0.333 * 1 * 0 * 1 = 0$$

$$P(\text{classB} | \text{Attributes})= 0.333 * 0 * 0 * 0 = 0$$

$$P(\text{classC} | \text{Attributes})= 0.333 * 0 * 1 * 0 = 0$$

We find here, there is no value for predicting a class. This is known as zero-value effect of Naïve Bayesian algorithm.

## III. NAÏVE BAYESIAN ALGORITHM WITH LAPLACIAN CORRECTION

### A. Laplacian Correction

The zero-value effect can be removed using Laplacian correction. We can assume that our training database, D, is so large that adding one to each count that we need would only make a negligible difference in the estimated probability value, yet would conveniently avoid the case of probability values of zero. This technique for probability estimation is known as the Laplacian correction or Laplace estimator, named after Pierre Laplace, a French mathematician who lived from 1749 to 1827. If we have, say, q counts to which we each add one, then we must remember to add q to the corresponding denominator used in the probability calculation. The algorithm is presented below.

#### Algorithm: Naïve Bayesian with Laplacian correction

1. for  $i=1$  to  $n$ : **begin**
2.  $PC_i = \frac{\text{count}(C_i)}{\text{count}(T_t)} + A_n \cdot \text{count};$
3.  $PT_i = \frac{\text{count}(C_i)}{\text{count}(T_t)}$
4. **end for**;
5. for  $i=1$  to  $n$ : **begin**
6. for  $j=1$  to  $m$ : **begin**
7. If  $(i==1)$
8.  $PC_j = \frac{\text{count}(Ag_i, C_j)+1}{PC_j};$
9. If  $(i==1)$   $PC_j = PT_i * PC_j;$
10. else
11.  $PC_j = PC_j * \frac{\text{count}(Ag_i, C_j)+1}{PC_j};$
12. **end for**
13. **end for**

**Predicted class:**  $C_{(\text{index of max}(PC_i))}$

In the algorithm, from line 1 to line 3, we calculate the probability of the classes in  $PT$  array, also in  $PC$  array, we count the probability, and add the total attribute number.  $A_n$  is for  $n$  attributes. From line 5 to 13, we calculate the probability of attributes against the classes and then we multiply the values with the probability of the classes respectively. With the loop at line 5, we iterate through all the attributes, here we think that there is  $n$  attributes. With the loop at line 6, we iterate through all the classes,  $m$  indicates  $m$  classes. At line 7, at the initial attribute iteration, we multiply the classes probabilities with the attributes probabilities against the classes. At line 8, we add one to each count of attributes with the class, so that, there is no zero



value effect. After the calculation, the class having the maximum value is our predicted class.

#### B. Zero value effect removal with Laplacian correction

Let us examine how Laplacian correction helps in removing the zero-value effect with the data of table 1 and table 2.

First we calculate the probability of classes, also we calculate another temporary probability by adding the attribute number with the probability which will be used while we calculate the probabilities of the attributes against the classes.

$$P(\text{classA})=1/3=0.333$$

$$P(\text{classB})=1/3=0.333$$

$$P(\text{classC})=1/3=0.333$$

$$TP(\text{classA})=0.333+3= 3.333 \text{ (as attribute number=3)}$$

$$TP(\text{classB})=3.333$$

$$TP(\text{classC})=3.333$$

Here,  $TP$  Now we find the probability of the attributes against the temporary probabilities of classes respectively.

For (age, class):

$$P((N(\text{young}, \text{classA})+1)/TP(\text{classA}))= 0.6$$

$$P((N(\text{young}, \text{classB})+1)/TP(\text{classB}))=0.3$$

$$P((N(\text{young}, \text{classC})+1)/TP(\text{classC}))=0.3$$

For (sgpt, class):

$$P((N(\text{high}, \text{classA})+1)/TP(\text{classA}))=0.3$$

$$P((N(\text{high}, \text{classB})+1)/TP(\text{classB}))=0.3$$

$$P((N(\text{high}, \text{classC})+1)/TP(\text{classC}))=0.3$$

For (sgot, class):

$$P((N(\text{normal}, \text{classA})+1)/TP(\text{classA}))=0.6$$

$$P((N(\text{normal}, \text{classB})+1)/TP(\text{classB}))=0.3$$

$$P((N(\text{normal}, \text{classC})+1)/TP(\text{classC}))=0.3$$

Here,  $N$  is for occurrence number. In the example, with every occurrence of the attribute with classes, one is added so that there may never come zero value in calculation. Now we calculate the total probabilities.

$$P(\text{classA}|\text{Attributes})=0.333*0.6*0.3*0.6= \mathbf{0.035964}$$

$$P(\text{classB}|\text{Attributes})=0.333*0.3*0.3*0.3= 0.008991$$

$$P(\text{classC}|\text{Attributes})=0.333*0.3*0.6*0.3= 0.017982$$

As classA has the highest value, so **classA** is the predicted class. We find here, there is no zero-value effect after using Laplacian correction.

## IV. NAÏVE BAYESIAN ALGORITHM WITH PRIORITY BASED CORRECTION

### A. Priority Based Correction

Priority based correction methodology is a different approach to resolve the zero-value effect of Naïve Bayesian

algorithm. This correction methodology adds priorities to the classes which have maximum probabilities with the attributes. There may be a situation where more than one class may have same priority. For such a situation, probabilities of the classes is used to determine the only possible class. The algorithm is presented below.

### Algorithm: Priority Based Naïve Bayesian algorithm

1.  $I_a = \{\text{attributes}\}$
2.  $V_a = \{\text{attribute values}\}$
3.  $M(I_a, V_a)$
4.  $C_n = \{\text{classes}\}$
5. **for**( $i = 0$  to  $n$ ) **do begin**
6.      $\text{classSize}_i = \text{COUNT}(C_i)$ ;
7.      $P_i = \text{classSize}_i / \text{totalData}$ ;
8.      $\text{count}_i = 0$ ;
9.     **end**
10. **for**( $i = I_a.\text{length}-1$ ;  $i >= 0$ ;  $i--$ ) **do begin**
11.     **for**( $j = 0$ ;  $j < C_n.\text{length}$ ;  $j++$ )
12.          $\text{localCount}_j = \frac{\text{COUNT}(\text{get}(M(I_i), C_j))}{\text{classSize}_j}$
13.     **end for**
14.      $\text{maximumValue} = \max(\text{localCount})$
15.     **for**( $k=0$ ;  $k < C_n$ ;  $k++$ )
16.         **if**( $\text{localCount}_k == \text{maximumValue}$ ) **then**
17.              $\text{count}_k += 1$
18.     **end for**
19.     **end for**
20.      $\text{maxCount} = \max(\text{count})$
21.     **for**( $l = 0$ ;  $l < C_n$ ;  $l++$ ) **do begin**
22.         **if**( $\text{count}_l == \text{maxCount}$ )
23.              $P_l = \text{count}_a * P_l$
24.     **endfor**

**Result: class of the max( $P_n$ ).**

In the above algorithm,  $I_a$  is for attributes and  $V_a$  is for attribute values.  $M$  maps attributes with their values respectively.  $C_n$  stands for  $n$  classes. From line 5 to line 9, with the iteration, we count the class occurrence and store the occurrence values in  $\text{classSize}$  array.  $P$  is the probability array of classes. We also initialize the global count of classes to zero with  $\text{count}$  array, which will be used for prioritizing the classes. From line 10 to line 19, we go through all the attributes. From line 11 to line 13, we calculate the occurrences of the attributes with the classes separately. The class having the highest occurrence is selected from line 16 to 18, and the priority of that class is incremented to one. After all the iterations of attributes, we check the class having the highest priorities. There may be some situation where more than one class may have the same priority. For avoiding that situation, we use the probabilities of the classes to determine the desired class, which is done at line 21 to 24 with a iteration. After that iteration, we get the class, having the maximum value, which is our desired class.

### B. Example

Let us use table 1 and table 2 to examine how priority based Naïve Bayesian works. First, we calculate the probability of the classes.

Probability of classes:

$$P(\text{classA})=1/3=0.333$$

$$P(\text{classB})=1/3=0.333$$

$$P(\text{classC})=1/3=0.333$$

Then, we calculate the class occurrences from our stored data.

$$O(\text{classA}) = 1$$

$$O(\text{classB}) = 1$$

$$O(\text{classC}) = 1$$

Here,  $O()$  means the occurrence value.

We have three attributes from table 2, namely- age, sgpt and sgot. We check the probability of the attributes value against each classes.

$$P(\text{age:young} | O(\text{classA})) = 1/1 = 1$$

$$P(\text{age:young} | O(\text{classB})) = 0/1 = 0$$

$$P(\text{age:young} | O(\text{classC})) = 0/1 = 0$$

Here,  $\text{localCountA} = 1$ ,  $\text{localCountB} = 0$ ,  $\text{localcountC} = 0$ ; so,  $\text{countA} = 0+1=1$ .

Again,

$$P(\text{sgpt:high} | O(\text{classA})) = 0/1 = 0$$

$$P(\text{sgpt:high} | O(\text{classB})) = 0/1 = 0$$

$$P(\text{sgpt:high} | O(\text{classC})) = 1/1 = 1$$

Here,  $\text{localCountA} = 0$ ,  $\text{localCountB} = 0$ ,  $\text{localcountC} = 1$ . So,  $\text{countC} = 0+1 = 1$ .

Again,

$$P(\text{sgot:normal} | O(\text{classA})) = 1/1 = 1$$

$$P(\text{sgot:normal} | O(\text{classB})) = 0/1 = 1$$

$$P(\text{sgot:normal} | O(\text{classC})) = 0/1 = 0$$

Here,  $\text{localCountA} = 1$ ,  $\text{localCountB} = 0$ ,  $\text{localcountC} = 0$ . So,  $\text{countA} = 1+1 = 2$ .

After considering all the attributes, we have the following class based count value-

$$\text{countA} = 2, \text{countB} = 0, \text{countC} = 1$$

Now we multiply the occurrence with the probabilities of classes-

$$P(\text{classA}) = P(\text{classA}) * \text{countA} = 0.333 * 2 = 0.666$$

As,  $\text{classA}$  has the highest value, so,  $\text{classA}$  is the predicted class. With the example, we have found that, the zero-value effect is avoided successfully.

## V. BENEFITS AND LIMITATIONS

Both Laplacian and priority based Naïve Bayesian algorithm works in case of any zero class value. Both algorithms are being tested and it is seen that both of the algorithms are faster and their execution time differences are negligible. But, still priority based algorithm can be made more efficient and faster with some modifications and by simplifying the iteration processes.

## VI. CONCLUSION

Naïve Bayesian is an important algorithm for mining. Because of its fast execution property, most of the large database systems use this algorithm for mining large databases, for example, Hadoop, Microsoft Azure etc. In this paper, the limitation of zero-value situation is solved with two algorithms. This will help in getting error free result in case of any zero-value situation.

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# Comprehensive Socio-Economic Analysis of Biogas Energy Systems in Bangladesh: An Investigative Approach

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**Abstract**— By conducting comprehensive analytical study, it has been observed that the development of biogas energy in Bangladesh could be a sustainable solution to rural electrification. In fact, Bangladesh is a country where significant progress has been made through biogas energy. It has elaborated on different concepts of biogas technology. After all, the production of biogas takes place under anaerobic digestion of cattle dung, poultry droppings and agricultural residues. Biogas is a clean environment friendly fuel and it contains about 55-65% methane (CH<sub>4</sub>), 30-45% carbon dioxide (CO<sub>2</sub>). Not only this, it also contains hydrogen sulfide (H<sub>2</sub>S) and fraction of water vapor. Although it can be used only at the place where it is produced but by biogas power plant electricity can supply in other side especially rural area where national grid cannot able to supply electricity. Furthermore, it has also observed the feasibility study of biogas technology in Bangladesh. This paper systematically discusses about the scope and opportunity of implementing a mini off-grid energy system in remote rural areas in Bangladesh. Furthermore, it also discusses the socio-economic impact of adopting biogas based mini-grid in Bangladesh.

**Index Terms**--Anaerobic digestion, biogas, methanogenesis, hydrolysis, wet fermentation process.

## I. INTRODUCTION

Bio-gas is a gas that produced by anaerobic fermentation of different forms of organic matter and it composed mainly of methane (CH<sub>4</sub>), and carbon dioxide (CO<sub>2</sub>). Biogas technology is very important in most of the countries especially in Bangladesh. We can use biogas because it is a non-polluting and renewable source of energy. It provides enriched organic manure and by this manure we can produce fertilizers. Furthermore, it provides a source for decentralized power generation. In fact, our most significant issue is environment benefits on a global scale, biogas plant significantly lower the greenhouse effect on the earth's atmosphere and the plants subordinate methane emissions by entrapping the damaging gas and using it as fuel. In 1764 Benjamin Franklin in his correspondence to Josef priestly for a short time describes a trial during which he was managed to light up the surface of a small wetland lake in New Jersey, USA. Actually, the first scientific substantiation of flammable gas generation in wetland, Lake Sediments was given by Alexander Volta in

1776 by ascertaining the presence of methane in marsh gas. After all, after discovery of

Chemical formula of methane in 1804 by Dalton, European scientists has made first steps in investigating the practical application of biogas. In fact, the idea that rotting vegetable theme gives off a combustible gas or flammable gas has been under-stood since the ancient Persians.

In this field, the first step is Fermentation technology which is complicated modules like polymers, fat, proteins and carbohydrates are transformed to monomers, fatty acids, amino acids and saccharids. In this time, only the fermentative bacteria are active and process is known as hydrolysis. After complete first stage, than acetogenic bacteria dismantle the remaining complex organic molecules like alcohol into acetic acid. However, when acetic acid has been produced in sufficient quantities, a further type of bacteria starts to convert it into methane. The last step is called methane production and the bacteria involved are called methanogenic bacteria. At last the decomposed carbon is converted almost completely into methane. Finally, end product of fermentation is the combustible biogas.

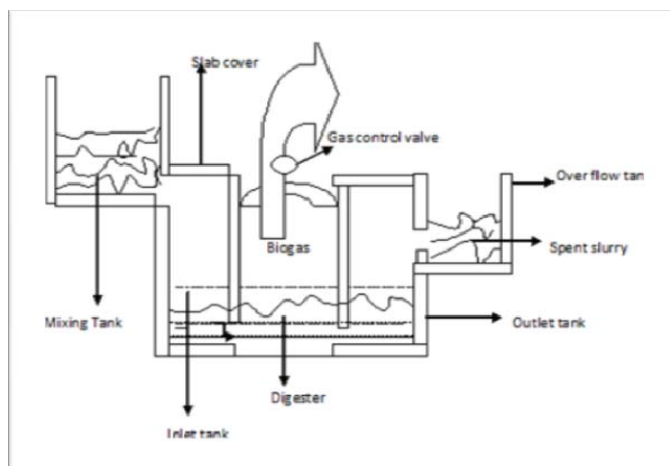


Figure 1: permanent dome type biogas plant.

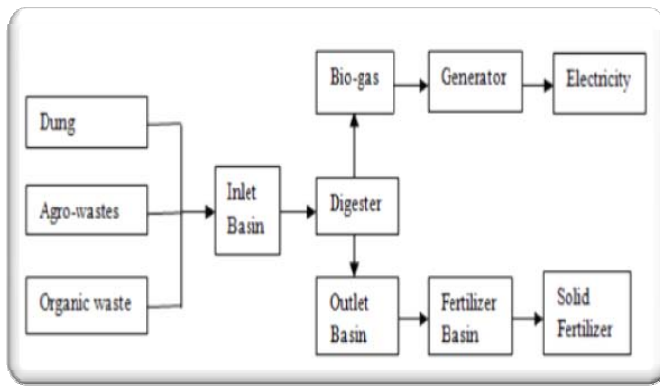


Figure 2: Electricity generation and solid fertilizer production procedure from biogas plant.

## II. WORKING PRINCIPLE OF BIOGAS PLANT

For producing biogas in the multi-stage process needs a huge amount of micro organisms which are able to use the stored force in carbon hydrates, fats and proteins in anaerobic conditions for their metabolism. In this field, nearly 70% of the contained methane bacteria which use acetic acid for their metabolism and 30% use hydrogen and carbon dioxide. In this field, the pH-value should be neutral up to low alkaline. Actually, the produced biogas is a combination of about 50-70% methane and 30-40% carbon dioxide. In fact, it also contains several traces gases like hydrogen sulfide, nitrogen, hydrogen, ammonia (NH<sub>3</sub>) and carbon monoxide. This gas can be used in many ways such as combustion for the production of electricity and heat, feed into a gas grid in fuel cells [1-5].

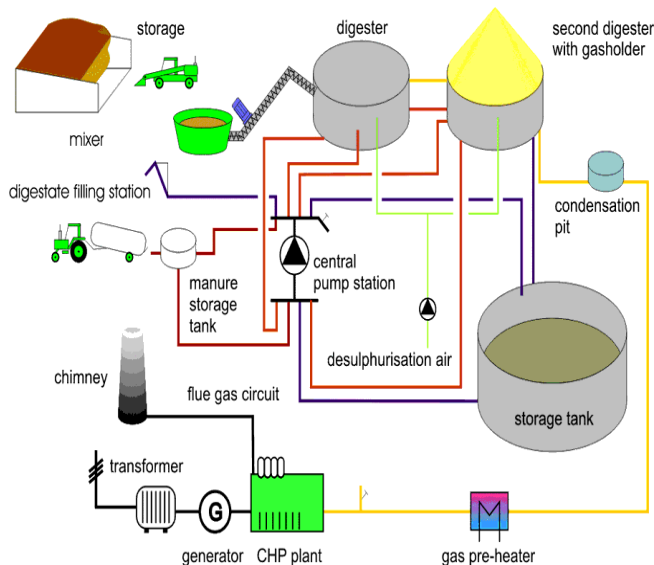


Figure 3: Schematic diagram of an agricultural biogas plant. [20]

However, the wet fermentation is used in the field of agriculture, where above the superseding years numerous plant types have been developed. After all, the most important meter is the wet fermentation technology became

established due to the option of using liquid substrates like manure, which is obtainable in most of the farms that is ideal for fermentation. On the other hand, the produced biogas can be used as a renewable, flexible and comfortable energy resource for the decentralized power supply. Furthermore, the utilization of the biogas for instance in a gas engine and the impurities contained have to be removed. The main problem the hydrogen sulfide (H<sub>2</sub>S) contained in the biogas. To prevent damages at the combined heat and power plant and other equipments such as heat exchanger, catalyst, gas engine, fuel cell the hydrogen sulfide (H<sub>2</sub>S) has to be removed to the gas to achieve the limits given by the producer. The limitations for hydrogen sulfide for biogas lie between 100 and 500ppm. Similarly, the period of the gas engine increases as soon as the quantity of H<sub>2</sub>S decreases. [6-9].

## III. AVAILABLE RESOURCES IN SAARC REGION

In SAARC region the energy resource particularly in relation to biogas, solar, wind, fossil and other energy options including hydro power. After all, the energy demand in this region is estimated to grow at a yearly rate of 5% with the household and industry sectors.

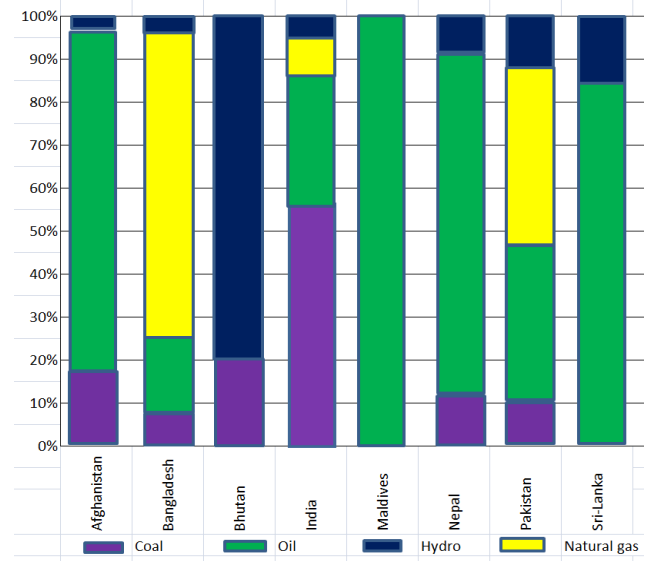


Figure 4: The available resource status in SAARC countries.

In this graph purple color denote coal, green color denote oil, yellow color denote natural gas and dark blue color denote hydro. The observations of this graph it is clear that four kinds of natural resources are in Bangladesh. Among them natural gas amount is maximum in Bangladesh. On the other hand Afghanistan has three types of natural resources. Bhutan has two types of natural resources. India has four types of natural resources. Maldives has only one type of natural resource. Nepal has three types of natural resources. Pakistan has four types of natural resources and Sri-Lanka has two types of natural resources.

#### IV. RESULTS AND DISCUSSIONS

In the field of renewable energy sector, especially biogas energy Bangladesh achieved 5MW, India 2648.5MW and Sri-Lanka 80MW in 2014.

Table 1: The present implemented biogas plant status in Bangladesh, India and Sri-Lanka.

Bangladesh	India	Sri-Lanka
5MW	2648.5MW	80MW

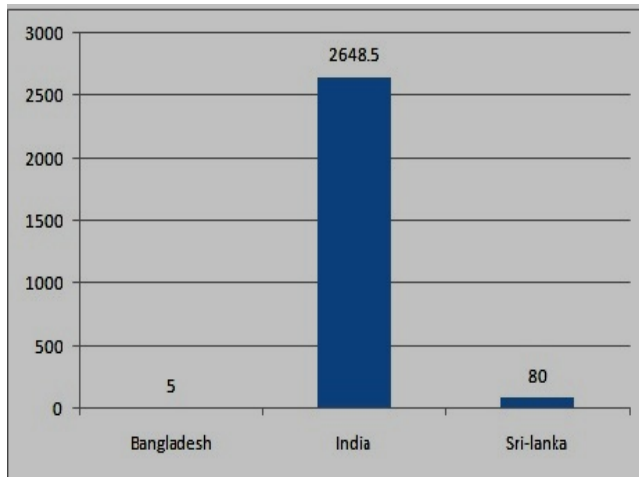


Figure 5: Comparison study of biogas energy achievement in Bangladesh, India and Sri-Lanka.

It has been observed from comparative study that biogas production in Bangladesh is less than India and Sri-Lanka. Although Bangladesh is a small country but biogas production should be standard level for its environmental and agricultural condition.

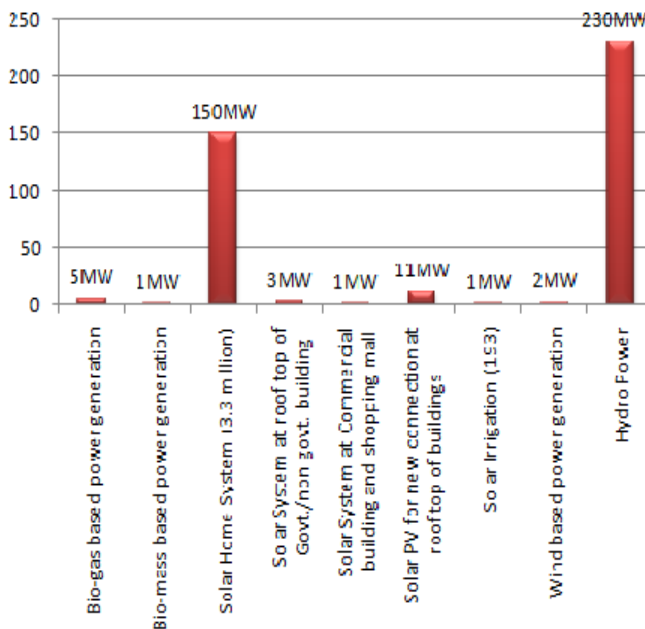


Figure 6: The implemented renewable energy status in Bangladesh in 2014.

The observation of the graph it has been clear that in renewable energy sector Bangladesh achieved total 404mw electricity and achievement for biogas plant only 5 mw electricity. This achievement for biogas plant is not sufficient. Bangladesh is a country which environment is suitable to generate electricity from biogas plant. Not only is this, raw materials are sufficient for biogas plant. So biogas energy is an important renewable energy source for Bangladesh.

Cost analysis for biogas plant: The cost analysis for biogas plant is divided into three categories.

1. Production cost
2. Running cost
3. Capital cost

Production cost: The production cost include all expenses which are necessary for the construction of the plant such as the land, excavation work, and construction of the digester and gas container, the piping structure, the gas utilization system and the dung storage system.

The determination factors for production cost of biogas are given below:

- The purchasing cost for land which is essential for the biogas plant and slurry storage.
- Dimension and size of the biogas plant
- Total prices of all kinds of materials
- Labor cost
- Specific model of biogas plant

The total cost for a biogas plant including all types of essential installation but not including land is between 3910-5866 taka per m<sup>3</sup> capacity. The total cost for the digester is 35-40%. The specific cost of gas production large plants is generally lower compared with small family plants[10-15].

Running cost: The maintenance and operation charge is comprise in running cost which consist of wage and material cost that depend on the following factors.

- Purchase, collection and transportation of the substrate.
- For cleaning and mixing the substrate need water supply.
- Feeding and operating of the biogas plants.
- Maintenance, repair and supervision.
- Storage and disposal of slurry.

After all, the running cost of a biogas plant management just as important as the construction costs for operation, maintenance, expenses service and repair. On the other, large scale biogas plants have high water consumption.

Capital cost: Actually, capital cost consists of redemption and interest for the capital taken up to investment the construction costs. However, for cost analysis initial investment, operation and maintenance cost, cost of capital

over the plant life has been taken under consideration to calculate the cost of power generation in US context that may also be used in Bangladesh context through customization of some observations [15-19].

$$LECBP = \frac{\sum_{t=1}^n \frac{I_t + O_t + F_t}{(1+k)^t}}{\sum_{t=1}^n \frac{E_t}{(1+k)^t}} \quad \text{----- (I)}$$

Where, LECBP= Average lifetime levelised electricity generation cost for biogas plant. The parameters of equation (I) is explained below sequentially.

**I<sub>t</sub>**= Investment expenditures in the year (t).

**O<sub>t</sub>**= Operation and maintenance cost expenditure in the year (t).

**F<sub>t</sub>**= Fuel spending in the year (t).

**E<sub>t</sub>**= Electricity generation cost in the year (t).

**k**= discount rate.

**n**= Life of the system.

By applying equation (I) total biogas plant cost expenditure calculation is being carried out in Table-2.

On the other hand, operation and maintenance cost can make a significant contribution to the levelised cost of electricity. It's typically account for between 9% and 20% of the LCOE for biogas power plant. It can be lower than co-firing and greater for plants with wide fuel preparation, management and conversion needs. Fixed operation and maintenance cost range from 2% of install costs per year to 7% for most biogas technologies and variable operation and maintenance cost of around BDT 0.39/KWh. Furthermore, landfill gas system have much higher fixed operation and maintenance costs that can be between 10% and 20% of opening capital costs per year.

The major capital cost items for a biogas power system include the fuel storage and fuel handling equipments, the combustor, digester, prime mover (Turbine or engine), generator, and stack and emission controls equipment. The total installed costs of biogas power generation a technology varies significantly by technology and country. However, anaerobic digester power systems had capital costs between BDT 200746.43 and BDT 476479.85/KW. On the other hand, in gasification technologies including fluidised bed and fixed bed solutions had total install capital costs of between BDT 167158.50 and BDT 445235.27/KW. The costs of CHP plant are higher than for the electricity only configuration.

However, many biomass power generation options are mature, commercially available technologies such as

anaerobic digestion, direct combustion, low percentage co-firing, municipal solid waste incineration and combined heat and power. The potential for cost reductions is therefore very assorted. Although different cost procedures are useful in different situations, the average lifetime levelised cost of electricity generation (LCOE) of renewable energy technologies is a broadly used measure by which renewable energy technologies can be evaluated.

Table 2: Status of investment cost and the levelised cost of electricity (LCOE) of biomass power generation.

SI no.	Name of instrument	Investment costs(BDT/KWh)	The levelised cost of electricity average range (BDT/KWh)
01.	Stoker boiler	146849.53-332754.78	<b><u>5.57 - 15.91</u></b>
02.	Bubbling and circulating fluidised boilers	169501.85-351501.53	
03.	Fixed and fluidised bed gasifiers	167158.50-445235.27	
04.	Gasifier CHP	435080.78-511239.44	
05.	Stoker CHP	277295.65-532720.09	
06.	Digester	201058.87-476792.29	
07.	Landfill gas	149739.65-190279.49	
08.	Co-firing	10935.60-66394.73	
Total =		1557620.43-2906917.62	

By SWOT analysis it has been found that there are four criteria of SWOT analysis. They are strength, weakness, opportunity and threat. Strength and opportunity is helpful and weakness and threat are harmful for biogas plant. Main strength it is renewable energy and it kills harmful pathogens. Furthermore, dumping of the organic waste in the streets to the spread of diseases causing organisms like E. Coli and Salmonella sp which causes diseases like Typhoid Fever and other air born diseases. In fact, the above mentioned pathogens are killed by fermentation process in the biogas plant. However, it reduces global warming.

Actually, main problem is biogas generated will be in atmospheric pressure. It solves organic waste disposal problem and 50-100% of LPG replacement. It produces H<sub>2</sub>S that direct react with steel in biogas plant as a result CHP plant can be hampered.

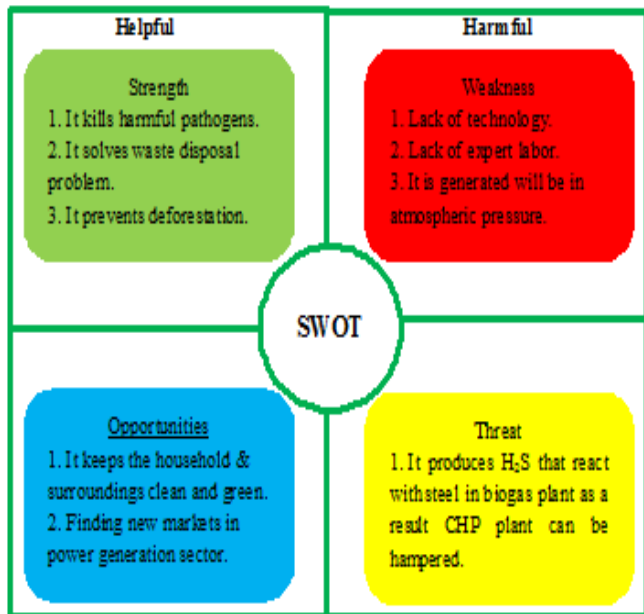


Figure 7: In-depth SWOT Analysis of Proposed Biogas plant

#### V. FUTURE PROSPECTS OF BIOGAS ENERGY IN BANGLADESH

Bangladesh is a very small country but her population is too much to her area. As a result, electricity and food demand increasing day by day. In fact, our government is not able to supply electricity in proportion to our demand by National grid because it is very expensive. So biogas energy is very important renewable energy source in Bangladesh. On the other hand, Bangladesh is an agricultural country. Now-a-days, poultry farms gradually increasing. However, biogas is a fuel gas that obtained from anaerobic digestion of cattle dung, poultry droppings and agricultural residues. So we can easily produce electricity from biogas energy in systematic way. Biogas provides enriched organic manure and by this manure we can produce fertilizer. As a result, from biogas we can produce electricity and its organic manure can be used as fertilizer.

#### VI. FUTURE WORKS

After all, it has been found that biogas plant obey significant role to generate electricity in proportion to remote corner demand in Bangladesh. However, it has been found that there is a village that name is Nolhora under district of Tangail in Bangladesh. In this village, there is no electricity still now. As a result, the people of the village are deprived of modern life and technology. On the other hand, Bangladesh is an agricultural country. So for irrigation the farmers use diesel engine that is very costly for them. In the village raw

materials is available and environment is suitable for biogas plant. If biogas plant will be installed in this village to generate electricity it will be hope that they will be got a modern life. The farmers can use electric motor for irrigation and ultimately the production of the harvest will be increased day by day. Furthermore, the residue of biogas plant can use as organic fertilizer.

#### VII. CONCLUSION

By doing comparative and feasible study of biogas energy systems in Bangladesh, it has already found out that at present some rural areas are not connected with national grid. If biogas plant will be installed in these areas they will get modern life. In fact, Bangladesh is an agricultural country and such areas people depend on their harvest. Furthermore, if sustainable and cost-effective biogas plant can be adopted, it can be immensely useful in the longer run to drive away the scarcity of electricity in those rural areas of Bangladesh and save a lot of resources.

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# A Survey on Bangla Machine Translation

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**Abstract**— This paper presents the different types of machine translation approaches such as- Direct; Transfer and Corpus-based approach, and MT refer to the use of computers for the task of translating automatically from one language to another. It is highly challenging to build up a proper MT system which will work for translating foreign languages to native languages but this paper aims at providing a solution that could be helpful for building a MT system which will convert the English sentences into Bangla sentences. Moreover, this paper will also show different ways of using tenses (present indefinite, continuous, perfect, past indefinite, continuous, perfect, future indefinite, continuous and perfect) words for the purpose of translating English sentence into Bangla sentence that will require finding out the meaning from our own database. In this paper, 4 different machine translation approaches including Google translate will be compared to find out accuracy in case of word and sentence.

**Keywords**— Machine Translation, Direct Approach, Transfer Approach, Corpus-based Approach.

## I. INTRODUCTION

Bangla (also known as Bengali) is one of the richest and highest spoken languages in the world. In the world the number of people who is speaking in Bangla is more than 220 million where it is ranked sixth based on the number of speakers out of total world population [1]. Bangla, the mother language of Bangladesh, is not only used in Bangladesh but also in eastern area of India (West Bengal and Kolkata as its capital) for speaking and writing.

There are many studies in the area of language translation but there is no fully successful language translation machine yet which makes Natural Language Processing (NLP) a quite tough job. Natural languages are highly complex, mentioning that, words may have different meanings and possible translations, sentences may have various readings, and the relationships between linguistic entities are often ambiguous. As it is a Human Language Technology (HLT) thus there are enormous varieties and opportunities for doing research. In fact, it's impossible to work on the whole language translation process together thereby it requires to be segmented into many parts. But there is also another dilemma that most of them select a part of the source language for translating to the target language. Such as, in this paper the source language is English and the target language is Bangla where there are different types of sentences in both these languages but the focus of this paper is mainly on different types of tense.

So far, a very few work has been done on English to Bangla language translation both in Bangladesh and West Bengal of India. Only the present indefinite and present continuous forms of English sentences are concerned in [2]. They represent a simple algorithm for language translation. Using Artificial Intelligence (AI) a Natural Language Processing (NLP) algorithm is proposed in [3]. In [4], Cockey-Younger-Kasami (CYK) algorithm is used for language translation. The main change they brought was that they used normal parse tree than the Chomsky Normal Form (CNF) parse tree because they proved that some problems arose during transfer from English parse tree to Bangla parse tree. Morphological analysis is done in [5] where morphemes means minimal unit of meaning of grammatical analysis. A phrasal Example Based Machine Translation (EBMT) is represented in [6].

## II. MACHINE TRANSLATION

Machine translation (MT) is a sub-field of computational linguistics that investigates the use of software to translate text or speech from one language to another. There are various approaches to Machine Translation. i) Word-for-Word translation, ii) The direct approach, iii) Transfer approach, iv) Corpus-based approach, v) Interlingua approach and vi) Statistical translation

### A. Word-for-Word Translation

Use a machine readable bilingual dictionary to translate each word in a text.

TABLE I. DICTIONARY

<i>English</i>	<i>Bangla</i>
I	আমি
Eat	খাই
Rice	ভাত
.	.
.	.

The advantages of this approach are Easy to implement, results gives a rough idea about what the text is about and the disadvantages are problems with word order means that this result in low quality translation rent designations.

### B. Transfer Approach

The transfer model involves three stages a) Analysis, b) Transfer and c) Generation. In analysis stage the source language sentence is parsed and the sentence structure and the constituents of the sentence are identified. Example: I eat rice. Here words are: I, eat, rice and the sentence structure: [subject] [verb] [object]. In transfer stage transformation are applied to the source language parse tree to convert the structure to that of the target language.

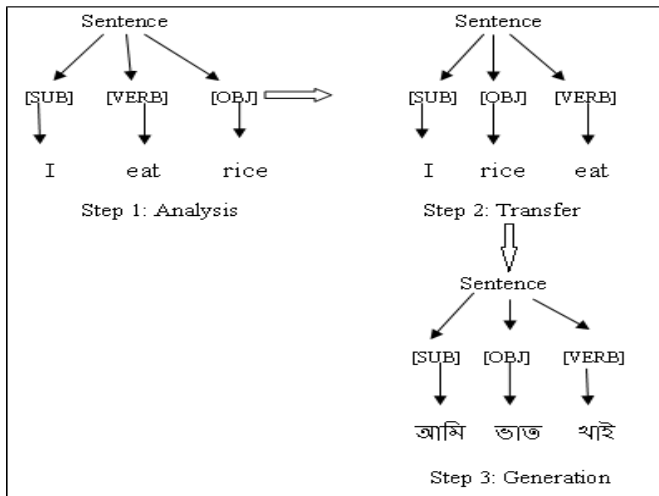


Fig. 1. Example of Transfer Approach

### C. Direct Approach

The most primitive is called the direct MT strategy, which is always between pairs of languages and based on good glossaries and morphological analysis. Direct Approach has five steps to translate. Example of direct approach is given in Figure 2.

Example: You are playing football.  
**Morphological analysis:** You playing PRESENT CONTUNIOUS football  
**Identify constituents:** <You> <playing PRESENT CONTUNIOUS > <football>  
**Reorder according to target language:** <You> <football> <playing PRESENT CONTUNIOUS >  
**Look-up in the source target language dictionary:** <ভূমি> <ফুটবল> <খেলছ>  
**Inflect:** ভূমি ফুটবল খেলছ

Fig. 2. Example of Direct Approach

### D. Corpus-based Approach

In corpus based MT (CBMT) approach two parallel corpora are available in SL and TL where sentences are aligned. First it is done by matching fragments against the parallel corpus and then adopting the method to the TL. Finally reassembling these translated fragments appropriately and then translation principle are applied. Figure 3 shows this method.

Corpus-based Approach entails three steps:

1. Matching fragments against the parallel training corpora.
2. Adapting the matched fragments to the target language.
3. Recombine these translated fragments appropriately.

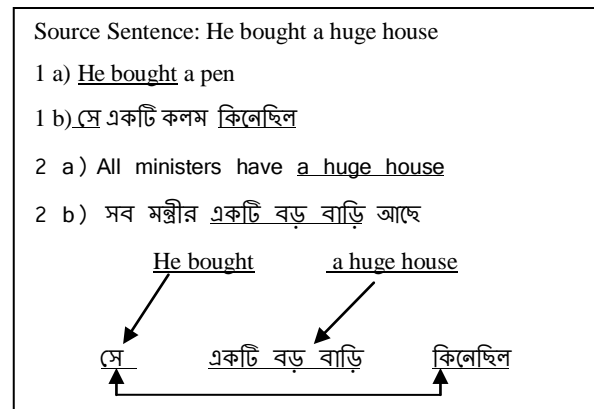


Fig. 3. Example of Corpus based approach

### E. Interlingua Approach

The most advanced system is called the interlingua MT strategy. The idea behind this approach is to create an artificial language, known as the Interlingua, which shares all the features and makes all the distinctions of all languages. To translate between two different languages, an analyzer is used to put the SL into the Interlingua, and a generator converts the interlingua into the TL. Figure 4 describes an example of interlingua.

Two stages to follow for Interlingua Approach:

1. Extracting the meaning of a source language sentence in a language-independent form.
2. Generating a target language sentence from the meaning.

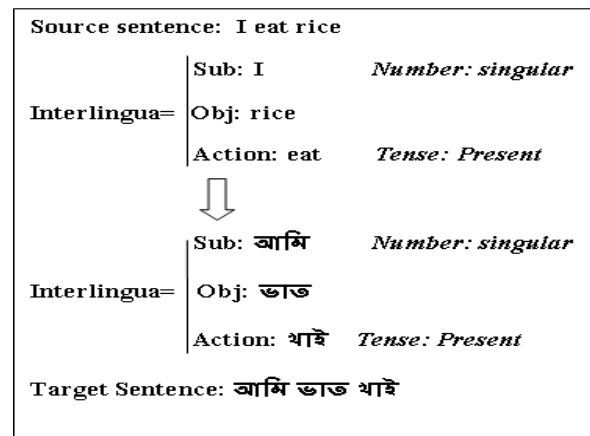


Fig. 4. Example of Interlingua

### F. Statistical Machine Translation(SMT)

SMT [8] models take the view that every sentence in the TL is a translation of SL sentence with some probability. The best

translation of sentence is that which has the highest probability. In SMT three major components are, language model, translation model, search algorithm. If t-target language and s-source language then we can write,  $P(t/s)=p(s/t)P(t)/P(s)$ ,  $p(t/s)$  depends on the  $P(t)$  which is probability of the kind of sentences that are likely to be in the language t. This is known as the language model  $P(t)$ . The way sentences in s get converted to the sentences t is called translation model  $p(t/s)$ .

### III. PROPOSED METHOD

Here we discuss about three (3) machine translation approach which we have already implemented-i) Direct approach, ii) Corpus approach and iii) Transfer approach

#### A. Direct approach

In direct approach the output for the sentence ‘Boys are playing football in the middle of the field’ is



Fig. 5. Example of Direct approach

The advantages of direct approach we get output more accurately (small amount of data set). But in case of huge data set this approach cannot achieve best result.

#### B. Corpus-based approach

The main advantage of this method is finding out the senses of words and phrases in different contexts in a speedy way. Moreover language users will find it very profitable as a corpus can provide them with a large collection of grammatical patterns, collocation and colligation of words and phrases to aid their analysis in a very short time. However the disadvantages are that corpora help in language learning and analyzing. Using corpora may, however, be a time-consuming task. The collections of texts in corpora may cause problems in analyses. The information, e.g. senses of words/phrases, might not be accurate or might be obsolete as the data in a corpus are recorded for a specific period of time [7]. The output for the same input is quite different in this method. The output is ‘ছেলেরা মাঠে মাঝখানে ফুটবল খেলেছে’ which is shown in this method. But in the original meaning ‘in the field’ means ‘মাঠের’ which is replaced by ‘মাঠে’.

#### C. Transfer Approach

It is possible with this translation strategy to obtain fairly high quality translations. However, sometimes it is not possible to show all the word meaning properly or sometimes in this approach some words are missing in the output text.

### IV. EXPERIMENTAL RESULT

We have total 406 sentences and total words are 1895. These data are applied on three (3) different machine translation approaches: Direct approach, Corpus Based approach, Transfer approach and Google translate. We get different accuracy rate.

TABLE II. ACCURACY RATE OF DIFFERENT APPROACH

	Direct Approach	Corpus Based Approach	Transfer Approach	Google Translate
Sentence Correct Rate (%)	85.714286	67.241379	88.177339	30.295567
Word Correct Rate (%)	96.249339	91.451187	93.984169	37.361477

From the above table it is clear that sentence correct rate and word correct rate of Transfer approach is highest among four methods and Google translate shows worst result.

TABLE III. WORD AND SENTENCE COUNT OF DIFFERENT APPROACH

Different Method	Total word	Total sentence	Line mismatch	Word mismatch
Direct Approach	1893	406	58	71
Corpus Based Approach	1895	406	133	162
Transfer Approach	1895	406	48	114
Google Translate	1895	406	283	1187

On table III we see that total word is 1893 in Direct approach and word mismatch compare to original file is 71. Moreover, total sentence is 406 and sentence mismatch to original file is 58. From our experiment we can say that Transfer approach shows more accurate among all those approach.

### V. CONCLUSION

Although it is a complicated work but it requires more improvement on detecting multiple Bangla meaning for an English word and on improving the artificial intelligence to detect phrases and idioms. The method proposed here fails to translate all sentences with highest (100%) efficiency because of the variation in sentence structure of Bangla and English language. The improvement in the proposed system for identifying multiple meanings, phrase and idioms along with

developing a strong data dictionary will be addressed in future.

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# *A novel approach to aware slum dwellers during fire breakthrough using device to device communication*

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**Abstract**—People living in slums are severely affected in case of any disaster such as fire or earthquake due to the unawareness of the situation and difficulties associated with rescue operations. Since disaster preparedness and responses are always better than recovery, our goal is to aware habitats for faster response during the disaster occurrence such as fire breakthrough. Conventional fire alarm systems comprising of fire sensors and smart phones offers fire alarm generation for the dwellers and quick communication to the rescue authorities. In addition to the existing system, we propose to aware the dwellers of the slum during fire occurrence not only by starting the siren but also by transmitting fire alarm to their smart phones to aware them; this task will be performed by a central public safety smart phone through device to device communication under LTE network. The public safety smart phone will establish communication with the nearby habitat's smart phone and repeat this action to ripple the alert signal to other habitats, so the nearby dwellers will be notified instantly. Then it will pass the information to the passerby to spread the news about the fire and to the responsible authorities for rescue operation. For the alert generation among the dwellers, we need 4G LTE network enable smart phone capable of device to device communication. Cost effective analysis and the simulations showed that minimal cost and time is required for the fire alarm generation and propagation to the dwellers compared to the safety of valuable human live.

**Keywords**- Slum, Fire breakout, D2D, LTE network, Public Safety, Proximity service

## I. BACKGROUND STUDY: LTE ADVANCED

### A. LTE

LTE stands for Long Term Evolution and it was started as a project in 2004 by telecommunication body known as

the Third Generation Partnership Project (3GPP). The main goal of LTE is to provide a high data rate, low latency and packet optimization [1]. LTE also support voice and SMS text messaging using existing networks. We choose LTE over GSM because it offers D2D communication which decreases the traffic communications while sending data, allows more users to use the same frequency in a cell and offers faster data rate transfer system. Same time its network architecture has been designed with the goal to support packet-switched traffic with seamless mobility and great quality of service.

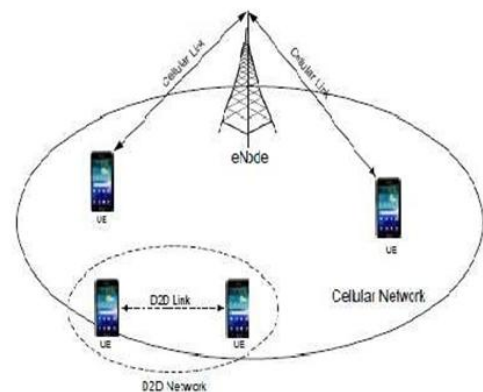


Figure 1. LTE network controlling D2D communication

### B. D2D

4G LTE Advanced offers local direct communications using LTE devices within a small area. It is a peer to peer link which does not use the cellular network infrastructure, but enables LTE based devices to

communicate directly with one another when they are in close proximity[2][3]. One of the particular applications where LTE device to device communication can be used is for the emergency services. LTE device to device communication is also being investigated for applications where peer discovery is required for commercial applications in the presence of network support.

Recent smart phones available for commercial use are capable to operate under 4G networks such as LTE networks. It is expected that the existing 3G networks will upgrade themselves to the 4G all IP based LTE network very soon and the LTE A will be equipped with proximity services to establish device to device communication.

### C. Recent Fire alarm systems

Fire breakthrough has been a common disaster either natural or man-made which causes severe damage to environment and live. Many inventions and developments are achieved for fire detection using smoke sensor, heat sensor, fire sensor etc. and various fire control mechanisms have been implemented to prevent fire or to response faster during fire breakthrough. Fire alarm control panel is a key equipment and works as a brain for automatic detection system receiving the fire information from the fire detectors and sensors and sending and notifying the information to the fire officers and to the public. Fire alarm control panel can be divided by conventional-type (P-type), addressable type (R-type) and M-type depending on the signal process and location of the equipment and by GP-type, GR-type and hybrid-type depending on the usage. Smart phones are integrated now-a-days with the fire alarm system to send text messages to the fire fighters or monitors. Smart phone applications linked with fire alarm control panel in automatic fire detection system have been developed for monitoring the fire situations in fire control mechanism such as situ including occurrence of fires, fire control related equipment, short circuit of the fire detectors, and status of the control panel. As a result, the fire related information in situ can be monitored by the fire officers anywhere and anytime [5]. In large public areas, such as building, school campus, fire alarm system implemented can be monitored by the security personnel. Internet of Things (IOT) is also proposed for fire alarm generation [6]. Smart home plans are also integrating smart phones in the fire alarm systems for prevention and also to inform the owner of the house for safety issues.

## II. CASE STUDY: FIRE BREAKOUT IN BANGLADESH

In many under developed countries, most of the citizens live under poverty level and are deprived from fundamental constitutional rights such as food, shelter, education etc. Low income people in large number are forced to live inhumanly in slums or highly populated area with high risk of health and safety issues. Houses are often build too close with very narrow passage way through them

and are very crowded. Like many other Asian countries, Bangladesh is a highly populated country with many people living under the poverty level. Dhaka, the capital city of Bangladesh, is one of the most crowded cities around the world.

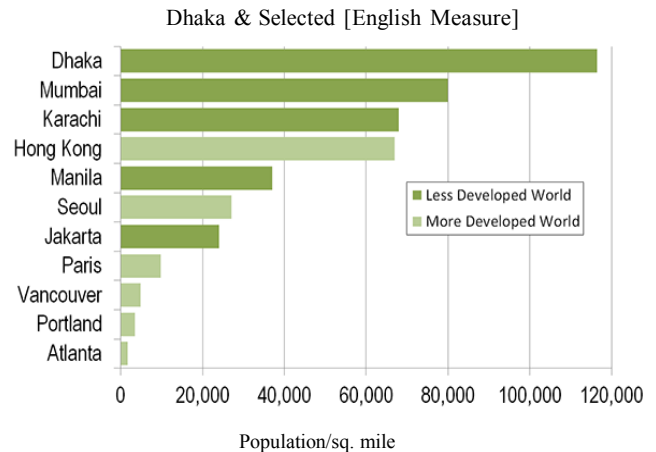


Figure 2. Average population in urban areas in some cities around the world

It is estimated that 40% of the capital city Dhaka's population live in slums under the Dhaka City Corporation (LGED Slum survey, 2005). Some statistical data are stated below as provided by Center for Urban Studies [CUS] Dhaka [10].

Total population cities	:15.5 million
Total slum population	:5.4 million
Slum clusters	:9000
Total number of slum households	:1 million
Population density in slums	:200000/sq. km

Over the years, fire broke out very often in these slums causing loss of properties and lives. More than 120 people were killed in June 2010 when a fire at a wedding party destroyed six buildings in the densely populated old part of Dhaka. In 18 November 2012, At least 11 people, all women and children, have died as fire swept through one of the biggest slums in the capital Dhaka destroying more than 500 homes. In 28 June 2014, around 400 homes in a slum in JhutPotti of Mirpur 10 were completely destroyed in a fire, leaving more than 1,000 people homeless. In 11 January 2015, 4-yr-old girl died in Battala slum in Dhaka's Katasur, where a devastating fire ravaged about 400 homes.

These statistics indicate the devastating high occurrence rate of fire in this country and the loss is unbearable. Since the slums are highly populated and houses are built too close with very narrow passage ways through them, it is even more critical to perform any rescue operations during the occurrences. So, in order to aware the habitats about the fire, this paper proposes heterogeneous network of fire sensors with smart phones to aware the habitats to secure and save their lives by facilitating faster rescue operation.

### III. PROPOSED SYSTEM

Conventional fire alarm systems merged with smart phones are capable of sending text messages to the monitoring fire officers using the 3G telecommunication networks. The fire alarm system will turn on the siren for attention of people and to evacuate the place and will send messages to the corresponding authorities. As we studied various fire occurrences in slums of Bangladesh, it was observed that people could not get alerted due to the absence of any fire alarm systems and also due to the sudden severity of fire spread during night while the dwellers were asleep. Our goal is to provide a low cost fire alarm system for the slum people which can aware the dwellers by texting on their mobile phones along with siren and to contact authorities. Since people living in a slum are floating dwellers, we cannot have the list of mobile numbers of the dwellers to contact through the current 3G networks, so we propose for 4G LTE network to implement the service of texting unknown dwellers by d2d communication. In this paper, we propose to merge wireless sensor network with fire alarm system integrated with a 4G smart phone capable of D2D transmission for public safety under LTE network. Since D2D works well in close proximity, it has a certain range such as 30 meters of perimeter to communicate with each other and it can easily establish transmission by pairing with nearby devices. Features of this proposal are summarized below:

- i. The smart phone will turn on the fire alarm as triggered by the sensor network for identifying fire breakout.
- ii. The smart phone will pair automatically with nearby habitat's mobile phone to establish d2d communication using proximity services and will send the fire alert signal.
- iii. This fire alert signal will ripple to other nearby habitats smart phones and eventually transmit to all including the passerby persons.

#### A. Assumptions

- In this paper, we have considered a slum in Dhaka where one square kilometer area will be covered by wireless sensors for simplicity of simulation process.
- The linchpin of the proposed network is a smart phone which will generate fire alarm during fire breakthrough.
- This smart phone of the system and habitats' smart phones must perform d2d communication capable of 4G wireless transmission under LTE network.
- The slum area will be covered with wireless sensor network and the gateway of this network will be the smart phone. As we planned of 1 sq.km slum area, we will need 100 pieces of lm35 temperature sensor to cover the area, so each sensor will have coverage area of  $1/100=0.01 \text{ Km}^2$ .

#### For awareness of the dwellers during fire breakthrough

If fire occurs, the wireless sensors can sense the fire signal, any one of them will transmit the information to the gateway sensor; the gateway sensor will then pass the fire signal to the smart phone deployed within the area; this smart phone will first set the fire alarm to aware the habitats and then it will transmit the fire alert to the habitats and passer-by through d2d communication to their smart phones.

As described later, *phase 1* and *phase 2* are designed for awareness of the habitants.

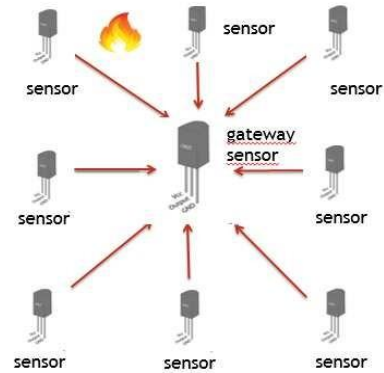


Figure. 3. Sensor (source) to gateway sensor communication

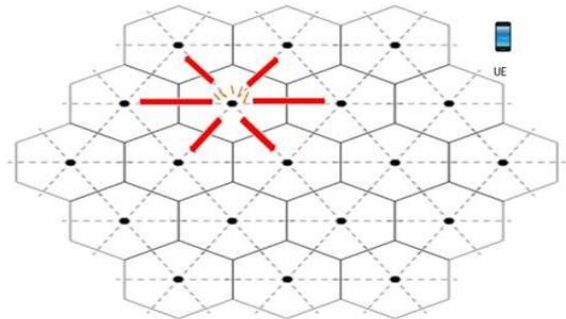


Figure.4. Sensor coverage area

#### For Recovery and rescue operation during fire breakthrough

The smart phone will also transmit the alert signal to the concerned authorities such as the rescue operators, law & enforcement agencies, emergency health workers etc. The smart phone will be programmed to send message of the fire alert signal to lists of contact numbers of nearest fire brigade, police station, hospital etc. This will be the wireless transmission performed under the LTE core network.

As described later, *phase 3* is designed for recovery and rescue operation of the habitants.

### B. Network model

#### Phase 1: Wireless Sensor network (WSN)

Sensors will detect the temperature of selected area. As all sensors are connected to the gateway sensor through their neighbors, whenever any sensor reads temperature more than or equal  $150^{\circ}\text{C}$ , the fire signal will be passed to the Gateway Sensor. In this phase, the fire signal will be transmitted in two steps:

- i) Transmit fire signal from sensor (source) to gateway sensor.
- ii) Transmit fire signal from gateway sensor to gateway smart phone.

#### Phase 2: Device to Device Communication (D2D)

The fire signal will be transmitted in the following two steps:

- i) Smart phone will trigger the fire alarm for siren.
- ii) Transmit fire signal from gateway smart phone to habitat mobile phone by establishing d2d communication.

#### Phase 3: LTE Communication (LTE)

The last phase requires LTE network for the smart phone to deliver the fire signal to the appropriate authorities. It will work in the following two steps:

- i) Transmit fire signal from smart phone to the core network, eNB using the list of contacts of emergency recovery and rescue units.
- ii) eNB will propagate fire signal to the metropolitan police, fire brigade and hospital etc.

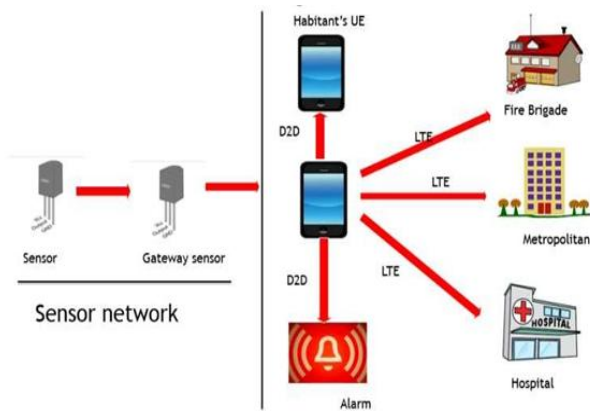


Figure 5. Proposed network diagram

### C. Logical model

Every wireless sensor deployed in the slum will monitor the temperature rise within its area and will send data to the gateway sensor. If the temperature is above or equal  $150^{\circ}\text{C}$ . The sensors used here are the primary source of data about the fire breakout.

### Sensor Temperature

High\_risk:  $\Rightarrow >150^{\circ}\text{C}$ ;  
No\_risk:  $\leq 50^{\circ}\text{C}$ ;

### Firealert:

Red\_state : High\_risk [fire breakthrough]  
Green\_state : No\_risk [no fire identified]

### Proposed Algorithm

Enable Sensor Network and Input values from every Sensor

```
Void Temperature_Sensor(void){
    If(Sensor_Temperature==No_risk){
        Then do nothing;}
    Else If (Sensor_Temperature ==High_risk){
        Then Transmit sensed_signal to
gateway_sensor;}}
Void Gateway_Sensor(void){
    While (signal_arrival==sensed_signal){
        Set Alert_signal==Red_state;
        Transmit Alert_signal to Smartnode();}}
Void Smart_Node(void){
    While (signal_arrival == Alert_signal){
        Set Fire_Alarm==On;
        Enable D2D_Communication(send Alert_signal){
        Start Proximity services;
        Search for habitat_node && Pair
        Transmit Alert_signal to habitat_node;
        Search for passerby_node && Pair
        Transmit Alert_signal to passerby_node;}
        Enable LTE_Communication (send Alert_signal){
        Process list_of_Contact;
        Transmit Alert_signal to authoritynode;
    }}}}
```

## IV. SIMULATIONS AND RESULTS

We have used omenet+ as our network simulator. Simulation is performed phase by phase as described below:

#### Phase 1: Wireless Sensor network (WSN)

- i) Sensor (source) to gateway sensor communication:

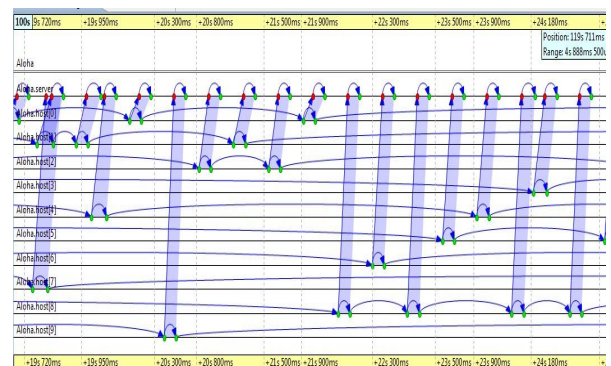


Figure 6. Sensor to gateway sensor communication



Here we have 10 temperature sensors which are connected by a mesh network with the gateway sensor. In this simulation we have used aloha protocol.

Calculated transmit time for transmitting fire signal from sensor (source) to gateway sensor = **10.2 milliseconds**.

ii) *Gateway sensor to gateway smart phone communication:*

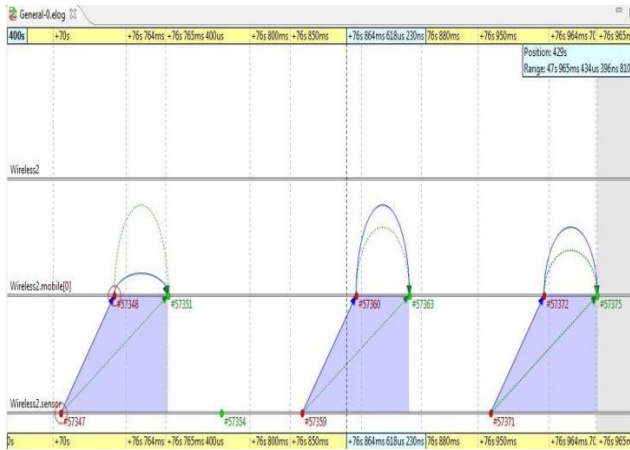


Figure 7. Gateway Sensor to gateway smart phone communication

Calculated transmit time from Gateway Sensor to gateway Smart Phone Communication = **0.816 milliseconds**.

Phase 2: Device to Device Communication (D2D)

i) *Gateway smart phone to alarm communication:*

After getting fire signal the smart phone sets alarm on. Calculated transmit time from gateway smart phone to Alarm communication = **0.01345 milliseconds**.

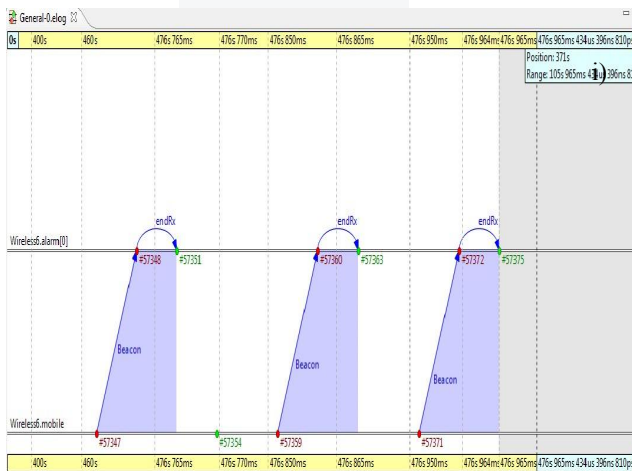


Figure 8. Gateway smart phone to Alarm Communication

So, the total time required for alarm generation in the slum to make awareness among habitat is around **11.02945 milliseconds**.

ii) *Gateway Smartphone to habitat mobile phone communication:*

Here we have used flooding protocol. Calculated transmit time from gateway smart phone to habitat mobile phone communication = **0.00066 milliseconds**. So, the total time required for the Alert Generation among habitat through mobile phone around = **11.01666 milliseconds**.

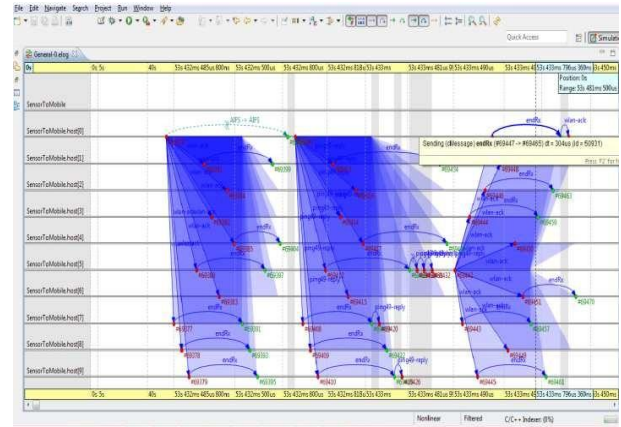


Figure 9. Gateway smart phone to habitat mobile phone Communication

**Time required for Awareness of fire breakout in the slum**

Time required for fire alarm to make siren is **11.02945 milliseconds**.

Time required for transmitting fire alert to habitants' smart phones is **11.01666 milliseconds**.

So, the habitats of the slum will hear the siren of fire alarm and will also get alert on their smart phones by **22.04611 ms**.

Phase 3: LTE Communication (LTE)

*Gateway Smart phone to Base Station Communication:*

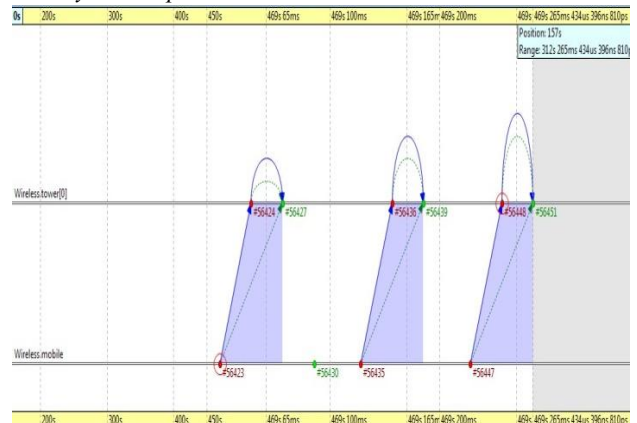


Figure 10. Gateway smart phone to eNB Communication

Calculated transmit time from gateway smart phone to Base Station(eNB) Communication = 0.02 millisecond. So, the total time required for transmitting fire signal after occurrence to base station is around 11.036 milliseconds.

ii) eNB to metropolitan, fire brigade and hospital communication:

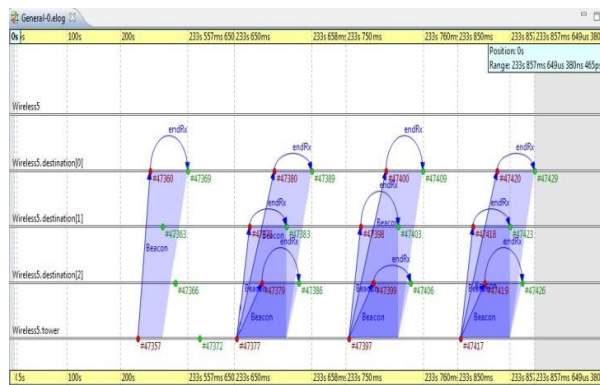


Figure 11. Core network to Metropolitan police, Fire Brigade Communication and Hospital Communication

Calculated transmit time from base station eNB to the concerned authorities= 0.001455 millisecond.

**Time required for rescue operators to be informed of fire breakout in the slum**

Total time required for transmitting fire breakout information to responsible authorities is around 11.03745 ms.

**V. COST BENEFIT ANALYSIS**

As we estimated implementation cost of this proposal of 1 sq.km slum area, we will need 100 pieces of lm35 temperature sensor costing maximum 20 dollar, a smart phone of nearly 120 dollar and an alarm about 10 dollar. So the total estimated budget is = 150 dollar. In case of large area to cover, only the price of the sensors will be in addition of 20 dollar for each 1 sq. km area in consideration. Our simulation showed excellent results in transmitting the fire alert to the habitants so quickly that they can rescue themselves from the damage of the fire. As this proposal requires small amount of money to deploy the system, there is no doubt of its competitiveness to save human live in a faster way.

**VI. CONCLUSION**

In this paper, we propose a good worth heterogeneous network of sensors, smart phones and fire alarm in a slum area for fire breakout by transmitting fire alert signal to create awareness among the habitants and the responsible authorities for quick rescue operation. Simulation process reveals that *estimated time required for fire alarm to set on is around 11.02945 milliseconds, for the alert generation among habitant through smart phone is around 11.01666*

*milliseconds and to transmit the fire occurrence to responsible authorities is around 11.03745 milliseconds. These excellent results prove the acceptability of the proposed system. At the same time we have focused on the cost-effectiveness of the budget for the proposed system so that it can easily be deploy the system in slum area with low cost involvement. The cost benefit analysis reveals that the total estimated budget is around 150 dollar and for large area coverage, the price of the sensors will be in addition of 20 dollar for each 1 sq. km area in consideration. As our budget is cheap, government or other non-government organization can easily fund this proposal to make real life project for the poor people and can save thousands of lives.*

The fire alert signal with sensors and a mobile phone is easy to build with 3G technology and is used in many places. This proposal differs from the existing works as it utilizes device to device communication between the system's smart phone and the habitants smart phones to aware them immediately of the situation. The proposal requires 4G smart phones working under LTE network capable of device to device communication which we expect to have in near future. The future 4G mobile phones will hopefully come with the proximity services enabling the D2D communication; then we can solve various real life problems such as lost and found, alert generation, real-time advertisement, help desk etc.

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# Feature extraction and Classification of EEG signal for body movement in different directions

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**Abstract-** In modern technology the use of electroencephalogram (EEG) signal is playing an important role in Brain Computer Interface (BCI). Brain Computer Interface connects brain with the outside world. Brain signals are recorded from scalp and can be used in many applications. In this paper different features are extracted using EEG signals for movement of body in different directions. Here both Time domain and Frequency domain analysis are considered. Then Support Vector Machine (SVM) and Artificial Neural Network (ANN) classifiers are used for determining the accuracy. This can be very effective for the movement of paralyzed people using electric wheelchair.

**Keywords-** Electroencephalogram, Biopac Student lab, Time domain analysis, Frequency domain analysis, Features extraction, Classification, SVM, ANN.

## 1. INTRODUCTION

Human brain generates electrical signal and this signal can be recorded by using electrodes at different position on the scalp. Those recorded signals are called Electroencephalogram (EEG) and this signal has vast application in the bioscience. It was first recorded by Berger in the year of 1929 by attaching several electrodes on the human skull [1]. It provides direct communication between the human brain and body. For different movement of the body, different EEG signals induce. A lot of people in the world are facing the problem with partial or complete paralysis. Those signals can be collected and can be useful for the movement of paralyzed people. A. Borgul shows a way by intuitive control for robotic rehabilitation devices by Human-Machine Interface (HMI) with EEG signals [2]. So proper EEG signal analysis plays a vital role in the area of human brain interface.

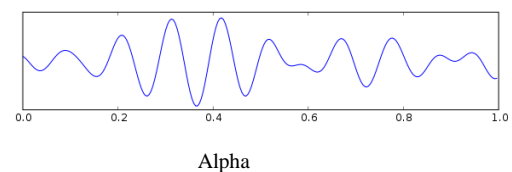
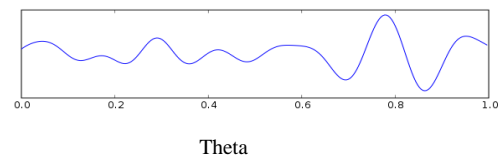
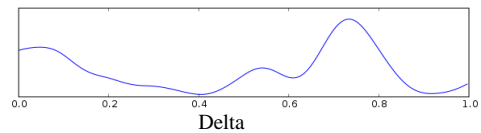
EEG signal has a very low frequency in the range of hertz. A EEG signal consists sum of other signals. EEG signal can be classified based on their

frequency bands. Those bands and region of brain from where it is extracted are given below.

Table 1: EEG frequency band and their extraction region

Band	Frequency	Location
Delta	<4	Frontal in adults, posteriorly in children; high amplitude waves
Theta	4-7	Found in locations not related to task at hand
Alpha	8-15	Both sides posterior regions of head, generally on dominant side there is higher amplitude. Central sites at rest
Beta	16-31	Both sides on head symmetrically distributed, most evident frontally; low-amplitude waves
Gamma	32+	Somatosensory cortex

Here the waveforms of those frequency bands are given.



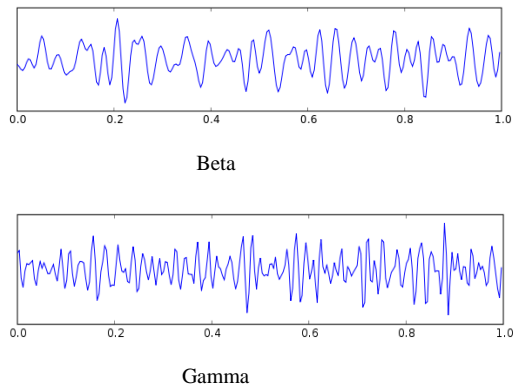


Figure 1: Waveform of frequency bands of EEG signal

## 2. DATA ACQUISITION

### A. Methodology:

A basic block diagram is given here which contains data acquisition, signal pre-processing and feature extraction.

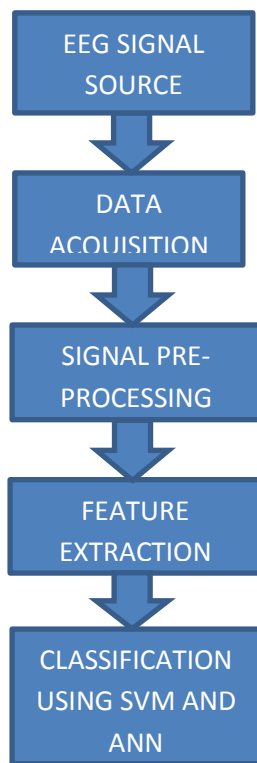


Fig 2: Block diagram of the Methodology of feature extraction and classification

### B. Data acquisition:

To collect data we've used Biopac Student Laboratory (BSL). The BSL system use to conduct basic physiology lab experiments including ECG, EEG, EMG, and EOG. Data can be recorded and analyzed using this system. Biopac Student Lab

system is the heart of every data acquisition unit. Its junction is to convert incoming signals into digital signals then that signals can be processed by a computer. The Biopac Student Lab records information about the outside world, although the types of information it collects are different. The Biopac Student Lab records information ("signals") about physiological state, whether in the form of human skin temperature, the signal from human beating heart or the flexing of an arm muscle. This physiological information is transferred via a cable to the Biopac Student Lab. When the signal reaches the Biopac Student Lab, it converts the data to be read by a computer.

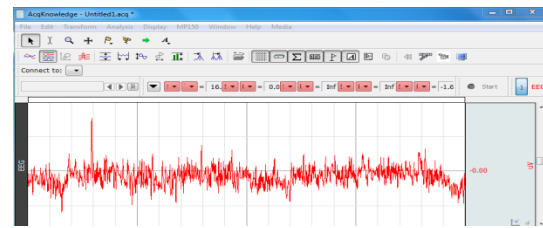


Figure 2: Raw EEG signal in forward direction of sample 1

### C. Data pre-processing:

Most of the time electroencephalogram signal has some non-cortical contribution while recording data. One of the main contributions is electrooculogram (EOG) originates from the eye-movements or blinks. Those create error in case of data analysis. The correlation between the EEG and impedance magnitude is lower for longer artifact segments, especially the ones containing artifacts with irregular movements or large variations in the applied force. This indicates a time-dependent, non-linear relation between the artifact-related phenomena, impedance magnitude, and EEG[3]. So it is needed to remove this artifact for better analysis. Here we used Biopac Student Lab (BSL) to remove this artifact. We used Band pass FIR filter (0.2Hz-48Hz) to remove artifacts.

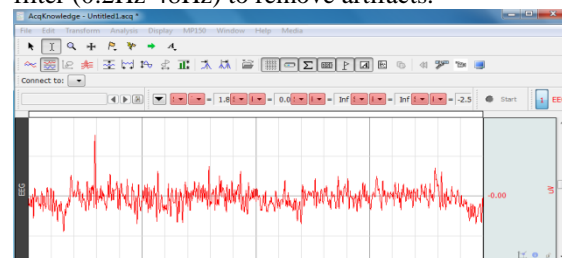


Figure 3: EEG signal in forward direction for sample 1 after filtering

### 3. FEATURE EXTRACTION

Here both time domain and frequency domain analysis are done.

#### A. Mean value:

If the time is not too short then the sum of the (both positive and negative) potential of EEG is usually very small (on the order of a few microvolts) and this can be considered as a constant. Any shift in the value indicates the change in potential that are of technical origin. The mean can be given as,

$$\bar{x} = \frac{1}{N} \sum_{i=1}^N x_i \quad (1)$$

#### B. Standard deviation:

Standard deviation is a measurement to find the amount of variation or dispersion from the average. A low standard deviation indicates there is small variation and high standard deviation indicates high variation. The standard deviation can be expressed as,

$$X_{\text{std}} = \sqrt{\frac{\sum_{i=1}^N (x_i - \bar{x})^2}{N-1}} \quad (2)$$

Where  $\bar{x}$  is the mean value.

#### C. Skewness:

It is a measurement of the asymmetry of the probability distribution of a real-value random variable about its mean. Its value can be positive, negative or undefined. This measure has the value of zero when the distribution is completely symmetrical and it is assumed some nonzero values when the waveforms are totally asymmetrical with respect to the baseline.

$$S_{\text{kmc}} = \frac{\sum_{i=1}^N \frac{(x_i - \bar{x})^3}{N}}{\left[ \frac{\sum_{i=1}^N (x_i - \bar{x})^2}{N} \right]^{\frac{3}{2}}} \quad (3)$$

Where  $S_{\text{kmc}}$  is the moment co-efficient of skewness.

#### D. Kurtosis:

Kurtosis is defined as the measurement of the peakness of the probability distribution of a real-value random variable. Negative values of kurtosis are observed when EEG with little frequency and amplitude modulation is analyzed. On the other hand when the EEG contains transient spikes, isolated high-voltage wave group, etc high positive values of kurtosis are present. The moment co-efficient can be written as,

$$K_{\text{mc}} = \frac{\sum_{i=1}^N \frac{(x_i - \bar{x})^4}{N}}{\left[ \frac{\sum_{i=1}^N (x_i - \bar{x})^2}{N} \right]^2} - 3 \quad (4)$$

#### E. Waveform length:

It is the cumulative length of the signal over the time segment. It depends on the amplitude, frequency and time. It is given by,

$$WL = \sum_{n=1}^{N-1} |X_{n+1} - X_n| \quad (5)$$

#### F. Slope sign change:

It is a method of representing the frequency information of EEG signal. It is the number of change between positive and negative slope. The expression is given below,

$$\sum_{n=2}^{N-1} [f[(x_n - x_{n-1}) * (x_n - x_{n+1})]] \quad (6)$$

$$f(x) = \begin{cases} 1, & x \geq \text{Threshold} \\ 0, & \text{Otherwise} \end{cases}$$

#### G. Cross correlation:

Cross correlation is defined as the measure of similarity of two waveforms as a function of a time-lag applied to one of them. We use it for searching a long signal for a shorter, known feature. It has various applications in the field of single particle analysis, pattern recognition, electron tomography, neurophysiology, cryptanalysis and averaging. The cross correlation of  $x(n)$  and  $y(n)$  is given by,

$$\hat{R}_{xy}(m) = \begin{cases} \sum_{n=0}^{N-m-1} x_{n+m} y_n & m \geq 0 \\ \hat{R}_{xy}(-m) & m < 0 \end{cases} \quad (7)$$

#### H. Power spectrum density:

It shows the point where the frequency variations are strong and weak. The power density (PSD) is calculated by,

$$\text{PSD} = \left| \sum_{i=0}^{N-1} x_i e^{-\frac{j2\pi ki}{N}} \right|^2 \quad (8)$$

Where  $k=0, 1 \dots N-1$ ,

$N$  is the length of the EEG data, and

$X_i$  is representing the discrete samples of EEG data.

#### I. Zero crossing:

It is the measurement of number of times that the amplitude values of the EEG signal cross the y-axis. In EEG feature, the threshold condition is used to abstain from the background noise. This feature provides an approximate estimation of frequency domain properties [6].

#### 4. CLASSIFICATION

Here we used two classifiers for extracting features. They are Artificial Neural Network (ANN) and Support Vector Machine (SVM). Kil and Shin [7] define a back-propagation neural network (BPNN) as a feed forward network with at least one hidden layer. Each neuron performs arithmetic summing followed by the sigmoid activation. The back-propagation algorithm is an iterative gradient descent algorithm to minimize the mean-squared error between the desired output and the actual network output.

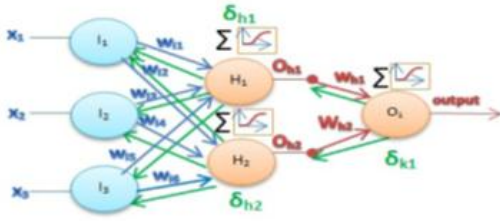


Figure 4: Feed forward back propagation Neural Network [7]

A Support Vector Machine (SVM) is a very effective discriminative classifier which is formally defined by a separating hyper plane. In other words, given labeled training data, the algorithm creates an minimum hyper plane which categorizes new examples. Then, the principle of the SVM algorithm is based on finding the hyper plane that gives the largest distance between the examples.

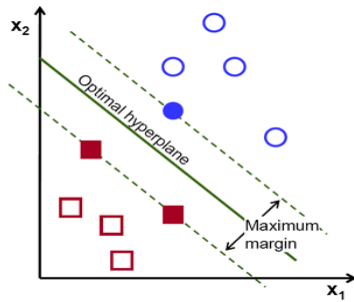


Figure 5: Classifying with maximum margin

#### 5. EXPERIMENTAL RESULTS

##### A. Feature Extraction Results

The EEG signal was recorded by Biopac Student Lab (BSL) and analyzed using MATLAB version 2014 (R2014a). The signal is first pre-processed using the Biopack. Those features are then extracted for body movement in different direction (forward,

back, left and right). There are some other features are also extracted but for classification we didn't use all those features. Those features are given below.

Table 2: Time domain extracted features of EEG signal in different directions for sample 1

Direction Features	Back	Left	Right	Front
Maximum Value( $\mu\text{V}$ )	156.989	109.676	263.949	380.72
Mean Value ( $\mu\text{V}$ )	0.971	0.925	1.450	1.957
Standard Deviation( $\mu\text{V}$ )	0.676	0.828	2.317	4.589
Skewness	0.237	0.609	0.161	0.089
kurtosis	3.293	3.127	4.010	5.154

Table 3: Time domain extracted features of Alpha band in different directions for sample 1

Direction Features	Back	Left	Right	Front
Maximum Value( $\mu\text{V}$ )	22.474	15.866	37.352	47.095
Mean Value ( $\mu\text{V}$ )	-0.005	-0.0005	-0.003	0.017
Standard Deviation( $\mu\text{V}$ )	0.719	0.525	2.017	3.587
Skewness	0.231	0.087	-0.011	-0.199
kurtosis	3.397	3.819	4.287	5.023

Table 4: Time domain extracted features of Beta band in different directions for sample 1

Direction Features	Back	Left	Right	Front
Maximum Value( $\mu\text{V}$ )	32.621	24.267	35.411	39.277
Mean Value ( $\mu\text{V}$ )	-0.007	-0.002	-0.0024	0.005
Standard Deviation( $\mu\text{V}$ )	0.832	0.347	2.405	2.653
Skewness	0.206	0.092	0.042	-0.011
kurtosis	3.278	3.366	3.764	4.163

Table 5: Time domain extracted features of Delta band in different directions for sample 1

Direction Features	Back	Left	Right	Front
Maximum Value( $\mu\text{V}$ )	205.606	145.959	232.942	307.072
Mean Value ( $\mu\text{V}$ )	0.006	-0.017	-0.00643	0.544
Standard Deviation( $\mu\text{V}$ )	0.552	0.378	0.939	1.488
Skewness	0.006	-0.090	-0.205	0.349
kurtosis	3.203	3.411	3.703	4.065

Here data for only one sample are shown.

Table 6: Frequency domain extracted features of EEG signal in different directions for all five samples

	Directions	Maximum Frequency (Hz)	Maximum Value( $\mu$ V)
EEG	Back	0.0	0.473
	Left	0.366	0.967
	Right	1.091	0.431
	Front	0.635	2.718
Alpha	Back	10.156	0.086
	Left	10.547	0.213
	Right	13.987	0.094
	Front	11.912	0.327
Beta	Back	16.156	0.133
	Left	21.379	0.229
	Right	27.723	0.096
	Front	26.912	0.400
Delta	Back	0.684	0.267
	Left	1.564	0.478
	Right	3.049	0.269
	Front	1.635	0.941

### B. Classification results

For ANN classification the features which are used for classification are maximum value, mean value, standard deviation, skewness, kurtosis in time domain and maximum frequency and maximum value in frequency domain. ANN classification result is shown below

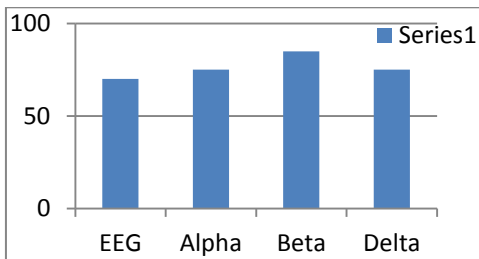


Figure 6: ANN classification result for different bands

Here we can see maximum accuracy is obtained by using the beta band which is **85%**

For SVM classification the features used for classification are maximum value, mean value, standard deviation, skewness, kurtosis in time domain and maximum value, maximum value for alpha band, maximum value for beta band and maximum value for delta band are used.

Rate of recognition for time domain raw EEG analysis = **62.5%**. Rate of recognition for frequency domain analysis=**58.33%**

### 6. FUTURE WORK

In future we will work with for sample data and more experimental setup for getting the higher accuracy of the system. We will also try to building up an automatic brain control wheelchair concept.



Figure 7: Electric Wheelchair using EEG signal [9]

### 7. CONCLUSION

In some papers only  $\alpha$  and  $\beta$  bands were analyzed, which can most reveal the intentions of human body movement [7]. In this paper we extracted different features not only some bands but the whole EEG signals for different directions. Both time domain and frequency domain analyses are done here. Those features are very important for classifying the right directions and this will be very helpful for removing the problem creates due to complete or partial paralysis.

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# Newspaper Data Mining: Cloud Computing

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**Abstract**—This paper describes how online newspaper data mining process is performed in cloud computing. Data Mining is used for extracting potentially useful information from raw data. Hundreds of thousands of news are being published in several online news portals every day. Within years it becomes several terabytes of data which contains a lot of potential useful information and relation that can be explored by mining those newspaper html raw data. This may become impossible to calculate conventionally when the data volume is big. Cloud computing may become a solution for retrieving these potential information and relations. There are several algorithms for data mining. The implementation of data mining algorithms through Cloud computing will allow the users to retrieve meaningful information from newspaper HTML raw data which reduces the costs of infrastructure, storage and time.

**Keywords**—cloud computing; html data Mining; newspaper data mining; Big data

## I. INTRODUCTION

Online newspaper becoming an increasingly popular online media, as its users are becoming more numerous. Over the past few years, petabytes of newspaper data has been published containing many useful information and relations which can be retrieved mining this big data.

In the early age of online newspaper, it was being made as html page. Popular data mining algorithms can be applied for mining this online newspaper html raw data in cloud computing for getting faster output using low configuration machines to reduce cost that can benefit the industry.

Cloud Computing is becoming more popular for its characteristic of scalability, high availability, ability of big data processing and low cost. At the same time data mining techniques are developing and becoming useful, retrieving information and relations from big raw data becoming increasingly essential in various research fields like science business, social research, medicine, and engineering etc.

Data mining techniques can be applied in cloud computing for mining online newspaper html raw data which can bring innumerable possibilities of exploring big data that can be used applying several data mining algorithms.

Newspaper data mining algorithms are becoming rich day by day because of the need to time. And to apply these algorithms and process this big amount of raw html data, cloud computing is the revolutionary invention of today time.

HTML pages of newspapers can be parsed into plain text using jsoup and processed using Natural Language Processing in cloud computing, detecting part of speech, making story grammars, applying Apriori algorithm or making semantic triplets where the data mining algorithms can be applied. Apriori, K-Means, PageRank, Correlation, Expectation-Maximization Algorithm etc. are widely used for data mining.

This paper contains six sections. Section I is the background of the research. Section II is small part for a little introduction of cloud computing and hadoop. Next one is section III that express our proposed system of online newspaper data mining in cloud computing.

In section IV, we have shown the practical implementation of our proposed system and its result as well as some performance and comparison graphs. Section V is the concluding part of this paper where we also mentioned our future work plan. Last one is the references part where we added the all the reference that help us doing this research.

## II. CLOUD COMPUTING

Cloud computing is a kind of computing where computer resources i.e. memory, storage, processor etc are shared using network or internet to store, process, and manage data in stead of using single computer or local servers. [1]

Cloud computing provides a lot of useful features like high availability, on-demand access, scalability, virtualization, parallel processing, big data processing etc.[2] It also provides solutions of remote computing and storage to the users and companies on demand.[3]

Now a days, cloud computing has become popular service for its high computing power, low cost, high performance etc. Cloud industry has a very high growth rate of 90% per annum.[4]

Apache hadoop is an open-source software for cloud computing. It can store and process big data in a distributed environment of thousand of computers.[5] Hadoop has become very popular cloud solution. Big companies like Amazon, adobe, Facebook, IBM, Yahoo! etc. are using apache hadoop.[6] We also used hadoop to design cloud and implementing newspaper data mining in cloud computing.

### III. PROPOSED NEWSPAPER DATA MINING USING CLOUD

In this paper, we are showing a simple way of data mining of online newspaper HTML raw data in cloud computing.

At the beginning of online news portals era, most of the sites used to create and publish online news as HTML page. We work on the raw HTML newspaper pages published in a period of time to retrieve crime scene and get statistical data based on frequency count. For example, if we want to know the total number of crimes occurred during the year 2005 published in the online newspaper thedailystar.net, as well as the type of crimes like murder, rape, hijack etc., what can be the way to extract this information from?

First, we generate plain text parsing HTML pages using jsoup on which we apply Stanford Log-linear Part-Of-Speech Tagger for tagging parts of speech[7] to determine subject, object, and verb. We can detect crime scene with the help of Crime Vocabulary Word List[8] as keyword listed in the system. All data are stored in cloud and processed using map-reduce.

From the frequency count of the retrieve crime scene, we get percentage of crime occurred during a period of time. From the extracted data, we can apply popular data mining algorithms like Apriori, K-Means, PageRank, Correlation, Expectation-Maximization Algorithm etc. to explore more useful information.

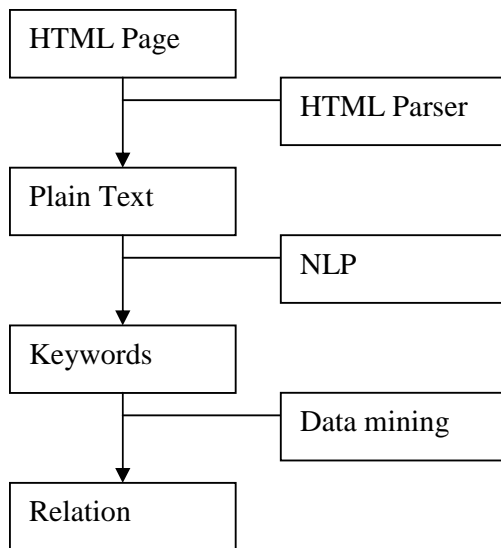


Figure 1. Online newspaper data mining process

Figure 1 showing the a complete process of online newspaper datamining in cloud computing. We can run the full process using following steps in cloud computing-

#### A. Extract plaing text parsing raw HTML page

Jsoup is a powerful Java library for parsing HTML file. We can extract plain text from HTML file and manipulate data

using its very convenient APIs.[9] We can load file from disk that contains HTML to parse or scrap HTML page directly from web using jsoup and then manipulate or extract data.[10]

Online news articles contains tile which are formatted using HTML heading tag i.e. <h1>, <h2>, <h3> etc. and main articles are formatted using paragraph tag <p>. Some other tags it may contain for formatting or showing image object like <img> or <br> which can be excluded during the data extraction process. Some exception of formatting has been observed like, <div class="heading"> or <div class="newsbody"> which indicates news title and content respectively.

#### B. Natural Language Processing

From the step a we have extracted plain text. Now, the machine need to learn natural language processing.

Stanford CoreNLP provides a set of natural language analysis tools. Among them, we apply Stanford Log-linear Part-Of-Speech Tagger. It gives the base forms of words, their parts of speech, numeric quantities. It also mark up the structure of sentences in terms of phrases and word dependencies, indicate which noun phrases refer to the same entities, indicate sentiment, extract open-class relations between mentions, etc.[11]

We can also use its other natural processing tool Stanford Deterministic Coreference Resolution System, Stanford Named Entity Recognizer etc. for further analysis.

#### C. Apply algorithm on sorted text

We also count the frequency of the occurrence of crime scene from the news using the following map-reduce

Map

- Input: KEYWORDS
- Output: (KEYWORD, 1)

Reduce

- Input (KEYWORD, 1)
- Output (KEYWORD, counts)

All the output data are now ready for further analysis where the effective algorithm is applicable.

### IV. IMPLEMENTATION AND RESULT

For the implementation of idea, we have designed a cloud infrastructure of ten data nodes and one name node having three replications with block size of 128MB using hadoop-2.6.0 in fedora 13 linux operating system. We used low configuration machines.

We have written the map reduce application CloudNewsMiner.jar in programming language java. That we compiled using eclipse and generated the jar file to run in hadoop.

We run the application using two types of input files to compare performance and efficiency of the system. The test cases are as follows-

- a) Generated single text file of 1.12GB size.
- b) Scraped html news files from the archive of the news portal thedailystar.net[12] of a volume of 1163.

Hadoop run 9 maps for test input file a and 1163 maps for test input files b.

To measure the performance we started running the application using one node with the input data of 1.12GB single text file and log the performance data. We repeat running the application using one node for 4/10 times to get an average performance report.

When the process is finished, we increased a node and do the full procedure again for two nodes. One by one, we increased nodes up to 10 nodes and repeat the whole process from the beginning. Some of the outputs are as follows-

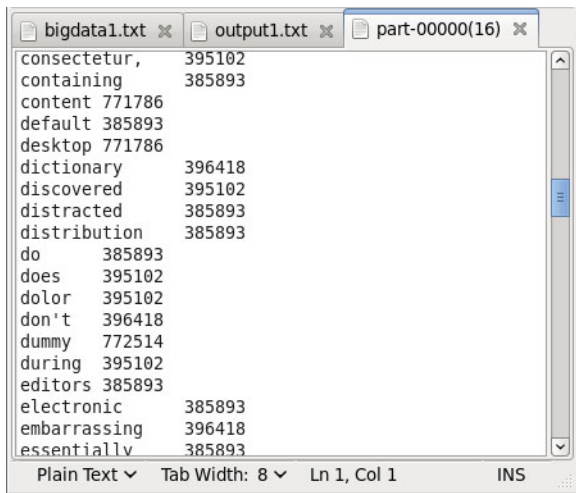


Figure 2. Output from data mining on single file of 1.12 GB

The above outputs are showing the result running the application on two input test data set. Figure 2 is showing the part of speech count for the test data generated in a single text file of size 1.12GB.

The output showing the number of each part of speech found in the generated test data. As the test data is generated from reputed text, it showing large number each count.

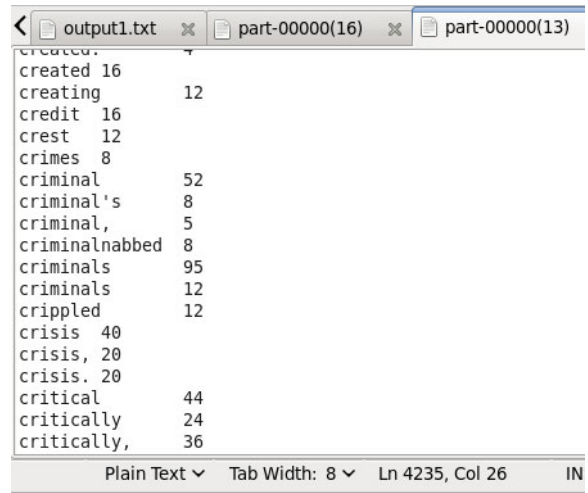


Figure 3. Output from data mining on 1163 html news files

On the other hand Figure 3 is showing part of speech count from the input data of scraped html news files from thedailystar.net of a volume of 1163.

Test case a is performed to check the efficiency of cloud computing. On the other hand, test case b is performed to check the efficiency of our idea using CloudNewsMiner.jar in the same cloud infrastructure as well as to compare the both scenario.

After getting the logs of all successful run of the CloudNewsMiner.jar application, we have found the following performance graphs-

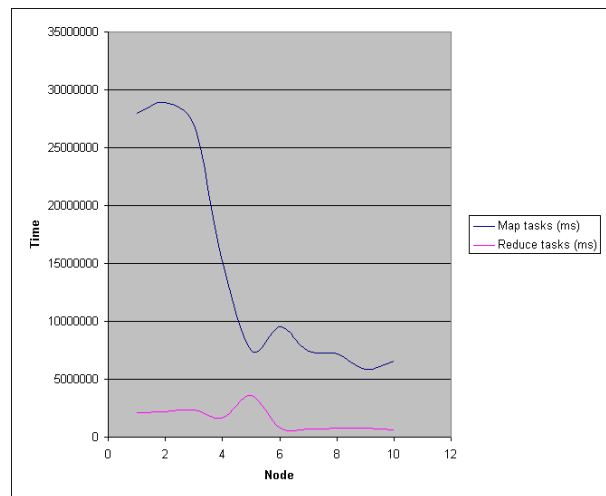


Figure 4. Total time spent by all Maps and reduces in occupied slots for 1 to 10 nodes to mine on one file of 1.12 GB

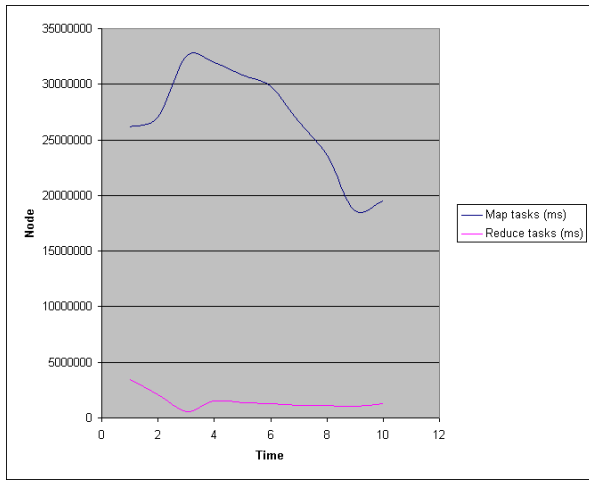


Figure 5. Total time spent by all Maps and reduces in occupied slots for 1 to 10 nodes to mine on 1163 html news files

Figure 4 is showing the performance of the application for one to ten nodes based on total time spent by all Maps and reduces in occupied slots for mining on one file of 1.12 GB.

And Figure 5 is showing the performance of the of the application for one to ten nodes based on total time spent by all Maps and reduces in occupied slots for mining on 1163 html news files.

In figure 4 we see the total time spent by all maps in occupied slots for node one is smaller than node two which looks strange. As the number of nodes increases, the performance should go up normally. But here it becoming slower as Hadoop needs to manage one more node, metadata, replication information, map tracker information etc. So the overhead cost goes higher to make it slow down. But as soon as we increase the number of nodes, the performance goes higher.

We see when the number of nodes is nine, it gives us the best performance and again it goes slower down. With the increment of nodes overhead cost again goes higher to make it slow down. Although we have available resources, the percentage of occupied resource decreases with the increment of resources i.e. nodes.

As we have 128MB of block size, Hadoop splits the 1.12GB file into 9 pieces and run 9 maps. But if the file size is changed, the performance graph will be changed.

On the other hand, we see a different performance graph in figure 5 for the test case *b* on same cloud infrastructure. As because, here we are using large number of files of smaller sizes. So, Hadoop makes the number of maps equals to the number of files. Here we see, the performance is in the peak for node eight. In this case, number of maps is large and overhead cost becoming higher for more than eight nodes.

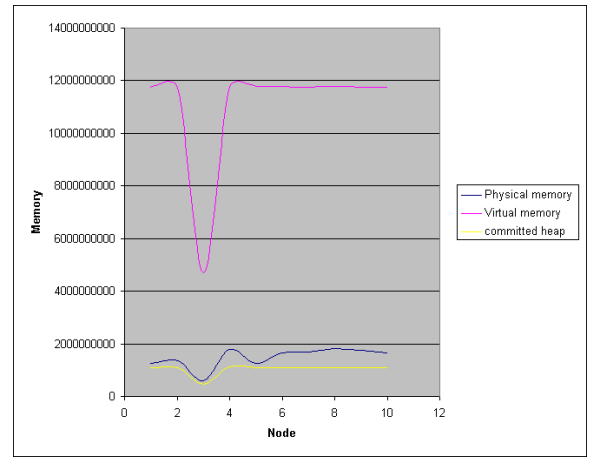


Figure 6. Physical memory , virtual memory, and committed heap usage

Figure 6 showing the usage of physical memory, virtual memory for one to ten nodes. We see from the graph that the consumption of memory increases along with the increment of nodes at the beginning. But it falls down near node three and rise up again. This fluctuation continues till node eight and become almost stable after eight nodes.

This happens due to overhead cost to run the processes and balance the resource by hadoop.

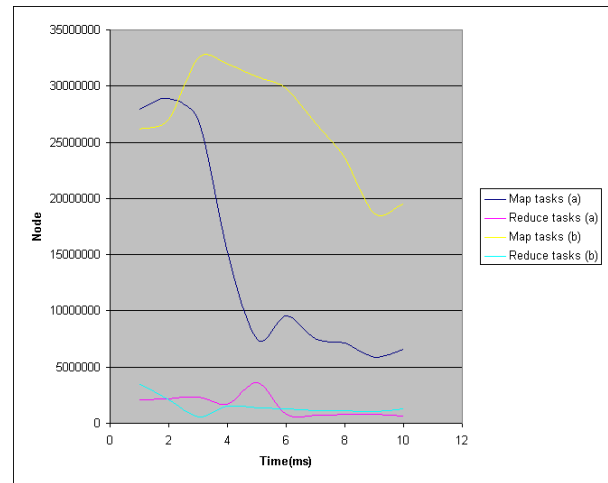


Figure 7. Physical memory , virtual memory, and committed heap usage

Here in figure 7, we can see a performance comparison of Maps and reduces in occupied slots for mining on both test cases i.e. one big file and large number of files.

Although the cloud infrastructure is same for the both cases, we see different graph for both cases.

This is because the total number of maps and the block sizes are different for both test cases. And if we see closely the graphs, they are same on their nature. That is, it gives high performance along with the increments of nodes.

We intended to make a system that can mine large data in cloud computing. Our three main goals were –

1. Newspaper data mining
2. Big data mining
3. Using cloud computing for better performance

From the above graphs and output, we can say that our main goals are achieved partially. And we feel, we need more experiment and tune up the system to get better result and performance.

## V. DISCUSSION AND FUTURE WORK

The primary results from the data mining look sound. Although there are several approaches and open sources present for individual task but the approach and process present in this paper may become a big platform for online newspaper data mining in cloud computing by further research , integration and implementation.

The main challenge is to develop map-reduce for the algorithms and implement the map-reduce properly as we intend to perform the process in cloud to use low configuration machine and get high performance together.

We also faced a lot of difficulties configuring the cloud, writing and implementing the application. It was a good learning process and apache hadoop documentation helped us a lot as well as the online tutorials. We had failed job several times due to network and machine disturbance. Also experienced how hadoop can carry a job running even after a

node fails. Also the data was secured. Despite of all the limitation and constrains, we finally could run and experiment the newspaper data mining process using hadoop.

We look forward for further research and experiments based on the output and performance. We can make a decisions based on big experiment while the current experiments are too small to draw any conclusive evidence. But this may become a good approach in future.

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# Problems and Challenges of Integrating Visible Light Communication for Current Infrastructure with Proposed Solutions

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**Abstract**—Connectivity is a modern era staple for everyone. Visible light communication (VLC) is communication system which uses optical frequency band in the electromagnetic spectrum. The infrastructures are already present to implement the technology and integrate it using simple techniques and devices. LEDs are to be used as transmitters and photo-detectors in smart devices can be receivers of the signal. The devices for the communication system are already in place but its current purpose is different to what the system demands. So, the challenge is to create a link between these devices, for which it can also serve as communication trans-receivers while fulfilling their current purpose. This paper discusses how the system can be integrated using the existing devices while addressing the obstacles during integration and provides solutions to overcome those limitations and to minimize complexities.

**Index Terms**—AC-DC Converters, Communication Network, Light Emitting Diode (LED), Photo-detectors, Photo-voltaic Cells, Programmable Logic Devices, Trans-receivers, Wireless Communication.

## I. INTRODUCTION

Mobility and connectivity are the demands of modern time. People wish to remain connected but refuse to restrain their motion with wires; hence emphasizing the need of wireless technology. Most wireless technologies rely on microwave or radio wave transmission [17]. According to research, microwave is harmful to human health and environment [4], [13], [21]. So, it cannot be used carelessly. Radio waves have their own limitations. We know that spectrum is limited and the more we use radio spectrum, the faster we are running out of it. Base stations which transmit radio wave are not very efficient. Most of the supplied power is used up in cooling the system [9]. Since microwave and radio wave are both penetrable, they can be intercepted easily. So there are some security concerns as well. Visible light communication systems are complementary to existing radio and microwave

Type		Frequency (Hz)	Wavelength
Radio waves		Less than $3.00 \times 10^{11}$	Above 0.3 m
Microwaves		$3.00 \times 10^9$ to $3.00 \times 10^{11}$	0.3 m to 1 mm
Infra-red		$3.00 \times 10^{11}$ to $3.80 \times 10^{14}$	1 mm to 789 nm
Visible	Red	$3.80 \times 10^{14}$ to $4.80 \times 10^{14}$	789 nm to 625 nm
	Orange	$4.80 \times 10^{14}$ to $5.00 \times 10^{14}$	625 nm to 600 nm
	Yellow	$5.00 \times 10^{14}$ to $5.20 \times 10^{14}$	600 nm to 577 nm
	Green	$5.20 \times 10^{14}$ to $6.10 \times 10^{14}$	577 nm to 491 nm
	Blue	$6.10 \times 10^{14}$ to $6.59 \times 10^{14}$	491 nm to 455 nm
	Violet	$6.59 \times 10^{14}$ to $8.00 \times 10^{14}$	455 nm to 390 nm
Ultraviolet		$8.00 \times 10^{14}$ to $2.40 \times 10^{16}$	390 nm to 8.82 nm
X-ray		$2.40 \times 10^{16}$ to $5.00 \times 10^{19}$	8.82 nm to 6 pm
Gama ray		Above $5.00 \times 10^{19}$	Less than 6 pm

Fig. 1. Electromagnetic spectrum showing visible light.

systems. It is not intended to completely replace microwave or radio wave, but it will decrease the dependency. Visible light spectrum is more abundant than radio spectrum. It has no proven harmful effects to human health [12]. Resulting, our communication systems having more capacity; greater efficiency; greater security and more "green" to our surroundings [16]. The word "Visible Light Communication" was first introduced by the Scottish-born scientist Alexander Graham Bell when he invented the "Photo-phone" in 1880, which transmitted speech on modulated sunlight over several hundred meters. It was the first ever implementation of visible light as a communication channel; thus leading many scientists to work on the system so that it can be a highly advanced communication system.

## II. SYSTEM INTEGRATION WITH AVAILABLE INFRASTRUCTURE

Visible Light Communication system is a progressive technology. The key product of this technology is LED for illumination. Due to less power consumption and cheap; LED is widely used in all over the world. [3] Each LED can be

used as a transmitter to transmit data through luminosity which depends on applied voltage. This applied voltage is changing in subtle way that is undetectable with naked eyes. On the other hand, there will be 50 billion devices and infrastructure (Smart phones, Computers, Laptops, Cars, Street Lights etc.) which will be connected to the internet by 2020 [7]. Each device requires proper photo-detector like solar cells and ambient light sensor to receive data. Solar cells (photo-voltaic cell) can be used for dual purpose; it can generate power and also used as a light sensor for the communication system as it responds to the brightness giving output as variable power. [10] Ambient light sensors and cameras are already prevalent in modern smart devices and most of the smart devices contain both modulator and demodulator. So, it is a huge opportunity to establish a data modulation device for visible light spectrum. [19] A report says, worldwide information and communication technologies require about 100 nuclear power plants [6]. VLC can be the answer to reducing this power consumption as it uses very little power for communication system.

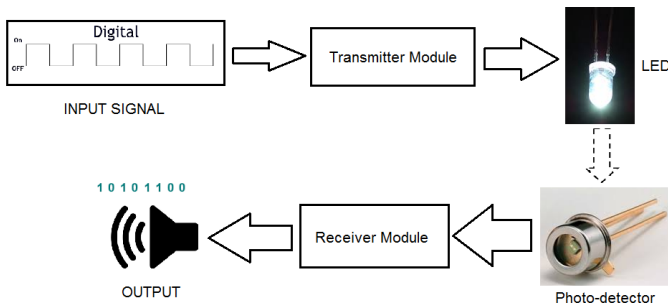


Fig. 2. Basic visible light communication block diagram

Street lights in developed and some developing countries are already equipped with LED lights and for cheaper utilizing cost, most of the street lights are also installed with solar cells. [1], [17] This solar cell generates power from sunlight and lights the LED at night. Since, all the necessary devices are installed on most streets in most developed countries; the integration of VLC becomes easier as customized communication network infrastructure is not required such as base station(BTS) for microwave communications.

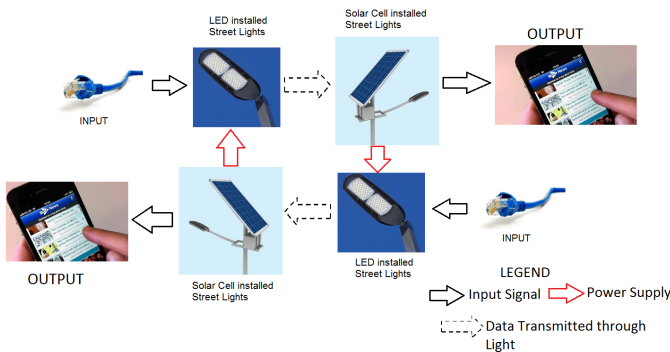


Fig. 3. Trans-Receiver model for street light

The above system can be also applied to smart devices such as smart phones, cars, smart TV and laptops. The only need is sensor which is already present in these devices. For example, OPT3001 is an ambient light sensor for mobile phones which change the brightness of the screen according to surrounding sunlight so, it can act as anti-glare [8]. Therefore, this sensor can also be used to implement VLC system.

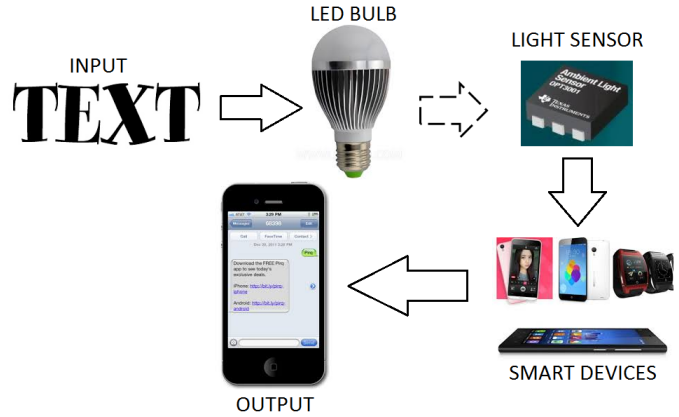


Fig. 4. VLC system in smart devices

### III. INTEGRATION CHALLENGES

The current infrastructure already exists to accommodate VLC system but the ways to integrate the system has many shortcomings and challenges in front of it. The challenges and shortcomings such as light based communication requires direct line of sight for its transmitter and receiver, it is heavily dependent on the environment and devices it is operating under for example, the ambient light present around the system and installation of the system in households. LED is a Lambertian source, therefore; it follows the Lambertian cosine emission law. The law states that the luminous intensity is proportional to the cosine of the angle between the surface normal and incident light. [11]

$$E(d, \theta) = E_0(d) \cos^m(\theta) \quad (1)$$

The above equation is the representation of the cosine emission law where  $m$  is the number of mode of the light,  $d$  is the distance and  $\theta$  is the angle between the surface normal and incident light. Hence, we can say that the data would be distorted if any obstacle is put in front of it or the emitter is not directly perpendicular to the sensors surface.

For two ways communication, the transmitter and receiver must be incorporated in the same module, i.e. it requires a transceiver. Transceiver must be designed in such a way that it does not receive its own transmitted data while making it compact enough to be fitted with existing lighting systems. The sensitivity of receiving sensors is of concern for high speed data communication. The sensors in existing smart devices can be accessed to integrate with receiving module, however, sensitivity varies from devices to devices. This indicates to the fact that using the preexisting sensors would lead to



inconsistent data reception rate. A similar problem arises for the transmission side as well. The readily found LED in the market may not have the same switching speed. [15], [20] So the transmitter has to be adjusted to each type of LED and the transmission speed will also vary accordingly.

Similarly, the environment around the system affects the quality of the transmission as the luminosity of light can vary during the day as the ambient light changes according to the light intensity of the sun. Therefore, the system should contain smart sensors which would enable to eliminate the ambient light and understand the environment surrounding such that the data sent is not distorted; such kind of sensors are not yet built. The sensors are not built yet because currently those sensors are utilized for different purpose rather light luminosity detector for data transmission.

Currently, households are supplied with single phase AC system and with a frequency of 50 or 60 Hz in various locations. VLC system requires frequency synchronization as supply frequency differs from system frequency. Such operation has not yet been tried and if it is to be avoided, then each of the light sources in a household requires to be connected with another wire, therefore, requiring concealed conduit which increases wiring costs. [14]

#### IV. PROPOSED SOLUTIONS FOR OVERCOMING ADDRESSED CHALLENGES

Integrating the VLC system has a lot of obstacles in front of it but for every problem there is a solution. The solutions are already in place but currently they are being utilized for illumination only. However, it can be used as a part of a transmission device for data transmission by synchronizing it using programmable logic controller (PLC) and sensors. A similar approach has already been proposed, for micro turbines which generate power, to address synchronization issues. Programmable logic controllers (PLC) are computer based control system that has the ability to monitor instant data from input devices such as sensors and make decisions based upon the programmed objective to control the state of the output devices. The advantages of a system containing PLC are that it can change and replicate the process while communicating vital information. It is also advantageous because it is a modular device, therefore, it can be integrated according to the user's application .

##### A. Installation of PLC

The installation of programmable logic controller will convert regular detectors into smart detectors thus, enabling it to assess its environment and change the necessary adjustments to continue transmission. So, it will have the functions which will allow removal of distortions in the transmission signals thus ,improving transmission quality.

##### B. Synchronization with AC Grid Supply

Synchronization with the current electrical system of a household with the VLC system is a major challenge. Although, solutions of such synchronization problems already

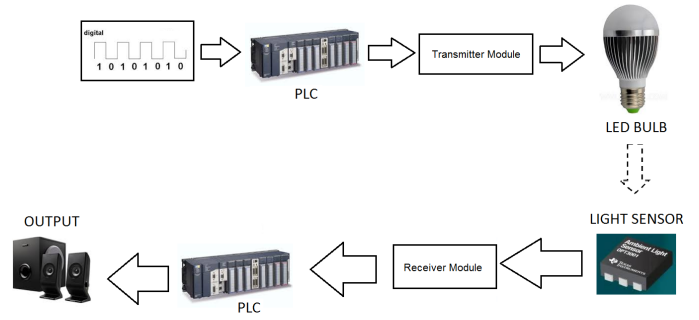


Fig. 5. PLC installed VLC system

lies in other sectors such as power generation of renewable and non-renewable sources. Using their methods it can be applied to VLC system. For example, micro-turbines are turbines which rotate at a rate which creates a power source with greater frequency to grid supply. Therefore, the system uses a rectifier circuit to convert the grid supply from AC to DC and then uses DC-AC converter which adjusts the frequency to the required frequency for operating conditions. System definition for Micro Turbine:

$$E_k = \frac{1}{2} J \omega^2 \quad (2)$$

Where,  $E_k$ = kinetic energy,  $J$ = Moment of Inertia,  $\omega$ =angular velocity The above equation is the kinetic energy of the micro-turbine. To increase kinetic energy either  $J$  or  $\omega$  needs to be increased. Since here the  $J$  is constant only  $\omega$  is increased. We know,

$$\omega = 2\pi N/60 \quad (3)$$

Where,  $N$ = number of revolutions per minute. Hence, with the increase of  $\omega$  results in the increase of  $N$ , this increases the frequency. Therefore, frequency is deduced as:

$$f = PN/120 \quad (4)$$

Where,  $f$ = frequency of the turbine,  $P$ = air proportion getting into the turbine. This similar concept of using 50Hz as input can be converted to greater frequency will be applied to the VLC system for its data to be transferred at a high speed so, that it is not visible through naked eyes. Therefore, the LED source gives illumination as well as provides communication.

Hence, taking a leaf out of the book for power generation it can be applied to VLC system at a modular level. Below is a proposed modular level flowchart diagram for such synchronization. [18]

##### C. Direct Line of Sight

Finally, the greatest obstacle for application of VLC system is its Lambertian model due to the use of led as its source. Since, the system is to be applied in enclosed areas such as indoor stadiums, households and supermarkets. The problems arising from line of sight significantly reduces. As due to obstruction the VLC data is not lost but the transmission speed is compromised. [2] The diffraction problem for light source

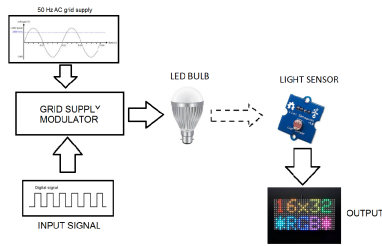


Fig. 6. Grid supply modulator module for VLC system

can also be reduced by using focus lens on the sensors which give the sensors more sensing ability as a greater sample of ambient light is sent towards it . [5]

## V. CONCLUSION

Visible light communication system is fast, low power consuming and harmless to human health. It can be implemented in places such as hospitals, mines, nuclear power stations where current wireless systems cannot be applied due to its harmful radiation nature. VLC can be implemented by slightly modifying the devices that have already been installed and are in use for other purposes such as LEDs in lighting systems and ambient light sensors in smart devices. A drawback of this system is that it works in direct line of sight (LOS). However, this may work as an advantage where high security is required. The revolution will allow us to create every light bulb from our houses to our street light which would be working like a hot-spot. Therefore, with relatively cheap installation cost and simple modular level design VLC can connect millions of people who were not able to use the internet before. We are considering it as the next big upgrade in the communication world.

## ACKNOWLEDGMENT

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# MEMS Based Formalin Gas Sensor: A non-contact Sensing Approach

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**Abstract**— Detection and classification of gases has become of vital importance in today’s world. Because of increased amount of innovation, emission of harmful gas into the atmosphere has increased ever since. Among many other gas sensing technologies out there, this paper focus primarily on the use of MEMS for formalin gas detection. A general background of formalin gas has been provided in this paper together with the methodology of the MEMS device for its detection. The results obtained in this report were generated through simulation over computer software called *COMSOL*. Through discussion of the results, it can be verified that the proposed method for formalin gas detection through the use of MEMS devices are very much possible, promising excellent efficiency and durability. Also, brief comparisons between the different sensing technologies have been provided in this paper with both selectivity and sensitivity analysis.

**Index Terms**— MEMs, formaldehyde, SAW (surface acoustic wave), sensor.

## I. INTRODUCTION

**G**AS sensing technology finds diverse applications in industries to detect the different gases like methane gas levels and also for automobile industries to detect the polluting gases emitted from vehicles [1]. Its application also ranges from medical applications (artificial physical simulation of nose, mimicking the olfactory organ of humans) to general consumer usage like the supervision of indoor air quality and also for academic applications such as environmental studies, etc. [1].

This paper concentrates on the use of gas sensing technology for the purpose of detecting/sensing formaldehyde in substances, typically food items. The remainder of this paper is organized with a literature review of the different gas sensors and techniques used in the past decade followed by a brief background on the gas Formalin, its harmfulness and usage in section 2. Section 3 discuss about the methodology of the proposed method of gas detection and its benefits. The detailed fabrication process is detailed in section 4. Simulation results and their discussions are detailed in section 5. Finally, a conclusion is given in section 6.

## LITERATURE REVIEW

Several gas detection techniques have been reported in literature which include micro hotplates for metal oxide based detection, nanowire based detection as well as optical method [2]. Recent advancement introduced the use of polymer-based sensors for low temperature and low power operation [1].

Different studies have been conducted during the last decade about various gas sensing technology, sensing principles and the way these sensors are fabricated [1]. During the last decade, sensors based on metal oxide semiconductor were used in order to detect gases. Although these semiconductors had greater sensitivity to inorganic gases like that of ammonia, it couldn’t detect minute quantity of volatile organic compounds (VOC) that could be lethal to humans [3]. These VOCs like alcohol or formaldehyde are common used household products (formaldehyde in furniture), and as the compound is volatile at room temperature, its vapor is regularly inhaled by us [1]. Hence, it’s a priority to monitor the level of these harmful fumes.

As stated earlier, nanowire based detection such as *carbon nanotubes* (CNT) is an effective method for gas detection technique as it has high sensitivity, but is costly to fabricate [1][4]. Also, to enhance the sensitivity and selectivity to certain gases, CNTs are mixed with other materials to raise the mechanical adhesion of the sample to the surface [1]. Hence, to deal with a much more cost effective detection technique, further research is being conducted [1][2].

Since this paper focus primarily on the detection of formaldehyde, current detection method must be discussed. Current techniques for detecting formaldehyde include the gaseous sample to be absorbed onto a filter or into a liquid solution and then further analyzed using methods such as electromechanical detection, ion chromatography, etc. [1]. But this technique cannot be used for real time operation and often requires large and expensive laboratory equipment. Hence, a new polymer based detection technique which is cost effective, mobile, efficient and highly sensitive is discussed in later chapters of this paper.

## II. BACKGROUND ON FORMALDEHYDE

Formaldehyde is an organic compound having the formula of  $\text{CH}_2\text{O}$  or  $\text{HCHO}$ . At room temperature, this gas is colorless and has a pungent, irritating odor and a corrosive and suffocating flammable gas [6]. The chemical process that goes on in the upper atmosphere (degradation of methane by sunlight) of the earth contributes to about 90% of the total formaldehyde [2]. For industrial purpose, it is produced by the catalytic oxidation of methanol [1][2]. The most common use of formaldehyde is in disinfectants and for preservation of biological specimens [2].

The compound formaldehyde is very toxic to human and the most common way for human exposure is through inhalation, skin contact and ingestion of foods containing formaldehyde

[3]. Some major symptoms of formaldehyde exposure on humans are irritation to the nose, mouth and throat causing respiratory distress and swelling of lungs and larynx, asthma and even cancer [3][7]. The effect level is also directly proportional to the exposure time a person comes into contact with formaldehyde [3]. Exposure for a prolonged period of time (above 10 ppm for over 8 hours) would lead to burns to the cornea of the eye, skin and also gastrointestinal tract [3].

### III. METHODOLOGY

PCE (Tetrachloroethylene), commercially known as Chloroform is an organic compound that falls under the formaldehyde family group, has the formula of  $\text{CHCl}_3$  and is considered to be one of the most harmful of the commercially used gases [8]. Nature of this compound is colorless, sweet-smelling and volatile with non-irritating odor. This paper focuses mainly on the detection technique of PCE.

#### a) Proposed Method

As a sensing medium Poly-isobutylene (PIB) polymer has been used. PIB adsorbs PCE (Tetrachloroethylene) gas present at its air interface, as result, density of PIB increases with increase in PCE gas density in air. SAW (surface acoustic wave) passed through the PIB experiences frequency shift based on the change in density of PIB [9][10]. Based on the shift of resonance frequency of SAW it is possible to determine amount of PCE in ppm in air [9]. Lithium Niobate ( $\text{LiNbO}_3$ ) was used as substrate material and Aluminum (Al) as electrodes. All the results were simulated in COMSOL Multiphysics simulation software.

#### b) Benefits

The proposed method is promising and is made up of less bulky electro-mechanical system. Since the device is based on MEMS technology, it tends to be extremely fast and because of its sheer geometry, it is very portable and implantable. Since the sensor is going to be based on MEMS technology, it would be more sensitive for detection purpose and also very stable [9][2]. Large scale bulk manufacturing is very much possible due to its small geometry.

#### c) Selection of material for use as the semiconductor

In this simulation, the selected polymer for the sensor fabrication is PIB (Poly isobutylene) and target detection gas as PCE (Tetrachloroethylene), and their corresponding adsorption coefficient is 2.9799.

#### d) Reason for the material selection

As substrate Lithium Niobate ( $\text{LiNbO}_3$ ) has been used.  $\text{LiNbO}_3$  is a piezoelectric material and can be bought in wafer format [11]. Piezoelectric material is needed to induce Surface Acoustic Wave (SAW) at the  $\text{LiNbO}_3$  and Poly-isobutylene (PIB) interface [11]. PIB is a polymer deposited over  $\text{LiNbO}_3$  substrate that adsorbs PCE and increases its density. On the top of  $\text{LiNbO}_3$  substrate, Inter Digital Electrode (IDT) made of Aluminum are used for the two connections of electrical excitation and reception points. Material property used for PIB has been shown in Table. I.

TABLE I MATERIAL PROPERTY OF PIB.

Material: PIB			
Density ( $\text{g/cm}^3$ )	Young's modulus (GPa)	Poissons ratio ( $\nu$ )	Relative permittivity ( $\epsilon$ )
.918	10	.48	2.2

Density of PIB will increase as it adsorbs PCE by the relation according to the following formula:

$\rho_{\text{PCE, PIB}} = \frac{KMpnm}{RT}$  [9], where,  $K$ = adsorption coefficient of PCE with PIB (2.9799) [9]

$M$ = molar mass of PCE (165.83 g/mol)

$n$ = number of  $m$  of PCE in air

$m=10^{-6}$  (for ppm)/ $10^{-9}$ (for ppb)/ $10^{-12}$  (for ppt). The target is to detect in ppt range.

$p= 101.325$  [kPa], (air pressure).

$T=20^\circ\text{C}$  air temperature.

$R= 8.3145$  [ $\text{Pa}\cdot\text{m}^3 / (\text{K}\cdot\text{mol})$ ] (Gas constant)

All the results were simulated in COMSOL Multiphysics simulation software.

### IV. DESIGN SCHEMATIC

In Fig. 1, a 3-D view of the structure and top view of the sensor structure have been shown.

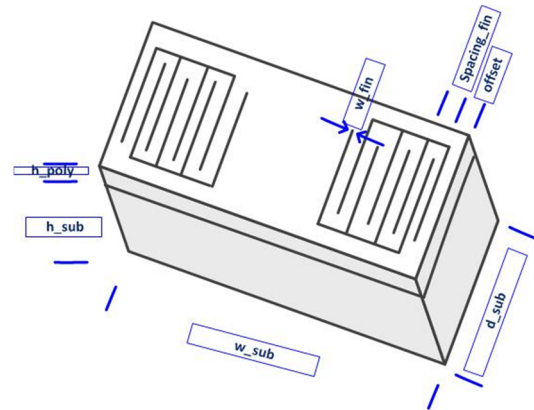


Fig. 1. Geometry of the formaldehyde gas sensor.

To fabricate the device, surface micromachining can be used with additive and pattern processing.

## V. SIMULATION RESULTS AND DISCUSSION

### A. Eigen frequency and corresponding voltage/displacement with no gas adsorption

Setting,  $n=0$  i.e.  $\rho_{PCE}, \rho_{PIB} = 0$ , means no adsorption of PCE gas. Eigen frequency and corresponding voltage and displacement profiles are shown in Fig. 2 and Fig. 3.

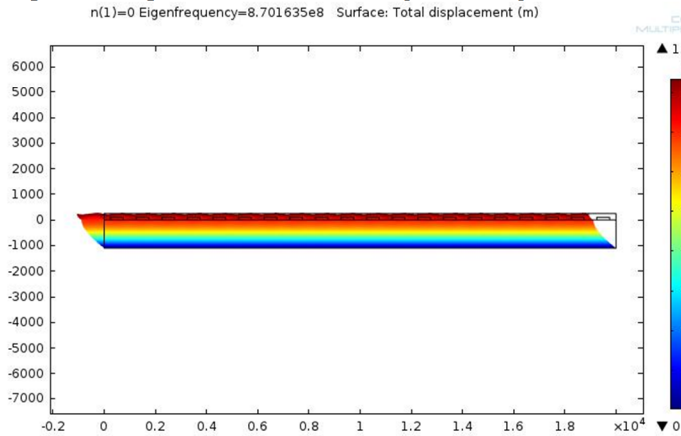


Fig. 2. Displacement of Piezoelectric substrate at resonance with no adsorbed PCE gas.

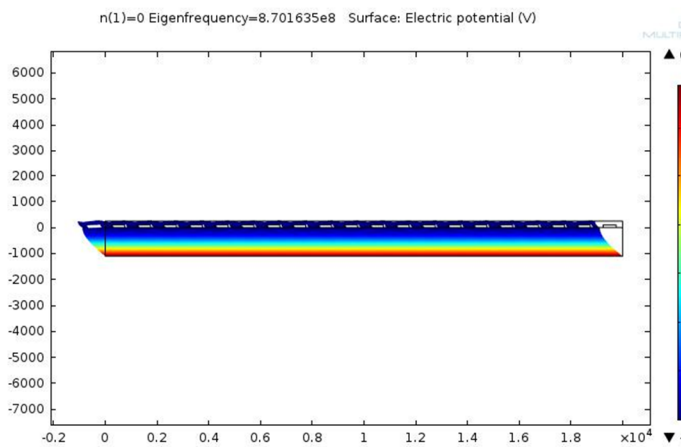


Fig. 3. Voltage profile along piezoelectric substrate at resonance with no adsorbed PCE gas.

Fig. 2 shows deformation of LiNbO<sub>3</sub> substrate at resonance due to acoustic wave induction. It has nodes and antinodes symmetrically that confirms its state at resonance. The substrate is piezoelectric. Deformation will cause voltage rise. At the highest displacement and lowest displacement voltage induced as shown in Fig. 3.

### B. Eigen frequency and corresponding voltage/displacement with gas adsorption

Now setting  $n=40$  and  $m=10^{-9}$  i.e. 40 ppb adsorption of PCE gas. Eigen frequency and corresponding voltage and displacement profiles are shown in Fig. 4 and 5.

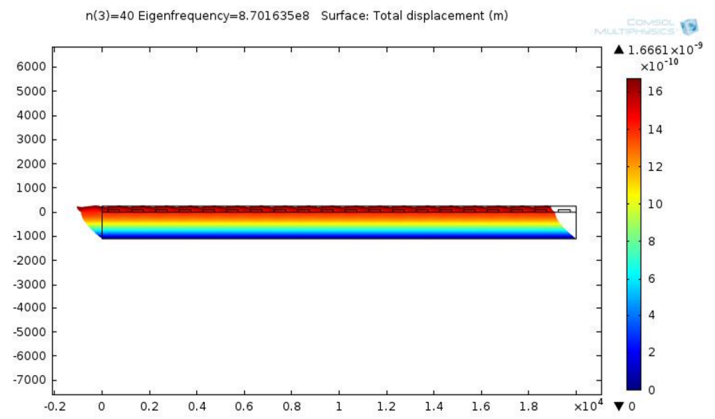


Fig. 4. Displacement of Piezoelectric substrate at resonance with 40 ppb adsorbed PCE gas.

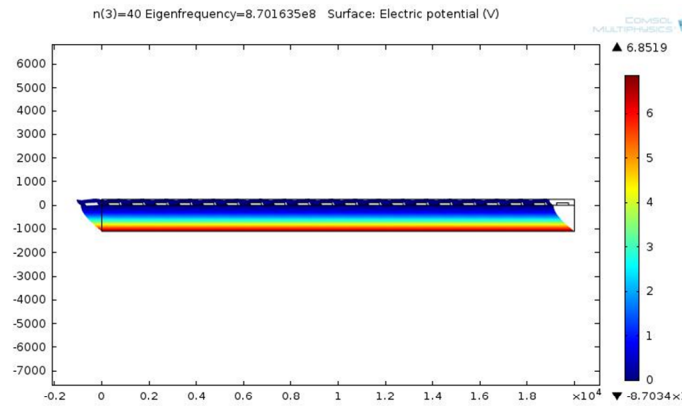


Fig. 5. Voltage profile along piezoelectric substrate at resonance with 40 ppb adsorbed PCE gas.

In the next section it is shown how resonance frequency shift can be used to distinguish between no gas adsorption and some ppt. gas adsorption.

Resonant frequency with no gas adsorption is 8.7016 MHz. Resonant frequency with 40 ppb gas adsorption is 8.7016 MHz. Seemingly there is no difference in MHz scale. But if it is written in Hz format, the difference would be clear. With no gas adsorption resonant frequency is 870163496 Hz. With 40 ppb gas adsorption resonant frequency is 870163487 Hz. Frequency difference in the scale of Hz is 9 Hz.

### C. Ppb. versus frequency shift for PCE

Detection range for this device has been targeted from 1 ppb up-to 200 ppb of PCE vs. frequency shift graph has been shown in Fig. 6.

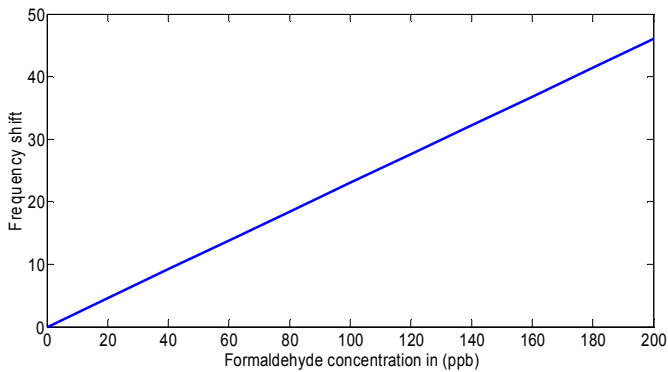


Fig. 6. Formaldehyde gas concentration versus Frequency shift graph for the sensor.

#### D. Low pass filter specification

A low pass filter is required to discard higher spectral component to only preserve the low frequency signal. Low pass filter require specified cutoff frequency around,  $f_c = 50$  Hz.

#### E. Frequency to Voltage Converter (FVC)

Based on the slope of the graph a Frequency to voltage converter can be designed which should have output voltage vs. frequency shift graph look like as in Fig. 7.

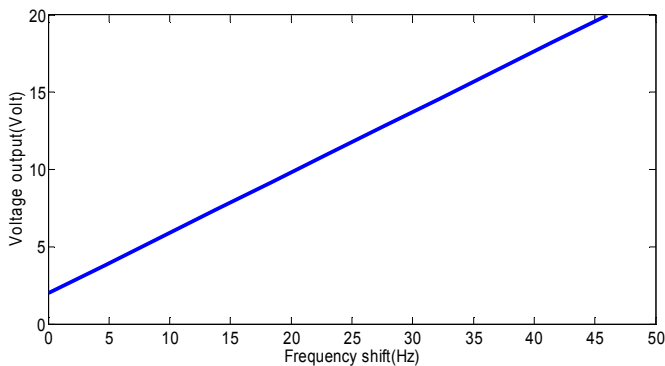


Fig. 7. Frequency shift versus Voltage output graph for Frequency to voltage converter.

#### F. Overall sensor transfer characteristics

Finally, it is possible to relate ppb of PCE gas vs. output voltage as shown in Fig. 8.

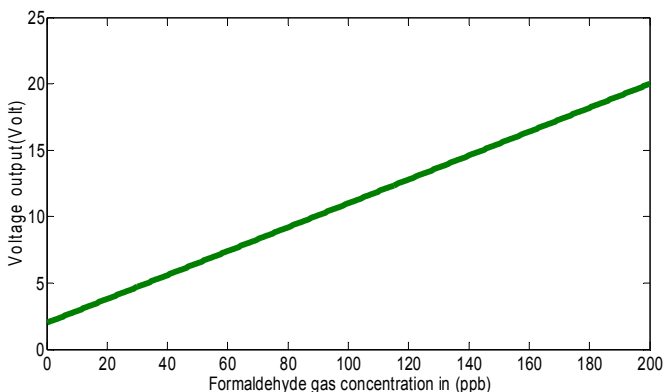


Fig. 8. Overall transfer function of the sensor.

Linear relation can be expressed with equation:  $Y = mX + C$ .  
Where,  $Y =$  Voltage output (Volt).

$$m = 0.09.$$

$$X = \text{Formaldehyde gas concentration in (ppb)}.$$

$$C = 2.$$

## VI. CONCLUSION

From the simulation results, it is evident that this gas sensor's performance is phenomenal in terms of detecting even the minute trace of the formaldehyde gas in its vicinity. It also acts as concrete evidence that this sensor could be a practical and realistic device which can be used in the real world scenarios with relative ease. It can also be concluded from the simulation results that this gas sensor would be much more efficient than other available formaldehyde gas sensor device, ensuring mobility and durability in detection. Further research is being conducted to find a polymer that has similar adsorption coefficient for Formaldehyde as used here of Poly-iso Butylene polymer for Poly Chloro Ethane gas.

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# Design of a Microbial Fuel Cell Using Copper Sulphate and Potassium Permanganate as Electron Acceptor

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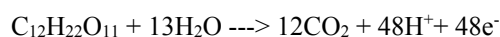
**Abstract**— The energy consumption rate around the world is rising day by day. On the other hand conventional sources of energy are finished at a fast rate. There is an uncertainty about the energy security around the world. The crisis of energy can be minimized by decently utilizing the renewable sources of energy. A latest manner of renewable energy recovery is reflected by Microbial Fuel Cell (MFC). It's like a device in which electrical energy is derived directly from chemical energy. The source of this energy is the oxidation of substrate material by bacteria. Potassium ferricyanide is the most used chemical as electron acceptor in MFC. In this paper several others chemicals are used as electron acceptor. Copper sulphate and potassium permanganate was used in the cathode to accept the electron. Potassium permanganate provided better output as electron acceptor than Copper sulphate.

**Keywords**—Microbial fuel cell; electron acceptor; Potassium ferricyanide; copper sulphate; potassium permanganate.

## I. INTRODUCTION

The need of alternative sources of energy is very acute due to the running out of conventional sources of energy in developed and developing countries [1,2]. Bangladesh gets 7628 MW of electricity from gas as of January 2016 [3]. But the amount of reserved gas is 14.16 trillion cubic feet (tcf) which will be finished within 2031 [Source: The Daily Star June 29, 2015]. For maintaining the current growth rate of our promising economy we have to move to renewable sources. It is very much urgent to find out a sustainable clean energy source with lowest emission of carbon due to global environmental concerns [4,5]. Fuel cells have represented themselves as emerging sources of renewable energy in recent years. Microbial Fuel Cell (MFC) is one of the members of fuel cell family which draws the attention of the researchers [6]. Bacteria are separated from a terminal electron acceptor at the cathode in an MFC so that the only way for respiration isto transfer electron to the anode. Materials like glucose [7], acetate or waste water [8] are catabolized by microorganisms. Chemical energy is converted instantly to electrical energy by bacteria in Microbial Fuel Cell [9, 10, 11]. Hydrogen can be

produced in Microbial Fuel Cell and it happens smoothly from the fermentation of glucose in the presence of *Clostridium butyricum*[12].



## II. OPERATIONAL PRINCIPLE OF MFC

Organic and inorganic matters are oxidized to generate current by bacteria which is used as biocatalysts in Microbial Fuel Cell (MFC) [13]. Electrons which are produced from the substrates by bacteria are transferred to the negative terminal (anode) and go to the positive terminal (cathode) through a load. Several chemicals like neutral red, methylene blue, thionine are used as mediators to accelerate the generation of current in MFC.

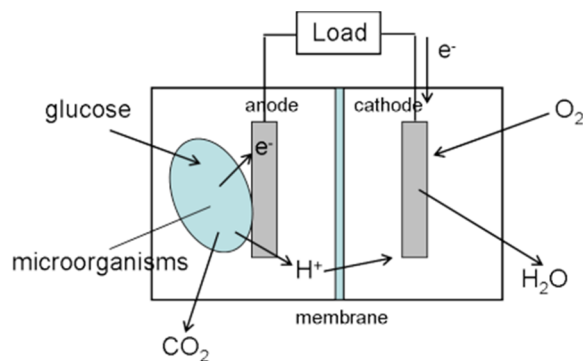


Figure 1. MFC mechanism

The above figure interprets that electrons gained from the substrate materials are transferred to the anode electrode by the bacteria present in anode chamber. Protons are also produced in oxidation reaction and passed to the cathode by proton exchange membrane. The transport of electrons from anode chamber to cathode chamber is occurred by direct contact or by mobile electron shuttles. Finally the electrons are participating with the electron acceptor and the protons in cathode chamber [14].

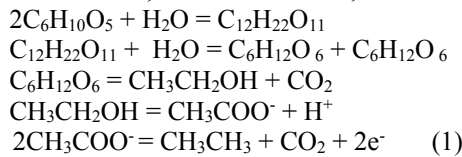
### III. BASIC STRUCTURE

In anode chamber organic materials are used which are oxidized and produce electron, proton. Here glucose, sucrose, glucuronic acid, starch etc. can be used as organic material [15]. Several chemicals are used to boost up the performance of anode chamber. These are called mediators. These include neutral red, methylene blue, thionine etc.[16]. As a mediator of electron transport from *Escherichia coli*, thionine has been used widely ([17], [16]). Mediators are responsible for passing the electrons to anode electrode [18, 19]. External mediators are not demanded by the "mediator less" MFC due to the capability of the bacteria present in these MFC of doing the job of the mediator. In anode chamber co enzyme like Nicotinamide Adenine Dinucleotide Hydride (NADH) is used to transport the electron to the electron transport chain. As electrode conductive, bio compatible and chemically stable in the reactor solution material can be used. The most versatile electrode material is carbon because it is available as foam, felt, cloth, granules, rods etc.[15]. The proton exchange membrane (PEM) is responsible for passing the protons produced in anode to the cathode. As proton exchange membrane Nafion membrane is the most used [15]. Ultrex CMI-7000 is another widely utilized PEM [20,21,22]. Zirfon [23] and Hyflon [24] are another alternative cut-rate PEM. The proton exchange membrane must be accessible to the chemicals which are used in both anode and cathode chamber.

### IV. STANDARD ELECTRODE POTENTIALS

The half-cell reactions can evaluate reactions occurring in the microbial fuel cell.

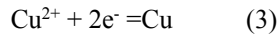
For oxidation of starch, we therefore have,



According to Nernst equation

$$E_{An} = E^0_{An} - (RT/2F) \ln [(CH_3COO^-)^2 / (CH_3CH_3)] \quad (2)$$

For the cathode potential  $E_{cat}$  if we consider the case where Copper Sulphate is used as the electron acceptor for the reaction, we can write



$$E_{cat} = E^0_{cat} - (RT/2F) \ln [(Cu) / (Cu^{2+})] \quad (4)$$

if we consider the case where Permanganate is used as the electron acceptor for the reaction, we can write



$$E_{cat} = E^0_{cat} - (RT/5F) \ln [(Mn^{2+}) / (MnO_4^-) (H^+)^8] \quad (6)$$

The Cell EMF is computed as,

$$E_{emf} = E_{cat} - E_{An} \quad (7) [15].$$

### V. PROPOSED MODEL WITH NEW CHEMICAL COMPONENT

For constructing a Microbial Fuel Cell, the configuration shown in figure 1 is the most efficient model as of now. But the chemicals as well as the components which are used in that model are unavailable in this corner of the globe. The production of some of these components like Nafion membrane is limited within some of the developed nations. So it is very

tough to make MFC popular as a renewable energy source in Bangladesh. It is urgent to develop a new model of Microbial Fuel Cell.

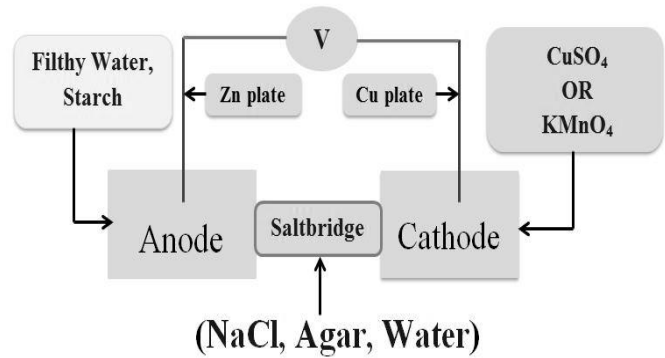


Figure 2. A substitute model of MFC.

Figure 2 represents a model which may be an alternative configuration of ideal model of MFC. In this configuration Nafion membrane is replaced with salt bridge. Actually salt bridge is the replacement of proton exchange membrane. The salt bridge is made of agar, sodium chloride and water. In anode chamber the co enzyme Nicotinamide Adenine Dinucleotide Hydride (NADH) is totally neglected. Also any mediators are not used. Only bacteria filled filthy water and starch as substrate are used in the anode chamber. Zinc plate is used as anode electrode whereas copper plate is chosen to do the function of cathode electrode. As electron acceptor potassium ferricyanide is widely used in cathode chamber of MFC. But it is a restricted chemical because it is poisonous to health. So we are replacing it with copper sulphate and potassium permanganate. The chemicals which are used in the model of figure 2 are quite available in any corner of Bangladesh.

### VI. EXPERIMENTAL SET UP & DATA ANALYSIS

Based on our proposed model two experimental set ups had been constructed recently. One was for Copper sulphate and another one was for potassium permanganate as electron acceptor. For both the cases drain water was used as the holder of bacteria. Actually the thick muddy layer was taken from the lowest stage of the drain. The thick layer was mixed with the filthy drain water. One kg of muddy layer was mixed with 250 mL of drain water. Then 0.5 litre of liquid was used from the mixture in the anode chamber. Starch was used as organic matter whereas mediators are neglected to be used. Both cases 125 gm. starch was taken. Zn plate was served as anode electrode where cu plate did the function of cathode electrode. The salt bridge was 0.5 inch thick and 5.5 inch in length for both the set up. For developing the salt bridge 5.5 gm. agar, 27.5 gm. Sodium chloride and 275 ml of water were used. The mixture of agar, NaCl and water was heated until it became adhesive. Actually two salt bridges were constructed with same composition of chemicals. All the data's were collected under no load condition and a multimeter was used to measure the experimental findings. Figure 3 represents the diagram of set up with copper sulphate as electron acceptor whereas figure 4



reflects the diagram for potassium permanganate as electron acceptor.



Figure 3. Experimental Set up for Copper Sulphate.



Figure 4. Experimental Set up for Potassium Permanganate.

TABLE I. EXPERIMENTAL DATA FOR FIG. 3

Observing internal hours	Voltage (V)	Current (mili amp)	Power (mili W)
After 2	1.046	5.78	6.046
After 8	1.034	5.42	5.604
After 16	1.011	5.32	5.379
After 24	1.009	5.28	5.328
After 32	1.003	5.38	5.396
After 40	0.972	5.59	5.433
After 48	0.931	5.19	4.832
After 56	0.931	5.11	4.757
After 64	0.834	4.97	4.145

TABLE II. EXPERIMENTAL DATA FOR FIG. 4

Observing internal hours	Voltage (V)	Current (mili amp)	Power (mili W)
After 2	1.283	1.515	1.944
After 8	1.224	1.419	1.739
After 16	1.227	1.406	1.725
After 24	1.252	1.389	1.739
After 32	1.176	1.099	1.292
After 40	1.233	1.161	1.432
After 48	1.237	1.284	1.588
After 56	1.033	1.165	1.203
After 64	1.002	1.133	1.135

## VII. COMPARISON WITH AN IDEAL CASE

An experimental model was constructed by using Nafion 117 as a membrane at department of aerospace and mechanical engineering in University of southern California, Test data's and graph are given below [25].

Chambers:	Anode and cathode
Length	3.3 cm = 33 mm
Diameter	3.9 cm = 39 mm
Projected surface area	11.94 cm <sup>2</sup>
Membrane:	Nafion 117
Thickness	177.8 um = 0.1778 mm
Projected surface area	11.94 cm <sup>2</sup>
Electrodes:	Anode and cathode
Thickness	0.6 cm = 6 mm
Projected surface area (large)	11.94 cm <sup>2</sup>
Surface/ Volume ratio	10 666*

Fig 5. Specific data for MFC experiments at University of Southern California [25]

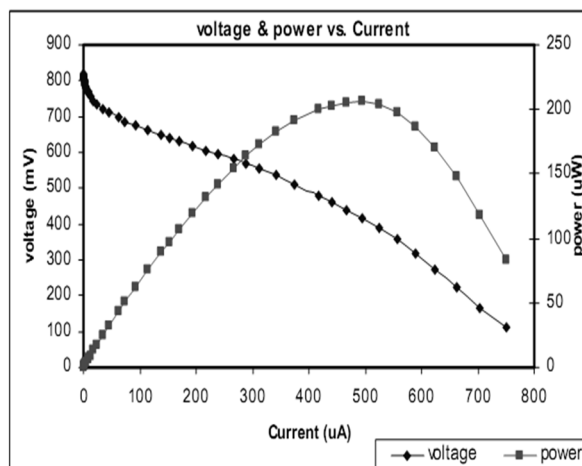


Fig. 6 Graphical presentation for voltage and power vs current for an MFC [25]

With a projected electrode surface area of 11.94 cm<sup>2</sup> the maximum Power attained was approximately 206.4 microwatts [25]. The values are given below for our experimental set up.

TABLE III. EXPERIMENTAL SET UP DATA

Chambers	Anode & Cathode
Length	28.5 cm
Diameter	7.4 cm
Surface Area	662.56 cm <sup>2</sup>
Salt bridge Length	13.97 cm
Salt bridge Diameter	1.3 cm
Electrode Length	12.7 cm
Electrode Width	5.08 cm
Electrode Surface Area	64.52 cm <sup>2</sup>

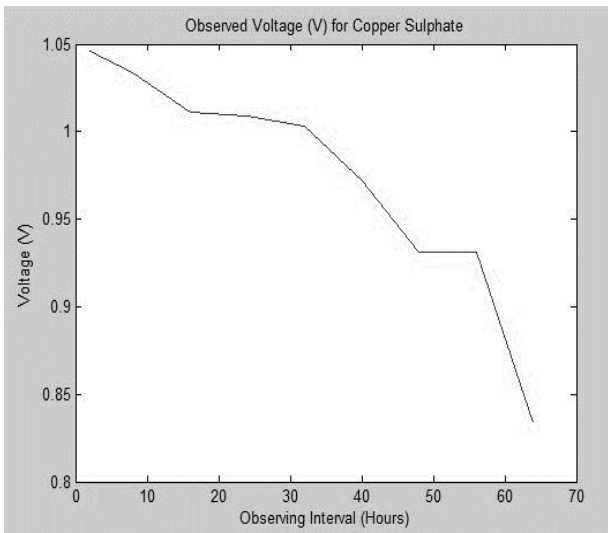


Fig 7. Obtained Voltage for Copper Sulphate.

1.046V was obtained as maximum voltage for Copper Sulphate as electron acceptor.

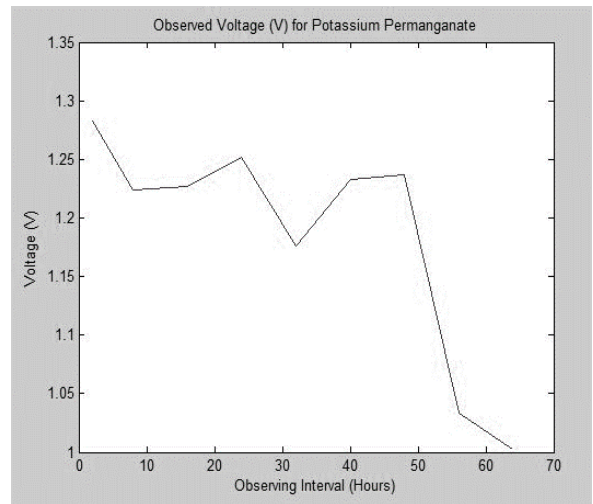


Fig 9. Obtained Voltage for Potassium Permanganate.

1.283V was obtained as maximum voltage for Potassium Permanganate as electron acceptor.

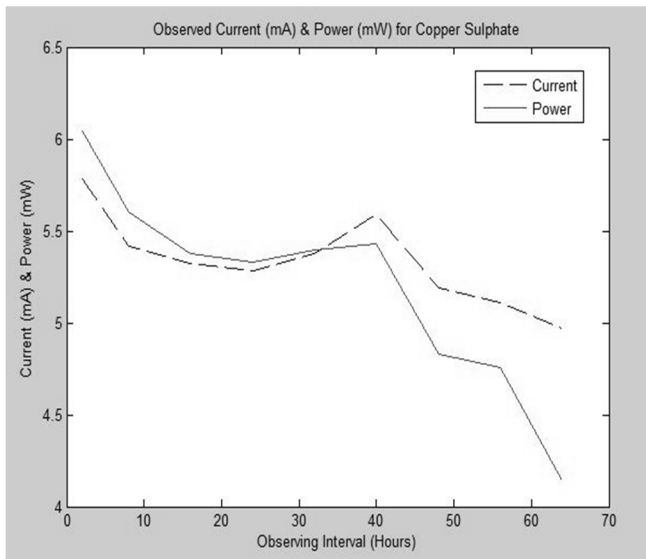


Fig 8. Obtained Current & Power for Copper Sulphate.

Figure 8 shows that 5.78 mili amperes and 6.046 mili watts were obtained as maximum current and maximum power respectively for Copper Sulphate as electron acceptor.

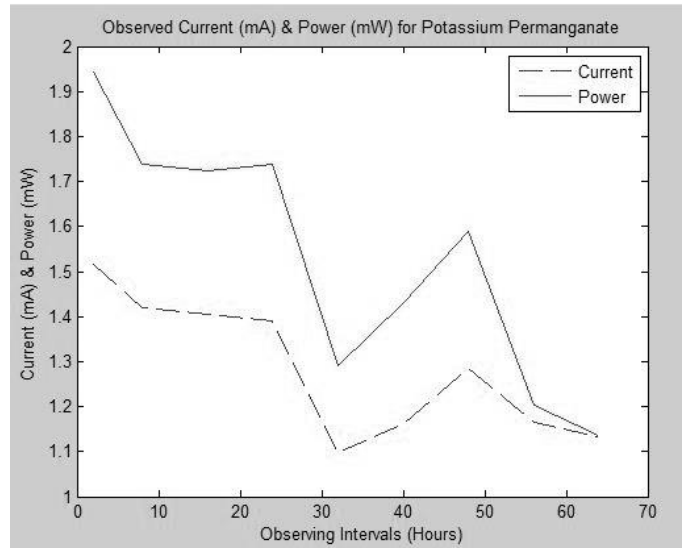


Fig 10. Obtained Current & Power for Potassium Permanganate.

Figure 10 shows that 1.515 mili amperes and 1.944 mili watts were obtained as maximum current and maximum power respectively for Potassium Permanganate as electron acceptor.

### VIII. CONCLUSION

The reduction of conventional energy sources forces the researchers to think such kind of renewable energy source. We checked the performance of Microbial Fuel Cell for different chemicals as electron acceptor. Our observations found that its output voltage is not stable. Further research on stable output as well as on different aspects like effect of surface area of anode and cathode chamber, effect of different electrodes materials may speed up the process of making it as a mainstream renewable energy source.

## ACKNOWLEDGMENT

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# Smart Disaster Notification System

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**Abstract**—The devastations of natural disasters are the lash of mother nature that every year hit us with a whip. They are inevitable. There are no alternative ways to prevent this incident, but we can take proper steps to reduce its damage. Now-a-days a great deal of attention is given to the potential of mobile communication technology. Short Message System (SMS) has a huge impact on the communication system. This paper propose an android application which will alert people before a natural disaster like Cyclone, Flood and tell them the optimal route to the nearest shelter via SMS, voice call and voice alert. In evacuation process, we use partition based shortest technique to find nearest shelter place.

**Index Terms**—Natural Disaster, Notification System, Android, Location Based, Nearest Shelter

## I. INTRODUCTION

Natural disasters are the consequences of natural hazards. It does occur a serious breakdown in the sustainability of human, animals and property. It also occurs economic losses and disruption of economic and social progress. The overwhelming number of dead or seriously injured and homeless people are affected by the occurrence of a natural disaster. The massive amount of money to be spent for reconstruction and rehabilitation equates to a natural disaster. They are nothing else but extreme environmental events that impact human activities. Hurricane, Earthquakes, Tsunamis and volcanic eruptions are the most frequent threats as well as flooding [11], tornadoes and droughts which are also prevalent.

According to the Annual Disaster Statistical Review 2010 [7], 330 natural disasters were registered worldwide in 2003. Within that, there has been a total of 21,610 people who have been killed where the number of people killed by floods was 9,819 and the number of these killed by storms were 8583. And the estimated damage was 118.6 billion dollar. The statistics only got worse. But the worst part really is that there is no way of preventing natural disaster. The only way we can survive these is preparing for what may come.

Researchers had tried to give early warning system to minimize the loss. They came up with some brilliant way to do it [23], [5], [16]. In this modern time mobile have really changed the way of communications [13], [19]. It is the most used communication tools. Some of them tried to use Short Message System (SMS)[17] as an alerting system for the disaster. SMS is used on modern handsets originated from radio telegraphy [21] in radio memos pagers using

standardized phone protocols. These are defined as the part of the Global System for Mobile Communications (GSM) series [22] of standards as a means of sending messages up to 160 characters to and from GSM supported devices. But by this method there is no way of evaluating the level of the disaster because no databases are used. This method only sends messages to the subscribers. But subscriber could be blind, so this method would not be helpful for blind people. Again, researchers used android technology [5] to easy the system. They used algorithm to calculate optimal routes to the shelter for evacuation at the time of disaster and showed the data into google map.

Our proposed technique is an android based application which takes weather updates from websites and calculates the disaster level. Subscribers data can be stored in this applications database. It can calculate the optimal route to the shelter from the subscribers current position and send voice call/ SMS with warning and shelter location to them. It sends voice call or voice alarm so blind subscriber can also get the alert. This is GSM type alerting system so subscriber do not need to have an android device in order to receive the service.

The remaining sections of the paper are organized as follows. In section II describes related work on disaster notification systems. Section III introduces our proposed smart disaster notification model. Implementation of our proposed technique has been described in section IV. Result analysis has been shown in section V. Application of the systems and discussion as well as the future researches are shown in section VI.

## II. RELATED WORK

Early disaster warning and evacuation approach are very general disaster management system in disaster-prone areas. Now-a-days mobile phones play an essential role in disaster management system in several ways: monitoring, communication, warning dissemination, evacuation and rescue and relief aid. A number of notification system has been proposed in our real world. In research paper [3], [9], Short Message Service (SMS) is sent to all citizens from the server about the awareness of upcoming flood warning. A huge number of SMS transfer from the server cause network congestion and can break the voice communication system in same network. To avoid this kind of congestion cell broadcasting service is

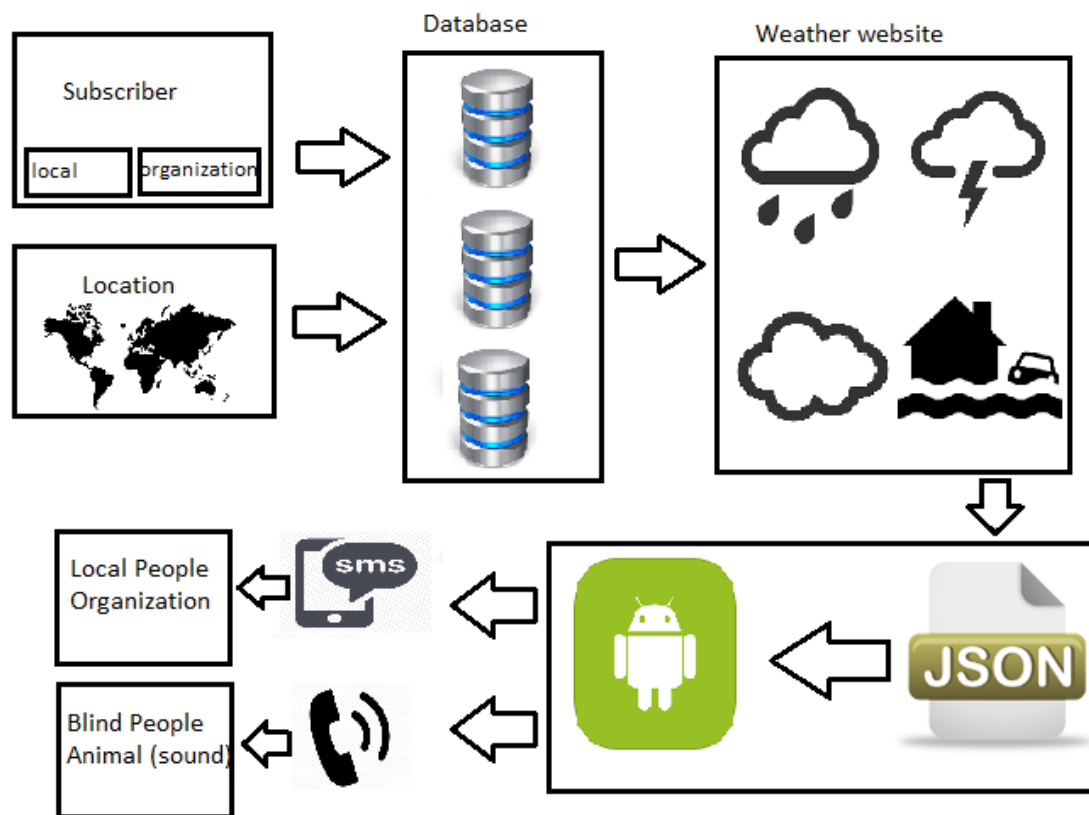


Fig. 1. System Overview

used to directly send messages to the subscribers in a specific area [20]. But this process fails to help in evacuation process which provides information about safe region. GSM alarm device is used for evacuation process in which three kinds of warning are sent to the police station or fire brigade station [8]. Although it can avoid network congestion, the GSM alarm is not a faster way for evacuation process.

Satellite communication systems will be very fast, reliable and robust. As a result well developed countries like Australia and South Korea are planning to use satellite communication for disaster management [18], [1], [9]. This satellite service maintenance is expensive and developing countries cannot afford this. Very few researchers propose location based services for disaster management on mobile phones. Previous works on location based services for disaster management did not distinguish normal people and blind people. Considering this, Amit Gosavi et. al. [6] presented a location based early warning and evacuation system by visual and audio warnings useful to both normal and blind people.

Natural Disasters such as cyclone, storm, earthquake, Tsunami and flood have shown the harmful, damaging mode of nature which has taken millions of lives including people and animals. Above all techniques are concern about people warning. Most of them did not discuss about evacuation processes by which people get shelter place. Dijkstra's algorithm based shortest path calculation is used to find the nearest shelter

place[6]. This process is time consuming because it search all paths from the source to destination. For this, we propose a location based smart disaster management system that can warn all subscribers (people, blind people and animals). In the evacuation process we used partition based trajectory to find nearest shelter place. It is very faster than the previous proposed methods.

### III. PROPOSED SOLUTION

The main purpose of Smart Disaster Notification System is to alert people before the time of disaster and tell them the optimal route to the nearest shelter. In our system we divide the whole application in some module. First one is database building that consists of subscriber information and locations whose probability of disaster is measured. Second one is based on locations in which our proposed methods take information from weather website. After that these information will be converted to JSON (JavaScript Object Notation) [2] format. Then, according to JSON information the system will be able to understand the probability of disaster and then the system will send nearest shelter information to the subscribers. The architecture of our proposed technique depicts in figure 1. Each part of our system will be explained details in the next few sections.

### A. Preliminaries

The consequence of natural hazards is called the natural disaster. There are different kinds of natural disaster such as cyclone, storm, earthquake, Tsunami and flood etc. Different kinds of natural disaster occurs at the different time in different geographical area. Some recent examples of violent natural disasters are the 2011 Japan earthquake and Tsunami, the 2010 Haiti earthquake, the 2007 cyclone SIDR, the 2004 Indian Ocean Tsunami, the 1991 Bangladesh cyclone. Geographically few South Asian countries are situated in between the Himalayas and the ocean, on the delta of wide rivers, means that the countries are very exposed to flooding [14]. The people live in coastal areas have to face several storms each year and cultivable lands disappear in the river due to river erosion. Such countries are mostly affected by the planets climate changes and number of cyclones. Hence, there is also the risk of Tsunami in these countries. Our disaster preparedness system protects the people from upcoming disaster. For this it uses SMS, voice call or voice alert. Our proposed work can be implemented on android mobile phones. Android [4] is an operating system for mobile devices such as smart phones and tablet computers developed by Open Handset Alliance led by Google. As android is more open and comprehensive than other mobile operating system, this is the best selling product worldwide. It also allows building of new applications at lower cost. Consequently, this is more interactive for users. Hence, an android mobile platform has been used in our proposed disaster awareness system.

### B. Input into database

We will keep the record of subscribers in the database. In there we will store the subscriber name, location and mobile number. Based on the subscriber locations we can give them the proper warning about the disaster. Smart disaster notification system will fetch the information from it and sends notification to the subscribers. Sending notification will depend on update from the websites.

### C. Update from website

This application will take update from website and evaluate the level of disaster. Then it will convert the data into JSON format. The following figure 2 shows the update process.



Fig. 2. update from website

### D. Minimum distance calculation

We determine the optimal route to the nearest shelter and show it to the application and in case of the non-android user we just give them the placement of the nearest shelter. If figure 3 subscriber gets a disaster awareness message form the system. The system will send nearest shelter information. Here if we calculate Euclidean Distance [12] we find nearest shelter point is B. But that existing path is so far than path A. For that reason we use trajectory partitioning method[15] to calculate distance between two places. Trajectory partitioning means path partitioning, which is very important because propose algorithm has used sub-trajectories.

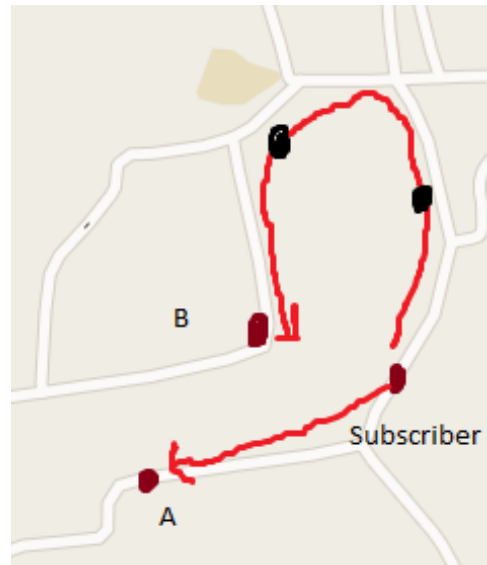


Fig. 3. Calculation of nearest shelter place.

For partitioning, we first took the starting and ending point of the route. Then from the starting point we move towards using the trajectory points. In the first trajectory point we measured the perpendicular distance with respect to the line which was drawn from the starting and ending point of the route. We used equation 1 to measure the perpendicular distance where  $(m, n)$  is the coordinate of the trajectory point,  $d$  is the perpendicular distance, and  $Ax + By + c = 0$  is the equation of the line. Then we check the perpendicular distance to the given limit to check whether it would need to partition the trajectory. If the distance is greater than the given limit, we would partition the trajectory into two parts. Figure 4(a) shows the approximate solution structure. The other partition will replace the existing line which was used to measure the perpendicular distance. Then from every point we follow these steps and determine the trajectory path and store them in the array and finally shows the result. In figure 4(b)  $P3$  trajectory partitioned into two parts. Then we measure the perpendicular distance for the partitions. For left partition the distance is lower than the given limit, so we can take the partition as an approximate solution and store the result in an array.

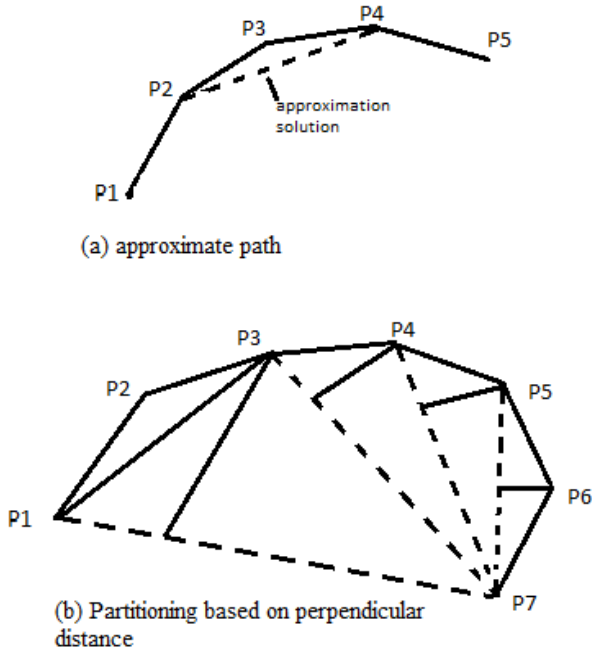


Fig. 4. Calculate Minimum distance function for path shelter

$$d = \frac{|Am + Bn + c|}{\sqrt{A^2 + B^2}} \quad (1)$$

Algorithm 1 and 2 shows the procedure to determine the distance of the trajectory path from the starting point to ending point. In algorithm 1 for every trajectory  $tr_i$ , we found the minimum distance of the subscriber  $u$ . Then we select the start point  $tr_i[pos]$ . And call the *distance* function explained in the algorithm 2. Then we recommend a shelter point to the subscriber  $u$ . In algorithm 2 for each *position* and for each starting point  $SP_i$  we check the perpendicular distance with the given limit. If the distance is greater than the given limit, then we can call the *distance* function twice for the left and right partition. If the perpendicular distance is lower than the limit we took the approximate solution and store the result. Lastly it calculates the total distance from the two partition or with the approximate distance for each trajectory and return the result in the algorithm 2.

TABLE I  
ALERT CLASSIFICATION

Disaster	SMS	Voice Alert
Rainfall	Yes	Yes
Heavy Rainfall	Yes	Yes
Cyclone	Yes	Yes
Wildfire	Yes	Yes
Flood	Yes	Yes

### E. Sending notification

After getting updates from websites minimum distance is calculated and then a notification is sent to the subscriber who already registered in the database. This notification is both audio and text message because subscriber can be blind.

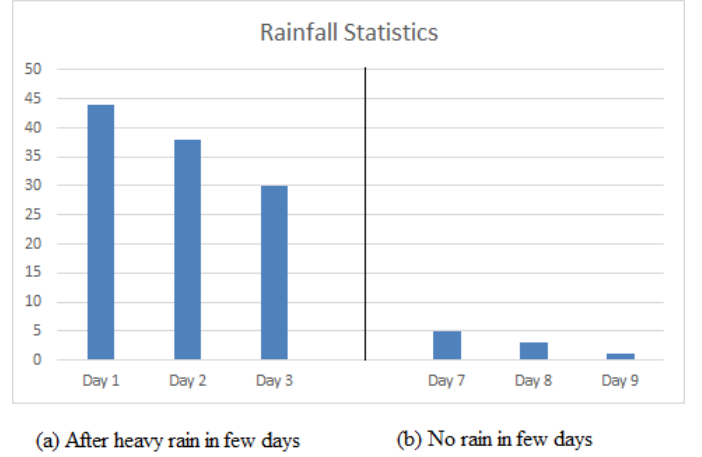


Fig. 5. Weather Update statistics view.

### F. Location tracking of victim

At the time of disaster, subscribers are in the middle of it. Then for rescue, this application determines the victims location by using GPS for android or triangulate location using mobile network for non-android phone and send back the data to the rescue center.

## IV. IMPLEMENTATION

In our implementation, we have used android based smart technology. For alerting people we first insert their data into the applications database. In database, subscriber locations are also saved. Then the application communicates with the server. Determining the kind of situation server responses with a JSON file containing the weather information. This application reads the JSON file and convert the data into a message which would be sent to the people whose data are in the database. If JSON file gets some disaster like as Cyclone, Flood, Wildfire it sends SMS or voice call to the subscribers.

### A. Database Design

This is an Android application so we used Sqlite database[10]. This database contains three attributes which are subscriber name, mobile number and region. The attribute mobile number acts as a primary key because mobile number is unique for subscribers. In the weather server, we create database tables for storing the weather status and to store the shelters position.

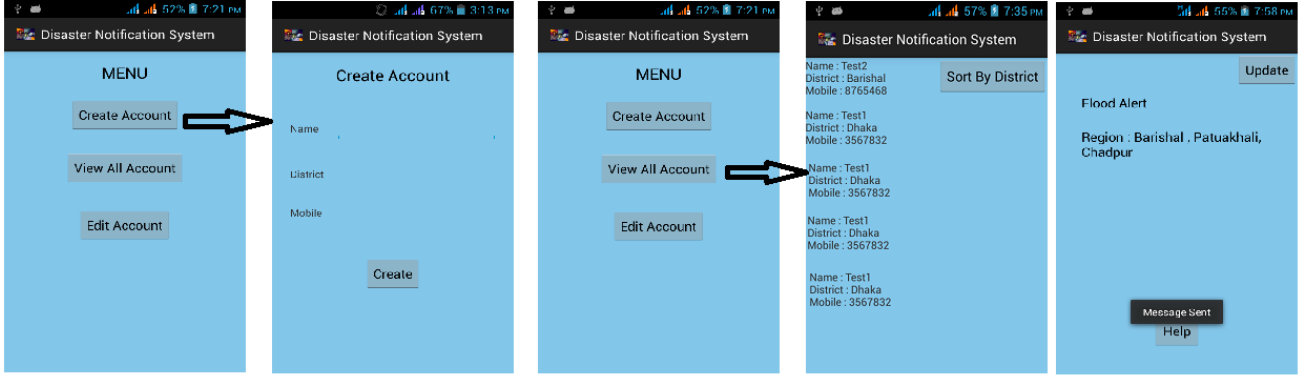


Fig. 6. Application Demonstration.

### B. Application Testing

Figure 5(a) shows that statistics of rain in 5 days. The heavy rainfall may cause flooding and it affects some areas so the JSON file pointed to those possible affected areas. If the statistics show no promising situation of disaster system, it will point to no warning in figure 5(b). The system will search if there is anyone exist in affected regions, it will send them the alert. By this only the affected people get alerts, not all the people in the database. Table I shows the overview of the alert classification.

Figure 6 shows inner looking of the application. For inserting data into the database users need to press the create account button and give the information. After completing registration, data of the people are saved in the database. User also can edit or delete account information by choosing Edit Account Menu. After pressing the Edit Account button there are two options edit account or delete accounts. If user wants to edit account, then user has to provide the mobile number which is unique (primary key) and then edit the information. For deleting account user have to again give the mobile number. Then systems will search the database corresponding that mobile number and will delete that information. When apps requests for weather updates, website calculates the situation of the disaster and make JSON report according to the condition of the weather.

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#### Algorithm 1 MinDistance (TR, U)

---

```

1: for each  $u \in U$  do
2:   for each  $tr(i) \in TR$  do
3:     Find minDistance  $u$  to  $tr(i)$ 
4:     Select startPoint =  $tr(i)[pos]$ 
5:     minDistance = Distance ( $tr(i)$  ,  $SP$ )
6:   end for
7: end for
8: Recommend minDistance up to  $u$ 

```

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#### Algorithm 2 Distance ( $tr_i[pos]$ , SP)

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```

1: for each  $psosition \in tr_i[pos]$  do
2:   for each  $SP_i \in SP$  do
3:     Check PD with the given limit/* PD = Perpendicular Distance */
4:     Distance ( $tr_i[pos]$ ,  $i$ )
5:     Distance ( $i$ ,  $SP_i$ )
6:   end for
7:   Calculate total distance
8: end for

```

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### V. RESULT

From table II we can see that for every test case the Euclidean distance is smaller than the trajectory distance. Because Euclidean distance only calculates through the direct path using co-ordinate of two places. But there may not be direct paths from those two places. In this case, the distance is more accurate than the Euclidean distance. Hence, we can calculate the nearest shelter and recommend the subscriber.

TABLE II  
TRAJECTORY PATH RESULT

Test Case	Euclidean Distance	Calculated Trajectory Distance
1	1.95 Km	5.1 Km
2	0.18 Km	0.19 Km
3	1.07 Km	1.39 Km
4	3.46 Km	3.96 Km

### VI. DISCUSSION AND CONCLUSIONS

Disaster do not consider any geographical boundary. To minimize the losses in these natural phenomena we should prepare ourselves. Android technology allows us to get information from websites easily. And disaster alert should be a solution to help and give necessary instruction to people that will save lots of human life. This application gives alert before disaster like heavy rain, flood, cyclone, wildfire and so on. This also calculates the optimal route to the nearest shelter.



In future work we will solve this kind of challenges. We will try to create awareness of other unexpected disaster that happen very quickly like Tsunami and Earthquake.

#### ACKNOWLEDGMENT

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# An Effective Hybrid Open Access Network for Broadband Communication using PON and Power Line

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*Abstract*—This paper proposes a passive optical network (PON) plus broadband power line (BPL) based new hybrid network architecture of an open access network (OAN). The new network architecture of the OAN uses optical fiber cable to the node, i.e., fiber to the node technology, and then uses the existing power line, i.e., 220V line, for covering the service area or user's premises and households. Such distribution architecture has many advantages like no cost of civil engineering construction from optical fiber node to the user premises, no need for new wires or drilling the walls and less requirement of sophisticated optical connectors and devices at the users end. In the illustrated OAN architecture, every user can have a bandwidth allocation of 6.3 Mbps for broadband communication. This paper presents results of practical implementation of a BPL communication system that was implemented in the laboratory for a short distance where two bidirectional power line couplers and a trap circuit were designed. In the experiment, maximum 13.3 MBps, i.e.,  $13.3 \times 8 = 106$  Mbps, throughput was obtained using power line and an average speed of 92 Mbps was found which fulfill the bandwidth requirement of the proposed hybrid OAN. It could provide real time playing of HD video where a power line was used as a transmission medium. We also performed the Matlab analysis on the experimental results and found that the transmission was errorless.

*Keywords*—Open access network, Passive optical network, Broadband power line, Bidirectional coupler, Trap circuit.

## I. INTRODUCTION

An Open Access Network (OAN) provides simultaneous use of a single network by the multiple service providers. The OANs offer freedom of choice for users to select the service providers (SPs), i.e., a common network infrastructure that provides competitive communication services, and lower cost for deployment of network and usage. The SPs are able to offer any number of services and the subscribers are also able to choose any SP for each of the services those they choose to subscribe [1]. In the context of an access network, a revenue model which allows an end user to freely choose its SPs, and for a SP to connect to the transport network and solicit customers for services is known as open access [2-4]. The end users can choose their information and communication technology (ICT) services, e.g., television (TV), Internet, Video-on-Demand (VoD), telephony, home surveillance, cloud

services, e-health, etc., from their favorite SPs. The passive optical network (PON) can be used as a common access network of the OAN because the PON provides huge bandwidth demand with very lower cost. Open access is a sustainable and profitable economic model for a broadband access solution such as EPON, as deployment cost can be recovered from the multiple SPs [5].

Fiber is a very attractive communication medium as it offers virtually unlimited bandwidth capacity and it provides very low error rates. Nevertheless, the absence of active components in the field gives the PON architecture higher longevity and reliability in a more cost efficient manner. A fiber access network which has fiber built to the node/curb called FTTN (Fiber to the node)/FTTC (Fiber to the curb) and then use the local copper loop to access households. This is generally a less costly option as it avoids reconnecting every household [2]. That means it can use existing land phone cable or twisted pair cable or existing power line cable or any other possible media. Again for densely populated countries, the FTTH architecture will be more complex. Experience shows that 80 percent of the cost of building last mile networks relates to the civil engineering construction costs, whereas electronics and cable component only account for 20 percent of the total cost. So, for developing countries, it will be better option to select an OAN which have fiber built to node or curve and then use the local copper loop to access households as it will be less costly and simple in architecture.

Modern researches show that the power line is capable of providing 1Gbps or more throughputs [6]. For example TP-Link product 'AV1200 Gigabit Pass-through Powerline Adapter TL-PA8010P' is capable of providing high-speed data transfer rates of up to 1200 Mbps which is perfect for bandwidth demanding activities like streaming of ultra-high definition (HD) videos to multiple devices simultaneously, online gaming and large file transfers etc. [7-10]. On 3 August 2006 the federal communication commission (FCC) has adopted a memorandum opinion and an order on broadband over power lines, giving the go-ahead to promote broadband service to all the Americans [11]. The FCC chief Kevin Martin said that broadband power line (BPL) "holds great promise as a ubiquitous broadband solution that would offer a viable alternative to cable, digital subscriber line (DSL), fiber, and

wireless broadband solutions" [12], [13]. In [6], it is highlighted that 1 Gbps transmission is achievable over PLC channel and it is also shown that the peak bit error rate (BER) constraint algorithms give better performance compared to the classical peak SER constraint algorithms.

Several dynamic bandwidth allocation (DBA) and fair bandwidth sharing algorithms are now available [14-16] those are implemented for the OAN by different researchers. This paper proposes a cost effective distribution network for the OAN especially for PON and BPL based OAN which use FTTN technology and then use the existing power line for covering the service area or users' premises and households. As a part of the research work, a practical BPL communication system was implemented in the laboratory. In the experiment, maximum of 13.3 MBps, i.e.,  $13.3 \times 8 = 106$  Mbps, throughput was obtained using the power line where the average speed was 92 Mbps.

The chronological arrangement of this paper is as follows: The descriptions of functional block diagram and practical works are presented in section II. Section III illustrates the proposed PON plus BPL system with bandwidth allocation scheme. Experimental results have been analyzed in section IV. Section V concludes the paper.

## II. FUNCTIONAL BLOCK DIAGRAM AND PRACTICAL WORK

### A. Block diagram of proposed network

The proposed network architecture consists of two main portions, i.e., (i) optical line terminal (OLT) to the optical network unit (ONU) whose medium will be optical fiber, and (ii) Node to the premises or households whose medium will be the existing power line. Here, in the first portion PON is used while in the second portion BPL is used. Fig. 1 shows the functional block diagram of the proposed PON plus BPL based OAN. The central offices of the SPs are connected to the OLT. Then a single optical fiber connects the OLT to optical splitter. Optical splitter divides the bandwidth of the single optical fiber into correct ratio, e.g.,  $1 \times 8$ ,  $1 \times 16$  or  $1 \times 32$ . A single  $1 \times 16$  splitter connects 16 Optical Network Units (ONUs) in the network to the OLT. The optical signal is then converted into electrical signal using optical to electrical converter (OEC) in the downstream direction and electrical to optical converter (EOC) is used in the upstream direction. The electrical signal

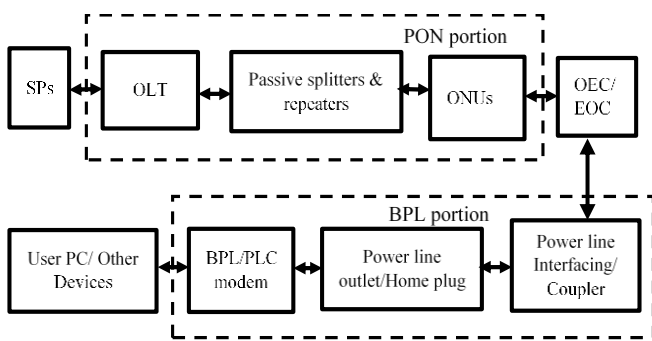


Figure 1. Functional block diagram of a PON plus BPL based hybrid OAN

obtained by the OEC is coupled to the power line using a bidirectional coupler. Then the users can get network access by plugging the BPL modems or power line starter kit or bidirectional coupler into home plug or power line outlet.

### B. Block diagram of the practical demonstration

1) *Bidirectional coupler*: This is the most important part of power line communication (PLC) that should be designed properly. As the signal is transmitted over the power line and the power line consist of 50 Hz 220V ac power, so it is needed to isolate the 50 Hz 220V ac power from the user's devices, e.g., laptop, desktop etc., for protection of these devices. To isolate this 50 Hz 220V ac signal a high pass filter is needed to allow the high frequency modulated signal to pass through while blocking the low frequency power signal. Here, a high value resistor in parallel and a high voltage low valued capacitor in series with a coupling transformer makes the coupler. This coupler blocks any signal of a frequency lower than the cutoff frequency and allows passing any signal having a frequency greater than the cutoff frequency. The analytical description of bidirectional coupler has been provided in the result analysis section.

2) *Trap circuit*: The line trap circuit is used for allowing the transmitted signal to receive over a limited area such as a building, institution, market or a town. There may be thousands of devices connected over the power line at a time. So there may have a huge signal loss of the transmitted signal. To reduce this loss the line trap circuit is needed. The line trap circuit has been used in series with the power line which actually consists of a parallel inductor and capacitor. In that case, the design is such that the resonant frequency equals the carrier frequency. Only a single inductor can also perform such action for high carrier frequency. For the 50 Hz ac signal of the power line it gives a very lower impedance but for the high frequency carrier signal it provides high impedance. So trap circuit provides no restriction for 50 Hz ac signal of the power line to pass through it but for high frequency transmitted signal the it doesn't allow to pass the transmitted signal out of the communication area (Fig. 2) between two trap circuits due to the high impedance.

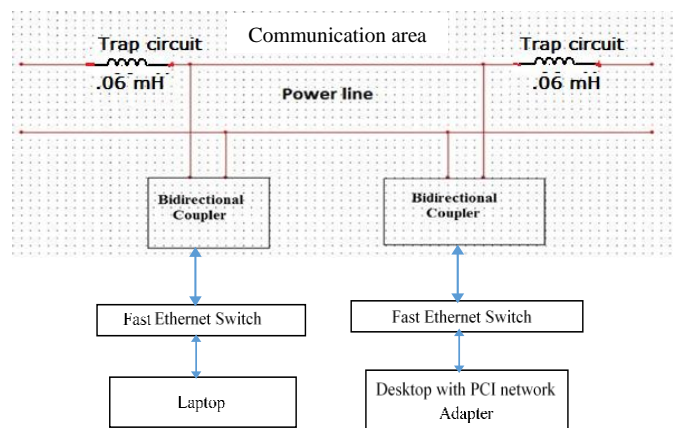


Figure 2. Block diagram of the practical implementation



(a) Working without load (b) Working with load

Figure 3. Practically implemented BPL system in the laboratory

### C. Practical Implemented Work

Figs. 3(a) and 3(b) show the practical implementation scenarios in the laboratory for without and with load cases. The data transmissions were successful by our practical demonstrations for both the cases. The above snapshots shown in the Figs. 3(a) and 3(b) were taken when the HD video was playing in over the power line.

### III. ILLUSTRATION OF PON PLUS BPL BASED OAN ARCHITECTURE

Fig. 4 describes a hybrid PON plus BPL based OAN architecture. Here, the 1Gbps EPON link has been considered. The splitting ratio of the optical splitter is 1:16 using this splitter 16 ONUs are connected to the single access network. Hence, bandwidth allocation per ONU is  $= 1\text{Gbps}/16 \approx 63\text{ Mbps}$ . Any BPL modem or any other designed power line coupler can be used for coupling the signal to the power line obtained from the OEC. In Fig. 4, Ethernet cable, e.g., twisted pair LAN cable, has been shown as a connecting media between the OEC and BPL kit because the BPL kit or power line adapter has the Ethernet ports, i.e., RJ45 port. This connecting media can be changed if the coupling device is specially designed or wireless media can also be used between O/E conversion device and BPL kit as wireless BPL kit or power line adapter is also available and in this case signal from the OEC should be transmitted without any wire. For long distance communication repeater should be used. The power

line adapter needs to plug in to the power outlet to connect to the network. In the designed architecture, one ONU is shared by 10 users which can be done by using a fast Ethernet switch having greater at least 10 Ethernet ports. In this case, bandwidth allocation per user is  $= 63/10 = 6.3\text{ Mbps}$ . Here, total number of users is 160, i.e., 10 users per ONU. This model is also valid for higher bandwidth, e.g., if the PON link speed is increased or the number of users connected to an ONU is decreased then the bandwidth allocation per user will be increased. For example if 10Gbps PON link is considered then bandwidth allocation per ONU will be  $= 10\text{ Gbps}/16 = 625\text{Mbps}$  and bandwidth allocation per user will be  $= 625/10 = 63\text{Mbps}$ . Again Power line can provide more than 1Gbps bandwidth. So someone shouldn't anxious about the illustrated bandwidth.

From the above discussion, it is clear that the power line should provide 63 Mbps speed for the above designed broadband network architecture. In practical implementation, fast Ethernet switches have been used and a 100Mbps link has been established over 220V power line.

### IV. RESULT ANALYSIS

#### A. Trap Circuit

The value of inductance used in the trap circuit was 0.06 mH. For the 50 Hz 220V ac signal, inductive reactance  $X_L = 2\pi fL = .0188\Omega$ . However, for 125 MHz high frequency signal the inductive reactance is 47.12M $\Omega$ . So the 50Hz 220V ac signal can easily pass through it but 125 MHz fast Ethernet signal cannot easily pass through it.

#### B. Bidirectional Coupler Circuit

In the bidirectional coupler circuit of Fig. 5, the resistor R1 and capacitor C1 makes a high pass filter. Here,  $R1 = 220\text{ Ohm}$  and  $C1 = 10\text{ nF}$ . Hence, cutoff frequency of this circuit  $= 1/2\pi R1C1 = 72.3\text{ KHz}$ . So, it can simultaneously couple 125 MHz signal in the power circuit and block the 220V power signal from the power line. It is clear from the frequency response curve of the coupler circuit is shown in Fig. 6. Our

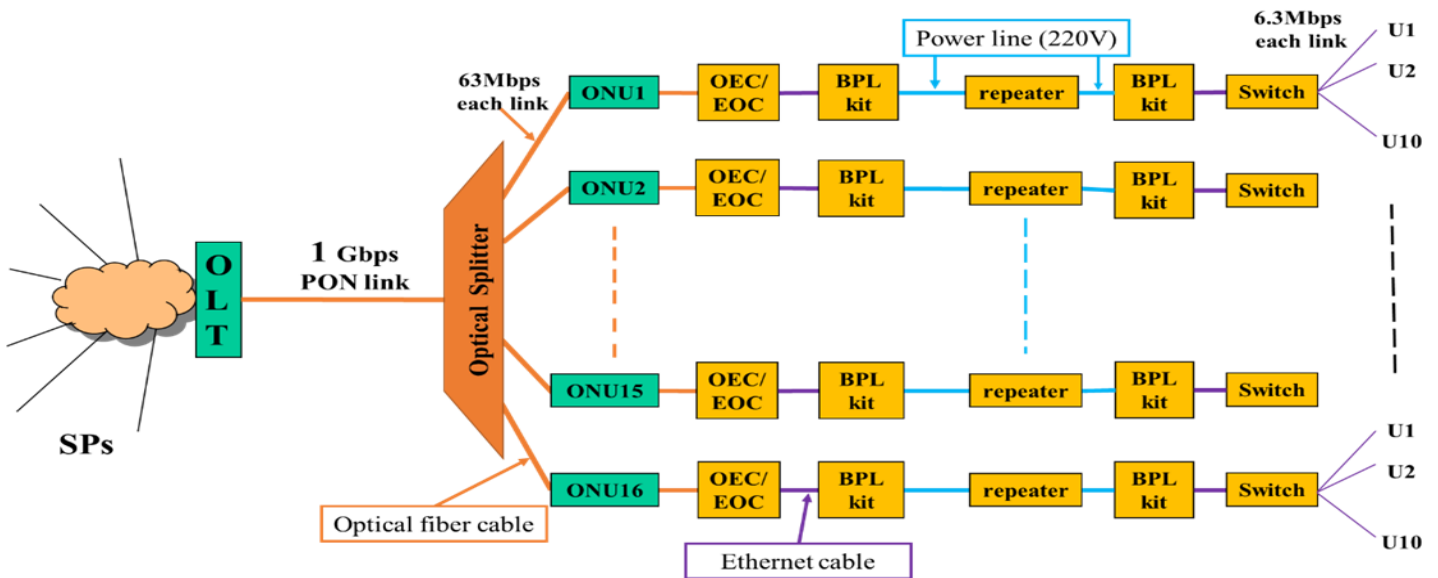


Figure 4. PON plus BPL based hybrid OAN architecture

designed coupler circuit completely blocks the 50 Hz ac power signal as response is 0 and passes the 125 MHz fast Ethernet carrier signal as the coupler response is 1.0. This action is

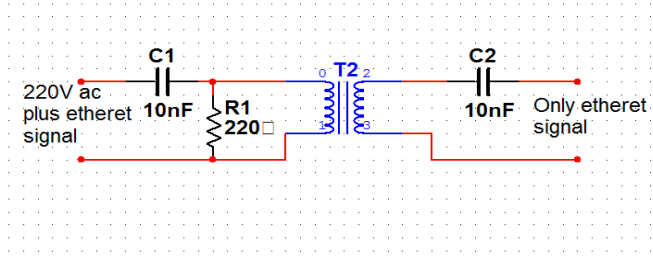


Figure 5. Designed bidirectional coupler circuit in multisim (core part)

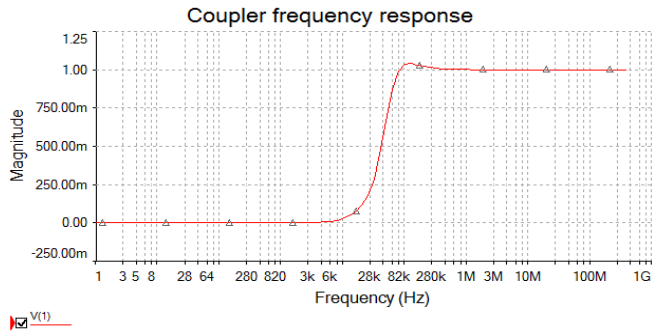


Figure 6. Frequency response curve of the bidirectional coupler

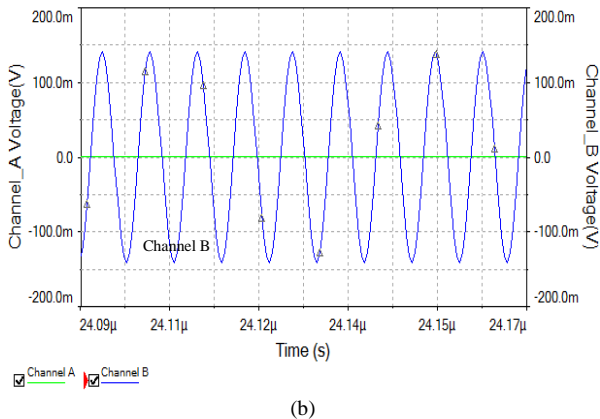
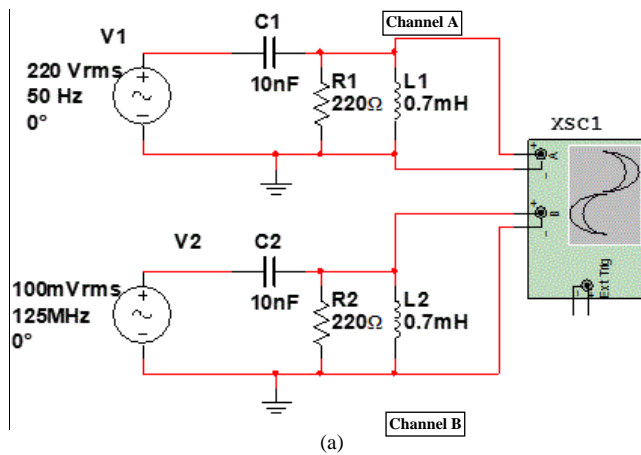


Figure 7. Simultaneously 50 Hz 220V ac signal blocking and 125MHz 100 mV signal passing action using Multisim. (a) Circuit diagram (b) Multisim grapher view tool's output.

shown in Fig. 7. The passing and blocking action has been analyzed for left side of the coupler where L1 or L2 indicates inductance of the left side transformer coil. The response of the full circuit will be similar.

### C. Matlab Analysis

In the experiment, maximum 13.3 MBps, i.e, 106 Mbps, throughput was obtained using the power line. Histogram analysis of a transmitted and received images are shown in Figs. 8. The histogram of the received image shown in the Fig. 8(d) is the exact replica of the histogram of the transmitted image in the Fig. 8(c). Therefore, it is clear that there is no error in the practically received image of our experiment.

Figs. 9 (a) and (b) show the PSD of transmitted and received audio signals, respectively, through our proposed PON plus BPL based OAN architecture. From the analysis of these two transmitted and received PSDs it is found that the proposed scheme can provides error free transmissions even for an audio signal.

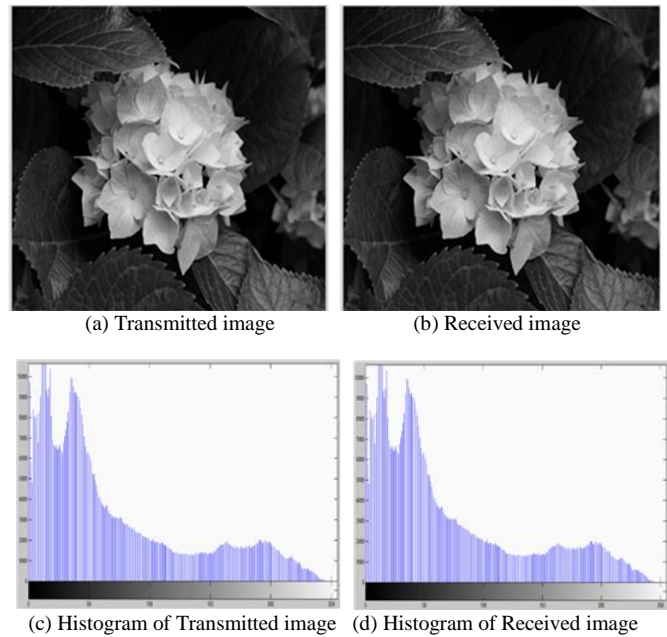


Figure 8. Analysis of an image file transmitted via the designed BPL system

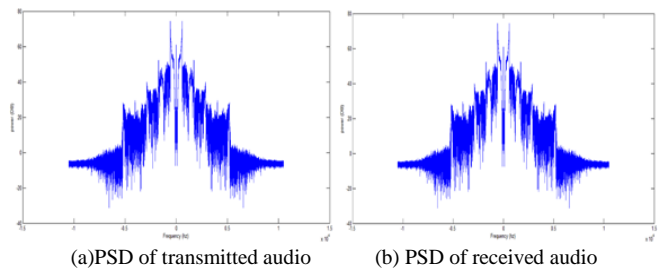


Figure 9. Analysis of an audio file transmitted via the designed BPL system

## V. CONCLUSION

In this paper, we have proposed a new hybrid network architecture of PON plus BPL based OAN. Performances of the proposed network structure have been evaluated by practical experiment in the laboratory. In the practical works, channel capacity of the power line was investigated using fast Ethernet compatible desktop and laptop. The maximum obtained throughput was 106 Mbps and an average speed of 92 Mbps otherwise if gigabit supported personal computer was used then more throughput would be obtained. However, the obtained speed in the experiment is enough to fulfill the demand of the bandwidth requirements for the proposed network. We can say that our designed hybrid network is capable of converging several ICT services, e.g., internet, VoD, telephony, e-health etc., as it can supports bandwidth demands of these services.

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# Design and Implementation of an Interactive Crisis Resolve System in Context of Bangladesh

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**Abstract**— Natural calamity is one of the major issues that works as a hindrance in the progression of an underdeveloped country like Bangladesh. To mitigate the disruption due to disasters, we propounded an mobile application based system through which people can get facilitation during natural calamities. The proposed system can help a user by generating weather update, nearby cyclone centers, hospitals, police and fire stations and also pointing those locations along with direction on the map and send emergency alert service. In addition, the user can see different reports submitted by the other users about unconventional incidents prevailed in any particular location and can also post a report on any escapade. The main goal of this paper is to present a system that could work both in online and offline and could facilitate a complete package of all informative contents to the user during a disaster.

**Keywords**—Natural disaster; distress center; alert service; report; notify; android.

## I. INTRODUCTION

A natural disaster is an unexpected event which occurs due to natural processes of the earth; example includes cyclone, flood, earthquake, tsunamis and other geological processes. Every year, a lot of people died, severely injured or become homeless because of such disasters. During the natural calamities, the telecommunication systems merely work and people can hardly communicate with others. As a result, it becomes even more difficult to tackle the unexpected situation.

During a natural disaster, a lot of people need to shift in the nearby natural disaster shelter. Considering this, we have developed a system where the user can find out the nearby cyclone center along with distance and direction and other stuffs such as: nearby hospitals, police stations or fire stations in an efficient way. In addition, a user can share his location perfectly if the user faces any problem using auto-sending message features of our system.

This application contains a reporting section. User can report an incident anytime from anywhere. Other users can observe the details of the incident through the map. This reporting section would help other users to become aware about any incident within an area. Our proposed system has also a survival strategy section which would help users to get suggestion in different situations and they also get notified by the admin in an emergency.

The main contribution of our system is to integrate a lot of useful functionalities in a common platform which works both in online and offline. The system could act as a survival

assistant in any distressed situation as it has different informative functionalities such as:

- Weather update,
- Search for shelter during emergency
- Search for police stations, hospitals and fire stations
- Sharing location map by image sending
- Incident report shows in the map as well as in custom list view
- Incident report post from any location
- Providing survival strategy
- User's current location sharing through SMS
- Sending alert notification during crisis, etc.

We have discussed on some relevant papers in section II. In section III we have explained the system functionality with proper demonstration. Later we have shown experimental result and survey summary focusing the necessity of our proposed system. Section V contains some future extension of our work and finally we conclude the paper.

## II. RELATED WORKS

The world is terribly affected by natural calamities every year. A lot of work has already done to reduce the loss due to such disasters.

The author in [1] proposed a location based early disaster warning and evacuation system using Google Map. Updates of the disaster (tsunami, cyclone or flood) are put on DMS by the local weather office. To get automatic notification of upcoming disaster device user registers on Disaster Management Server (DMS) else the user can get manual notification. The user keeps in touch with DMS to get most renew data obtained by GSM. But the system does not work in offline and only shows the rescue team on the Google map.

Rekha Jadhav et. al in [2] presented Emergency Management System (EMS), which enables smart phone based ad-hoc communications at disaster times over Wi-Fi. The person in an emergency or anybody at the emergency site will call the EMS at avail service. Location Coordinates are sent on each request. The system works on the principles of client-Server system, wherein the server responds to the requests of the Clients. The Client and Rescue Application was Implemented as an Android Application and the Sever is implemented as a Web based Java Application. But their system only based on sending messages by the admin to the victim and they did not use any kind of map to show the location in their system.

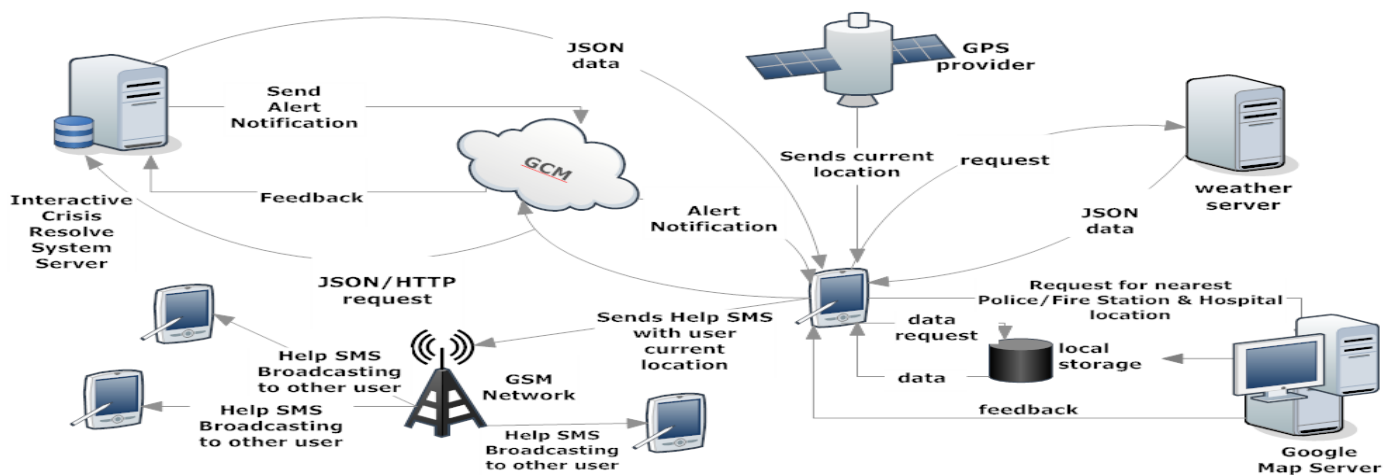


Fig. 1. System Architecture

A multi-faceted information portal is developed in [3] for citizens and emergency personnel during disasters and emergency response. This portal is the result of a collaboration between the RESCUE project at UC-Irvine and the City of Ontario, California Fire Department (OFD). The portal provides a wide range of real-time information in disaster situations, such as situation summaries, announcements, shelter information, and aggregated services such as family reunification and donation management. But the paper has a unclear demonstration of their system and they do not provide any emergency alert service generated by the user.

The authors in [4] developed a system named HelpMe, a self-learning opportunistic ad-hoc system, which enables smartphone-based ad-hoc communications at disaster times over Wi-Fi. As the system is implemented for ad-hoc network, it has a huge disadvantage if we consider distance matter.

T. Catarchi et. al [5] proposed a system which consists of a front- and a back-end layer. The front-end layer is composed of several front-end teams of first responders, and the back-end layer is an integrated peer-to-peer network that lets front-end teams collaborate through information exchange and coordination. But the system has very limited functionalities.

The authors of [6] proposed Area Mail disaster information service provided by NTT Do Como for tsunami alert and evacuation system for helping fishery workers. Area mail service capable of sending notification about damage due to disaster in limited areas, but for overall population it is an inefficient approach.

Australia and South Korea are planning to use satellite communication for disaster management when the failure of mobile network occurs [7], [8], [9].

After the tsunami that hit Sri Lanka on December 26 2004, the Sahana [10] FOSS (Free and Open Source Software) project was built. Key applications of Sahana projects are missing persons registry for finding missing persons, an organizational registry for a relief organization, coordination and tracking, request management system for tracking and matching

specific aid or relief requests and offers, camp and shelter registry, volunteer management, inventory management to track supplies, and situational awareness. But the problem is that it is a web based system and not responsive to use in portable device like mobile. Sahana Disaster Management System doesn't use any GPS system and doesn't support offline mode. So if any power disruption occurs during a disaster or crisis, the system will not work. Similarly, the authors in [11] also proposed a web-based system named 'The RESCUE Disaster Portal for Disasters and Emergency Response' and has the similar drawbacks.

The author in [12] proposed a disaster management system which can help the user to send his current location using GPS through a message and can see nearby shelter zone on the Google map. But the system cannot work in offline, has limited feature and does not have the capability to display the nearby hospitals, fire service or police stations which are crying need during a disaster.

S.Shanthini et. al [13] suggested an idea of sending alert service by a trusted party during a disaster. As a result, the registered user will be acknowledged about the upcoming disaster through a message or audio clip. But the user would not be able to report anything about any witness he observed and there is no opportunity for the user to generate alarm service if any problem arises.

A portable mobile phones can play an important role to resolve the crisis or disastrous situation in many ways, such as monitoring, communication, warning dissemination, evacuation, rescue and relief aid. Moreover, the approach of smart phones supporting GPS functionality can play a vital role in the crisis or disastrous situation management. There are plethora of applications that will benefit users in an emergency on a specific service. But none of them actually provides the integration of various functionalities in a single platform that works both in online and offline.



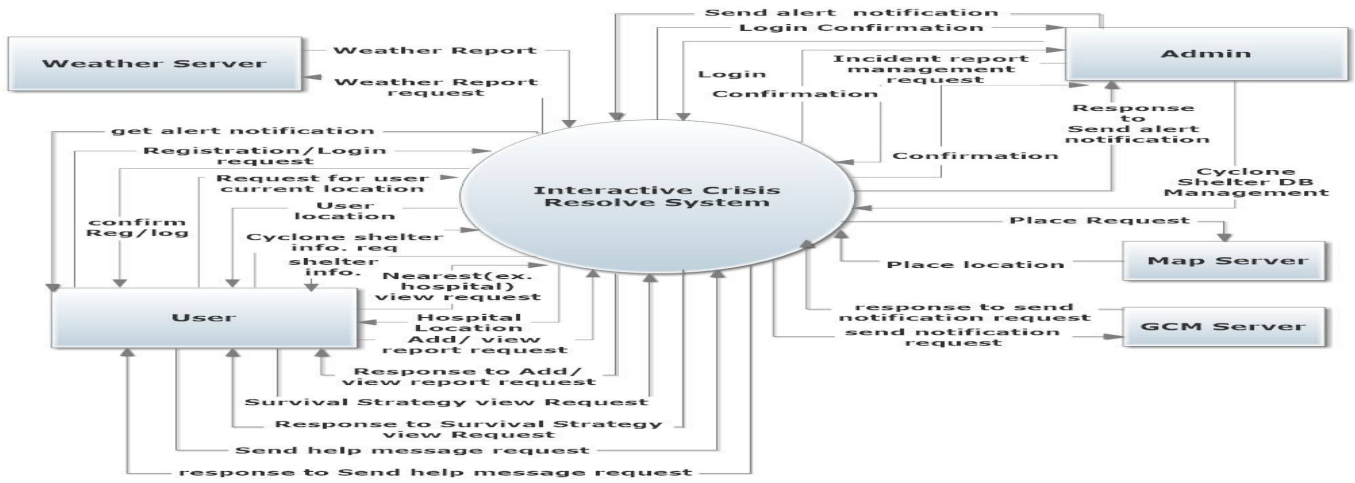


Fig. 2. Context diagram

### III. SYSTEM IMPLEMENTATION

#### A. System Architecture

The architecture displays the main components of the system (fig. 1). It shows the working of server database and android database, GPS and GCM cloud service. The server database information is fetched by sending HTTP request to the web server and the web-server provides the data in JSON format to android device. GPS satellite is used to get the current location.

#### B. Context Diagram

The context diagram of our proposed system is presented in fig. 2. Here we have propounded the overall data flow of our system among different entities. The main entities of our system are weather server, admin, user, map server and GSM and the data flows are shown by the arrow sign.

#### C. Mobile Application

Our proposed system is a mobile application named “Interactive Crisis Resolve System” and for the successful deployment of our system, we have used Eclipse IDE, JAVA, MySQL, SQLite, PHP, Java Script, JQuery, GCM (Google Cloud Message) service, GPS (Global Positioning System) and XML layouts.

1) *User registration and GCM registration process:* When a user does register for the first time in our application, on background a GCM registration process will issue a unique GCM id for user android device. After receiving a unique GCM registration id, our application will send GCM registration id along with user information to our server. Our server will store GCM registration id and user information in the database (fig. 3).

2) *Cyclone Center Module (Online Mode):* To implement this module initially we have stored district, upzila, union and cyclone shelter information in server side relational database table. We have also designed an interactive user interface for our mobile application end. At first user has to select the

mode, online or offline. By providing district, upazila and union information a disaster victim can find all nearest cyclone shelter locations according to the victim’s present location via the google map (fig. 4, 5).

3) *Cyclone Center Module (Offline Mode):* During an emergency or disaster situation power disruption or network failure can be occurred. So if there is no internet connection is available during crisis situations, the user can use our cyclone shelter offline module. If a user wishes to see the location of the shelter, an offline OpenStreetMap will display the shelter and user current location. To implement this module we have used SQLite offline database, Osmdroid library, and Mobile Atlas Creator. Using Mobile Atlas Creator we have computed an offline OpenStreetMap for Chittagong region (fig. 6).

4) *Nearest Police/Fire Station and Hospital location:* During an emergency situation, this module will find out the nearest police stations, fire brigade stations and hospital location within a radius limit based on user current location. Besides, user can search nearby police/fire station and hospital location for a specific location from the different part of the country shown in fig. 7.

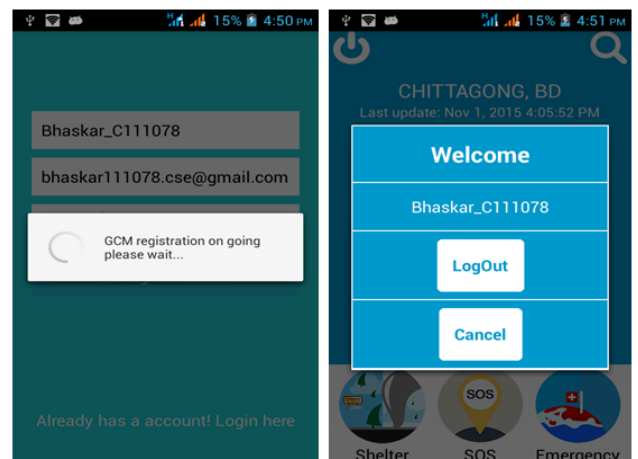


Fig. 3. User registration process

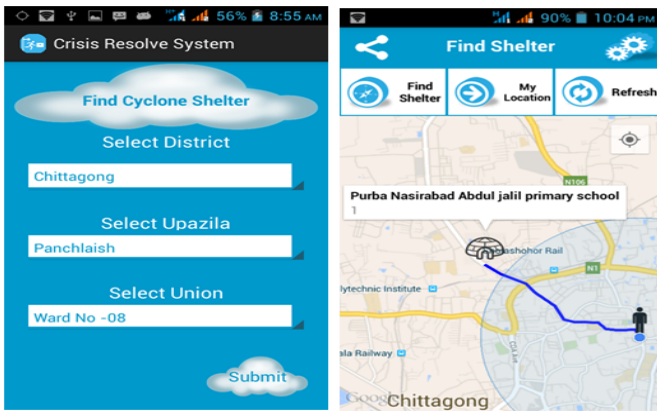


Fig. 4. Online cyclone center module

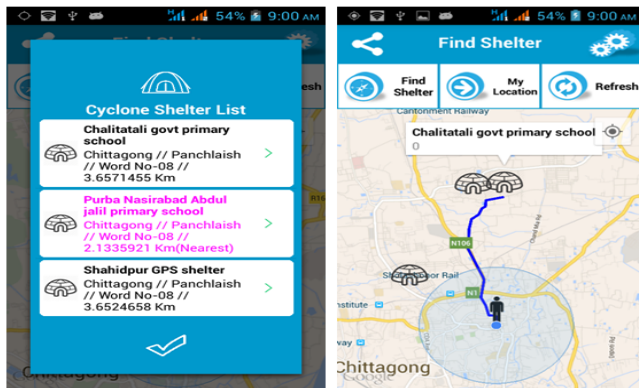


Fig. 5. Online Cyclone shelter details information with distance and path

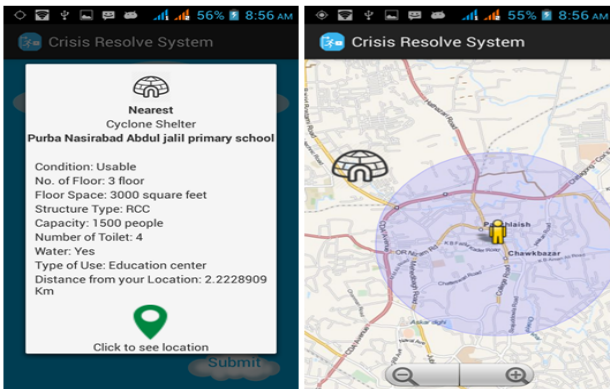


Fig. 6. Cyclone shelter details information with location (offline mode)

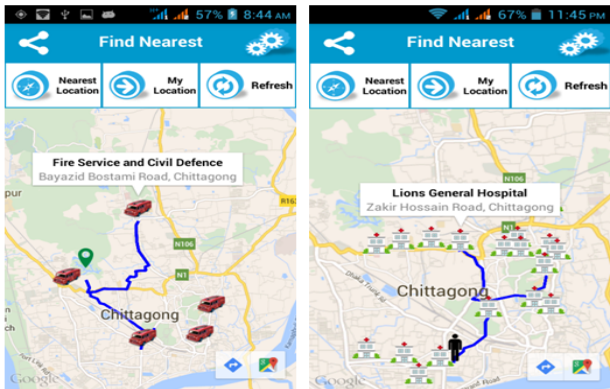


Fig. 7. Nearest Fire Station and Hospital location with path direction

5) *Incident Report Section*: In this module, report data will be collected from users. This module gives power to the registered user. A user could report what he knows or sees and other user instantly gets informed. A map will show all the events occurred in different location using different marker. If a user wants to report on any incident they have to pick a location from map, then a report form will be appeared. Report form contains title, incident type, severity level, source, description, impact statistics, photo, location and more. User can also take an image of the event instantly and attach it with the report. The user can search incident for a specific location or nearby to user current location. From the searched incident list user can view a specific incident's detail information. User can comment to share his opinion and can see other user comment about any incident (fig. 8, 9,10).

6) *Help Message Sending Feature*: Help message sending feature will let user to save some of his friends or family's phone numbers. This feature sends an alert to those pre-stored contact with a message alerting them that the user needs assistance. Here user can store three contact numbers and an emergency SMS. User can also update this information if needed. We used unique shared preference memory to store this information. So if a user logout anytime and login later to our application, he/she will get this information preserved. And this feature will work in offline mode.

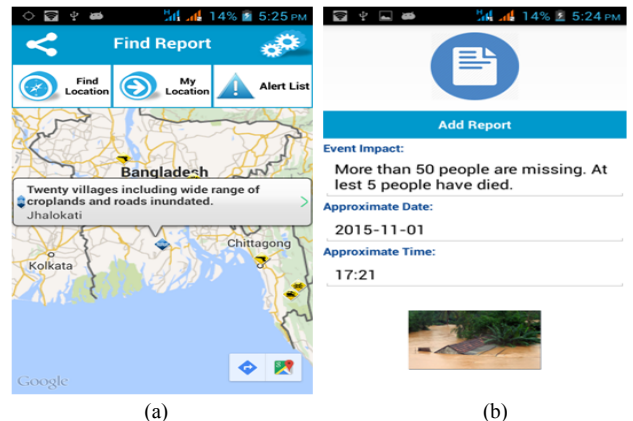


Fig. 8. (a) Incident report map (b) Reporting an incident

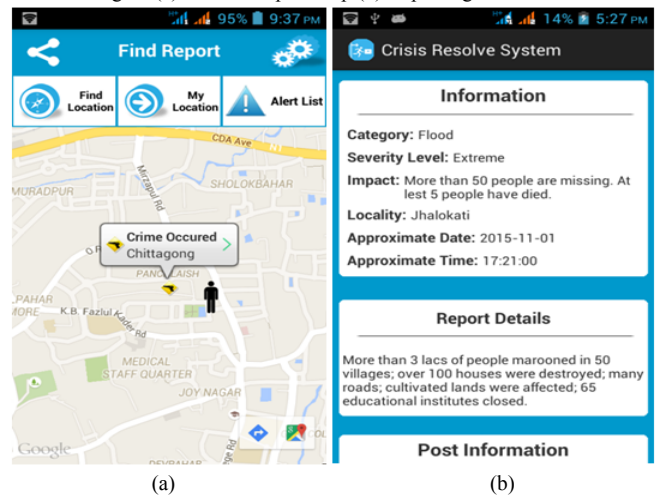


Fig. 9. (a) Report shows for a specific location (b) Detail of a report

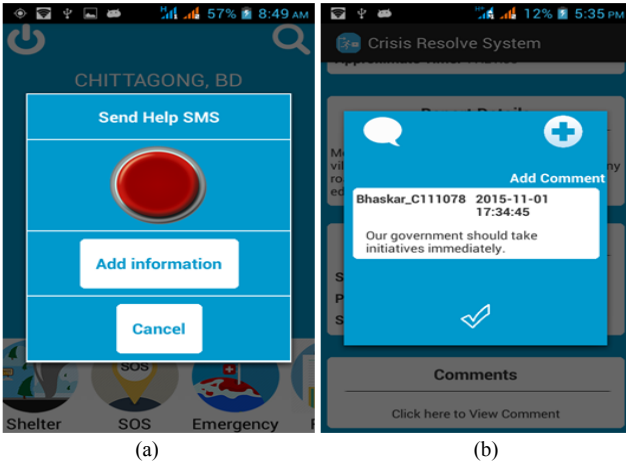


Fig. 10. (a) Help SMS Feature (b) User comment on a report



Fig. 12. (a) Survival strategy (b) Weather update for a specific location

7) **Push Notification Alert:** Govt. and institutions can send emergency alert to the citizens in emergency situations through our system. The push notification alert feature will help admin to send alert notification, such as alert signal, emergency news to registered user which is given in fig. 11. Whenever push notification is needed, our server will send a message to GCM(Google Cloud Message) server along with device registration id which is stored earlier in the databases. GCM server will deliver that message to all registered user mobile device using device unique registration ID. All registered user will receive this alert notification immediately. If any emergency contact number, web link is shared with an alert message, the user can directly call those numbers or visit those links from our application.

8) **Survival Strategy:** We know the world is constantly changing and becoming volatile each and every day. This feature includes instruction a person may use in those unexpected situations to save themselves. Here we have propounded a slight portion of this feature in fig. 12(a).

9) **Weather Update:** This feature brings all weather information available for the locations all around the world. The system generates current temperature, humidity, pressure, cloud condition for a specific location which is presented in fig 12(b).

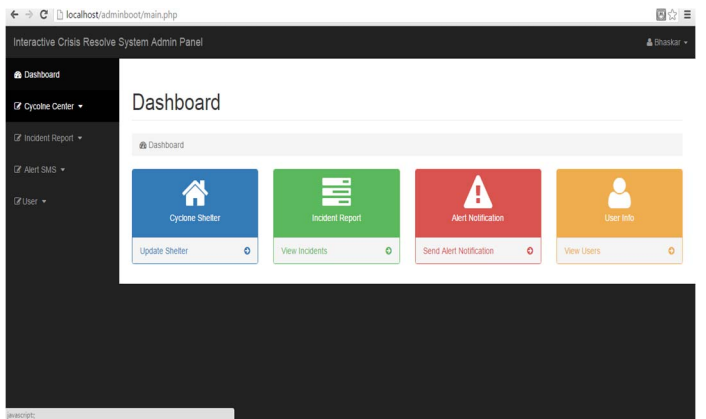


Fig. 13. Admin panel of the system

10) **Admin Panel:** In admin panel, the admin will be able to login, perform insert, update, delete operation on the shelter information table. Admin can verify, view and delete the incident report submitted by the registered user, send push notification alert to the users (fig. 13).

#### IV. EXPERIMENTED RESULT

After developing our system, we have tested it by assuming that a cyclone will hit the coastal region of Chittagong. We have selected 15 different users and installed our application in their smartphones. The total scenario is given with time in table 1.

TABLE I. TESTING OF THE PROPOSED MODEL

Time	Scenario
5.00 pm	The experiment starts. Suppose weather office has announced about a new warning of a cyclone in the coastal region of Chittagong.
5.05 pm	Admin panel sends alert message to all registered users in Chittagong.
5.06 pm	Users received the alert message.
5.07 pm	User search for nearby shelter location. The system tracks user current location and generate all the nearby

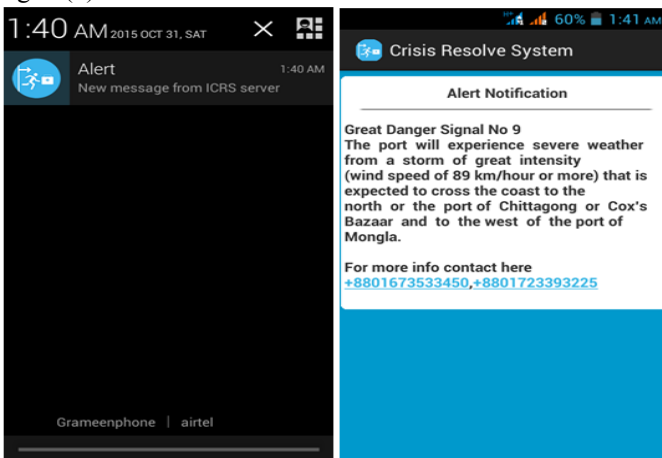


Fig. 11. Notification received by registered users

	shelter location pointing on the map.
5.08 pm	The user sends an image of a current location map and emergency help message to the pre-stored three numbers and follow the map.
5.18pm	Three people injured and need to admit in a hospital immediately. The user search for the nearby hospital at once and the system computes all the nearby hospitals with approximate distance and direction on the map.
5.21 pm	Create a report about the disaster incident in Chittagong city to other users.
5.23 pm	Other users comment and share their opinions.

We have analyzed the other disaster management systems and find out their qualities. After that, we have compared our proposed system model advantages than the related works and the result is given in table 2.

TABLE II.  
SOFTWARE QUALITIES IN SOME EXITING DISASTER MANAGEMENT SYSTEMS AND OUR PROPOSED SYSTEM MODEL

Disaster Management Systems	Software Qualities
Envimon [14]	Availability Interoperability
Intergraph GeoMedia® [15]	Interoperability Modifiability
Sahana [10]	Modifiability Portability Scalability Usability
Decision Support Systems [16]	Modifiability
Interactive Crisis Resolve System (our proposed system)	Availability Modifiability Interoperability Portability Scalability Usability

After constructing the application, we displayed it to various users to observe their responses. We installed the application in the user's smartphone and ask them whether the application is helpful during disaster situations. The user responses are pictorially shown in fig. 14.

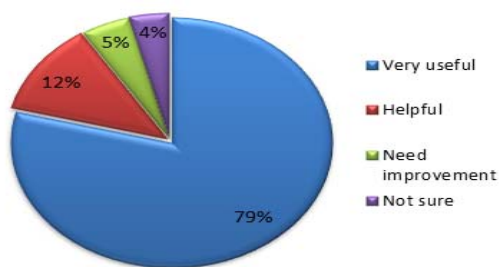


Fig. 14. User response

## V. CONCLUSION

Our proposed system can help a user to overcome in different crisis situations. The system not only help a victim in a disaster situation, but it also aware other people about any

unexpected incident. The push notification alert feature also helps administrator to send alert notification, such as, disaster alert signal, emergency news to the registered users. During natural calamities, when the network does not work properly, our system can work perfectly as it has the capability to work both in online and offline. In the future, we have a plan to make the system in Belgali and to implement the system in windows and iOS platform also. Hopefully, the system works as an rescue assistant and helps the user to tackle any hurdle situations.

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# Possible Asthma Attack Prediction From Air Pollutants

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**Abstract**— Asthma is a chronic, often devastating, condition that has no cure. In recent years, studies have shown that air pollution is a major cause of asthma attacks. Air pollution also may develop asthma in previously healthy people. Understanding what might trigger an asthma attack helps asthma sufferers keep their disease in control. Sometimes it is as simple as avoiding dust, tobacco smoke etc. Asthma attack triggered from air pollution could easily be avoided if there is a way to monitor air pollution level continuously in the surroundings. In this paper we have presented a system that will be able to predict possible asthma attack for individuals and alert them. The system is developed using an air pollutant monitoring device combined with an android application. Using supervised learning technique and analyzing (frequently taken) air pollutant data, the system will be able to create an air pollution map for cities for better pollution management.

**Keywords**- Air Pollution; Asthma; Sensors; Prediction; Smart City; Android App; Supervised Learning;

## I. INTRODUCTION

Air pollution is a major environmental issue and responsible for different respiratory and heart diseases. While there is no evidence that air pollution causes asthma, it can trigger attacks in people who have asthma. Many studies have found a link between air pollutants and the worsening of asthma symptoms [1]. Important outdoor air pollutants are particles, sulphur dioxide, nitrogen oxides, ozone, carbon monoxide and lead. Smoking, combustion of fossil fuel and organic matter, tobacco smoke and exhaust fumes increase these pollutants significantly in the air and causes exacerbation of asthma which often leads to hospitalization of asthmatic people. The impact of air pollution gets severe when outdoor and indoor pollution levels become high. Indoor air pollution arises from both outdoor pollution and indoor sources. Indoor (or in closed spaces like cars) tobacco smoking, using wood fuel or gas for heating and cooking, room full of dust etc.

causes indoor air pollution which is threatening for asthmatic people. Potentially, indoor air pollutants can greatly exceed outdoor levels.

Associations between particles, ozone, nitrogen dioxide and asthma hospital admissions have been confirmed in Sydney, Brisbane and Melbourne [2]. Studies in different regions of world, demonstrated an association between modest levels of particles (causing from bushfires or other sources) and emergency hospital attendances for asthma [3][4][5]. Another study found that exposure to nitrogen dioxide, nitrous oxide and carbon monoxide were positively associated with a higher prevalence of childhood asthma and exposures to particulate matter was positively associated with a higher incidence of wheeze in children [6].

It is important that people with asthma stay aware of air pollution level wherever they are. Knowing when and where air pollution would be high could be crucial to reduce attacks of asthma. Sometimes it is known simply by observing the air - for example, on a smoggy or hazy day. But often it is hard to know. In some part of the world, air quality forecasts and reports on local TV or radio are available which reports using the Air Quality Index (AQI) [7]. AQI is a simple color scale, to express how clean or polluted the air is. But availability of these kind of services are not found everywhere in the world. Also these services are not sufficient for instant increase of air pollutants due to sudden increase in car traffic, fire causing accidents etc. In this paper we have presented a system which will collect air pollution information from the environment in short intervals and make the user aware of the level of air pollutants in the air. This system is developed using a cheap air pollution monitoring device combined with an android application prototype. Using supervised learning and constant checking of pollutant level in the environment, the system will be able to predict possible asthma triggering situations and alert the user. Consequently, this will reduce such attacks. Also,

since the system collects location specific air pollution information, it will be possible to create an air pollution map smoothing the steps to create a smart and healthy city.

## II. RELATED WORK

Air pollution is one of the major threats of recent times. Evidently, many research works have been conducted in air pollution monitoring [8][9][10][11]. In [11], a comparative cost study of air pollution monitoring device was provided and a cheap device was also presented.

Many mobile applications have been developed for helping asthmatics in certain ways. Most of these help maintaining medication plans; keep tracks of attack causing incidents; provide what-to-do suggestions during attacks and a communication medium with doctors. To our knowledge, none of these applications provide any sort of air pollution monitoring using physical device to get actual pollution data to predict possible asthma attack triggers and alert the user. Mobile applications that provide air quality monitoring service are found but these either rely on costly external devices measuring one or two pollutants in air or some external AQI providing services. Also, these applications are not focused on reducing asthma attacks by learning user specific data and alerting the user.

## III. SYSTEM ARCHITECTURE

### A. System Design

The proposed system has two major components – a hardware and a software component. Hardware component measures air pollutants from environment in short intervals and send the data over to the software component to use. Software component receives the data, determines the location of the data and saves it into internal database with time information. Software component also records user input whenever they feel like facing asthma attack. Based on these available inputs from hardware component and user, software component then learns about the asthma attack triggering environment and evaluates the environment immediately after receiving input from hardware component. Data which are saved into the internal database get sent over to remote server whenever the user connects to the internet. A system context diagram is provided in figure 1.

### B. Hardware Component – Air Pollutant Measuring Device

For the proposed system we wanted to use a cheap device to minimize the cost of the system and maximizing the number of users of the system. We propose to use the device described in [11]. That device is made of arduino, three sensors and a Bluetooth module. It can measure airborne particles, nitrogen oxides, carbon monoxides, smoke etc. from environment. Details about the device and cost comparison can be found in [11].

### C. Software Component – Android Application

The software component of the proposed system is an android application. It records air pollutant measurement information from the hardware component in short periodic intervals and interacts with the user and a remote server. This component is installed on user’s smart phone. Hence, it can

access location and time information. It can save data internally and whenever user connects to the internet, it can send recorded data to remote server to create a central spatio-temporal air pollutant data repository. Details of this component are further discussed in section IV.

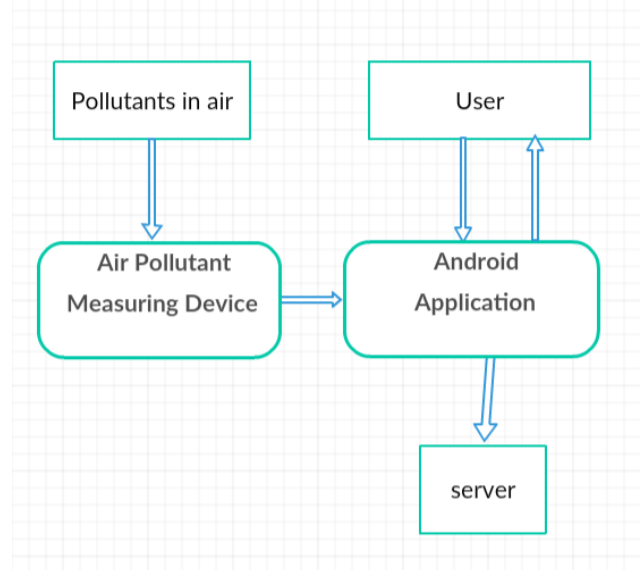


Figure 1. System Context Diagram

### D. Assumptions and Requirements

For the proposed system to work successfully, it is assumed that user of the system carries the hardware component with them. User needs to have smart phone with working GPS, Bluetooth and Network modules. One important requirement is that user proactively let the system record information about asthma attack without delaying much time so that the system can associate a particular set of pollution measurement data with the attack incident and could be stay aware of such scenario in future. No technical skill is required to use the system other than knowing how to use a smart phone.

## IV. ANDROID APPLICATION

### A. Application Architecture

The name of the android application is “Asthma Trigger Predictor” (ATP). The application is developed using Java programming language. It is compatible with any android version up-to Lollipop (Android 5) [12]. We have used Android SDK to build this app. Reason behind choosing android as the platform is that android based phones are usually inexpensive. A person can get an android phone with around \$40. This often will reduce the cost of deploying the system because most people who are going to use the system may already possess an android phone. Just installing the app in their phones will enable them to use the system if they have the air pollution measuring device. ATP will run in the background and will constantly receive data from the external component and analyze potential threats of asthma attack. User can turn the background process off and on whenever s/he wants. For

internal database management, we have used SQLite [13] as database server since it is open source and available within the android OS. Data will be sent to the remote server using XML format.

Important modules in the application are described below. Also, a screenshot of the application prototype is provided in figure 2.

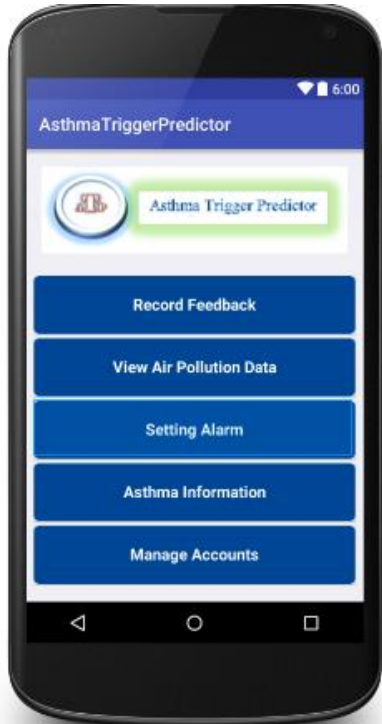


Figure 2. Home Layout in Asthma Trigger Predictor Prototype

### B. Registration and Tuning Module

Immediately after installing ATP in user’s smart phone, this module starts working. First a registration form is presented to the user so that user can provide certain information (name, email, date of birth, medication plan, emergency number etc.). Then ATP will look for the hardware component to connect using Bluetooth. To achieve this, ATP lists all Bluetooth devices nearby and user will tap on the hardware device listed there to permit ATP to establish a connection. From next time ATP won’t bother the user to go through this process again.

Once a connection is established, ATP presents the tuning interface to the user to start the learning process. At this point, it receives pollutant data from the hardware device for the first time. Then the application will try to figure out whether the received data represents clean air for the user or not by asking few things. For example, how the user is feeling at that moment; if s/he is feeling not well then, it will present an asthma attack symptoms list to choose from and so on. This process continues in short intervals till the application records a clean air. In this process, ATP gets to learn about good or bad environment relative to the user.

### C. Air Pollutant Data Collection Module

Once the tuning is done, ATP will start receiving air pollutant data periodically in short intervals (20minutes) or

whenever the user wants to receive data. This data contains amount of carbon monoxide, carbon dioxide, dust, nitrogen oxides, and smoke present in the air. After receiving these data, ATP will determine location using the smart phone’s GPS or AGPS or from mobile network. This pollution, location and time data will be packed together and saved in SQLite database used by ATP for further use.

### D. Asthma Attack Incident Recording Module

This module records asthma attack incidents which is crucial for the whole system to work successfully. Whenever asthma attacks the user or the user starts feeling like s/he is getting attacked by asthma or may be just feeling bad suddenly because of breathing problem, coughing etc. s/he should let ATP record the time, location and pollutant information via this module. It is advisable that the user records the incident within 20 minutes of incident. This module ask for few inputs (symptoms of asthma attack) to determine the intensity of the situation and then collects the location, time, pollutant amount. Gathering these data, ATP stores these data along with user inputs in the database for learning purpose.

A safety model is then automatically created/updated from the records of these incidents. This model helps to determine a threshold value of each pollutant recorded by the device which is significant to that specific user. To update the safety model, the algorithm in figure 2 is used.

The updateModel function retrieves all records in recordSet from the database. Then, values of each pollutant in each of the recordSet are appended to respective list of pollutants. After that, minimum values in each those lists get assigned in respective threshold variables. At last these threshold variables are stored / updated in the database for prediction purpose.

```

1 public void updateModel(){
2     List<Record> recordSet = getAllRecordsFromDB();
3
4     List<double> coValueList = new ArrayList<double>();
5     List<double> noValueList = new ArrayList<double>();
6     List<double> smokeValueList = new ArrayList<double>();
7     List<double> dustValueList = new ArrayList<double>();
8
9     for(record in recordSet){
10        coValueList.add(record.coValue);
11        noValueList.add(record.noValue);
12        smokeValueList.add(record.smokeValue);
13        dustValueList.add(record.dustValue);
14    }
15
16    double thresholdCO = minimum(coValueList);
17    double thresholdNO = minimum(noValueList);
18    double thresholdSmoke = minimum(smokeValueList);
19    double thresholdDust = minimum(dustValueList);
20
21    updateCOThresholdInDB(thresholdCO);
22    updateNOThresholdInDB(thresholdNO);
23    updateSmokeThresholdInDB(thresholdSmoke);
24    updateDustThresholdInDB(thresholdDust);
25 }

```

Figure 3. Update Model Algorithm

### E. Probable Attack Predicting Module

To predict probable asthma attack triggering situations this module compares currently taken values of each pollutant in the air with respective threshold values determined and saved previously in the database. It runs as a background process and after receiving each input set from the hardware device, this comparison gets done once. If the current value of any of the pollutant is very close to its threshold value, then this module alerts the user immediately using alarm tone and requests the user to take safety precautions.

### F. Bulk Data Sending Module

This module creates a well formatted XML file containing the spatio-temporal air pollutant data from the application's internal database and sends over the XML file to a remote server where all other same systems would be sending more XML files eventually helping to create a huge spatio-temporal air pollutant data repository which could be used in many useful services like generating a high quality air pollution map etc. To send over the data, this module looks for user permission and internet connection. Also, it keeps tracks of previously sent data to stop sending same data over and over again.

## V. FUTURE WORK

In future we hope to deploy the proposed system to hundreds of concerning asthmatics through adding more useful features in the android application. Eventually a huge amount of spatio-temporal air pollutant data would be available in a central server. Then it will be possible to tune the performance of the application since we will have data to evaluate the prediction process. For example, we will be able improve the learning process of the android application for better prediction using regression analysis on different pollutants and principal component analysis on different persons' asthma attack incidents.

Using that spatio-temporal data, a highly dense, almost real-time, air pollution map of a country can be created. A lot of other service applications can be developed and deployed to improve public health in general.

## VI. CONCLUSION

Ability to collect air pollution data constantly (in short intervals) can help monitoring air pollutants in the environment and help controlling adversities due to the pollution. In this paper we have presented such a system that will help asthmatics by alerting them about potential asthma attack triggering environments in advance. This will decrease hospital

admissions due to asthma wheezing. Also, knowing about the pollution level will help preventing other severe respiratory and heart diseases. Furthermore, since the collection of pollutant data has location data associated with it, a high quality air pollution map could be created subject to the wide use of the system. This map will further help concerning people and government to take important decisions for the betterment of the health of the entire population; eventually creating a smarter and healthier environment.

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# Computer Based Spectrum Analyzer Design Using Microcontroller

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**Abstract**—FFT-based digital spectrum analyzer has become nowadays more and more widely used as a result of the development of Digital Signal Processing (DSP) techniques. Traditional spectrum analyzers might provide snapshots of the signal in the frequency domain and the time domain, but this is often not enough to describe the dynamic RF signals produced by the device. Moreover, it's not economically justified and therefore is not available. Thus our objective is to design a microcontroller and FFT based spectrum analyzer system with a maximum degree of integration, which is compact and provides large cost-savings as well as accessibility. The design consists of both hardware and software part where a specified signal is converted from analog to digital via A/D converter, interfaced through microcontroller and acquired the resultant spectrum using MATLAB.

**Keywords**—A/D conversion, Frequency domain, FFT, Microcontroller.

## I. INTRODUCTION

Signal is a function that conveys information about the behavior or attributes of some phenomenon. In the physical world, any quantity exhibiting variation in time or variation in space is potentially a signal that might provide information on the status of a physical system or convey message between observers [1]. Electrical signals can be measured in two ways. One is time domain measurement which is done with an oscilloscope and the other is the frequency domain measurement which is done with the aid of a spectrum analyzer. The spectrum analyzer is basically a laboratory instrument which is used to display signal amplitude (on the vertical axis) that varies by signal frequency (on the horizontal axis). The frequency domain measurement has its advantages over time domain measurement. Determination of the harmonic distortion of a signal has significant effect on analysis of any system. Moreover a great number of telecommunication systems such as FDMA or FDM based, are congenitally frequency domain oriented. A frequency domain analyzer can give information to reduce noise by proper system design, as it has the ability to narrow the measurement bandwidth [2]. Previously, swept-tuned super heterodyne analyzers were used to measure only amplitude. However, with the advancement of technology and communication systems, spectrum analyzers are of various types. Initially, there were two apparatus for spectrum analysis; Fourier Analyzer and Swept-tuned Analyzer. Nowadays, Network Analyzer and Real-time

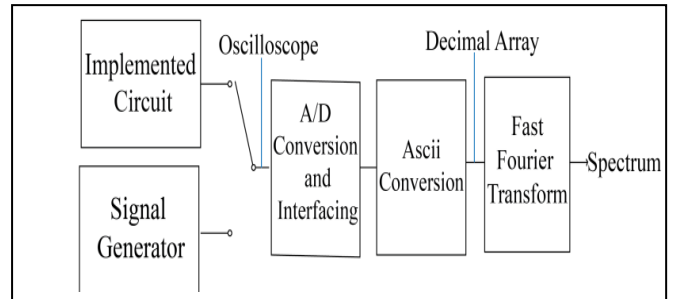


Fig. 1. Block diagram of implemented system

Spectrum Analyzer are also available for further measurements of the signal. In this study, to materialize our desired spectrum analyzer, at first we have implemented a circuit which multiplies two signals of different frequencies and filters the signal to get the desired frequency. Then, it amplifies the output of the signal to increase its strength. This obtained analog signal is at first digitized by using an A/D converter (ADC0804). This digital data is sent serially to the PC through interfacing by using an 8051 microcontroller (AT89S52), a buffer driver (MAX232) and a USB to RS232 Serial Converter. In PC, the digital data is received through RS232 port in ASCII form by Hyper Terminal, a Windows XP application. This ASCII data can finally be converted to decimal, binary or hexadecimal form by using the ASCII converter. In our hardware project, we used the decimal values. Taking the decimal values as input of the MATLAB code generated for FFT, we get the frequency spectrum of the signal.

## II. EQUIPMENTS

Hardware parts included in implemented circuit part (BC548a transistor, UA741 op amp, BD135 transistor, Signal generators, Oscilloscope, DC supply, Capacitors and Resistors), A/D conversion part (ADC0804, Microcontroller AT89S52, Resistor, Capacitor and 11.0592MHz Crystal) and Interfacing part (MAX232, Male to Male Jumper Wire, Male to Female Jumper Wire, Capacitor, and USB to DB9-RS232 Serial Cable). P-Spice, Hyper terminal, ASCII converter and MATLAB software were also used for designing and implementing our spectrum analyzer.

### III. SPECTRUM ANALYZER DESIGN

#### A. Technical Aspects of Some Practical Spectrum Analyzers

Poormans spectrum analyzer was one of the first invented low cost spectrum analyzers. Its price was about \$150 and was invented in 1982 by Frank H. Perkins [3]. That could be used to check HF transmitting equipment whose range was about 0-60MHz. It was useful for checking low pass filter performance and band conditions. In 1986, low cost spectrum analyzer with kilobuck Features was invented which cost only \$50 [4]. A varactor tuned TV tuner was used that covered the VHF low (50-88 MHz), VHF high (135-220 MHz) and UHF TV (500-800 MHz) bands. The integrated circuits used were oscillator, dual ceramic filter, IF amplifiers/detector, and audio amplifier. In 1998, the most desired invention was the radio frequency spectrum analyzer by Wes Hayward and Tenny White [5]. Its region was about 50KHz-70MHz with double conversion super heterodyne design. It could be easily extended into VHF or UHF region. Besides, it was narrow tuning range analyzer which examined transmitter sideband suppression and distortion. But it needed extensive shielding and its output had spurious response. Within \$50, another analyzer was invented by Scott Armitage in 2006, which was low cost 2.4 GHz spectrum analyzer. Here a CC2500 chip was used which was a 2.4-ghz transceiver [6]. Atmel's atmega48 processor was used to control that chip. A commercial PC controlled the hardware and displayed the results of spectrum analysis. To connect the PC to microcontroller, a USB-to-UART bridge chip called CP2102 was used. Now, new versions of CC2500 are available among which the cheapest is Nordic (nrf24l01). Its data rate is faster. This chip had sophisticated packetized data transfer and forward error correction. In 2013, android based spectrum analyzer was invented by Prasanna Shete, Aditya Kurude, Mayur Bhole and Tushar Khose [7]. It is a new concept of analyzing the signal in frequency domain using application based on Android OS. This proposed system has four major blocks: signal conditioning block, microcontroller, Bluetooth module and Android device. Signal conditioning block is LMP7312 programmable amplifier/attenuator that is connected to the microcontroller via SPI bus. This signal is then transmitted to Bluetooth device via UART. Bluetooth module LMX9838 transfers them to android device. Java based application performs FFT on them and displays the spectrum of signal. It is a portable handheld device whose processing power is high. But as it is a window based design, its frequency range of operation is limited up to 20 kHz. Error shows in result for above this range. Finally in 2015, a spectrum analyzer based on the idea of Software Defined Radio (SDR) was proposed by Zhu Hengjun and Wang Wenxing [8]. The design is divided into three signal input module, signal processing module and signal output module. Firstly, the input signal is modulated by signal conditioning circuits, then converted into digital signal by A/D converter. After the data is sampled by STM32, it is transformed for processing by FFT and then transferred to the TFT-LCD display or send to computer for further processing. Its performance is mainly affected by CPU speed, ADC speed, output speed etc. This method is flexible and has wide measuring range, but there are some shortages such as complicated design etc.

#### B. Spectrum Analyzer Basics

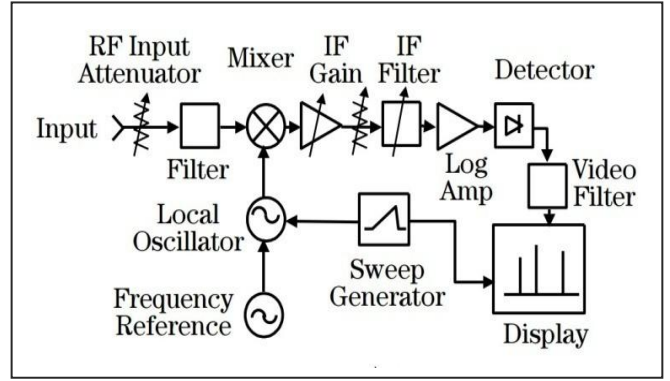


Fig. 2. Block diagram of a basic swept-tuned spectrum analyzer [10].

Swept-tuned Analyzer is the most widely accepted general purpose spectrum analyzer which enables frequency domain measurements over a large dynamic range and a wide frequency range. Here, the superheterodyne technique is used i.e., to translate super-audio frequencies or frequencies above the audio range, shown in Fig. 2. The swept-tuned analyzers sweep across the frequency range of interest where all the frequency components are displayed [9]. The input signal goes to the mixer through LPF and RF attenuator which reduces the level of distortion product. The signal is then combined with the Local Oscillator (LO) through the mixer to convert it into an Intermediate Frequency (IF). IF filter indicates the presence of a signal at the analyzer's tuned frequency. The output voltage of the detector drives the vertical axis (amplitude) of the LCD display. Sweep generator provides synchronization between the horizontal axis (frequency) and tuning of the LO. The resulting display shows amplitude vs. frequency of the spectral components of each incoming signal.

#### C. Spectral Estimation Techniques

Spectral estimation means estimating the spectral density of a random signal from a sequence of time samples of the signal. Its usually based on the procedures which employs the fast fourier transform (FFT) [11]. But FFT approach has some inherent limitations and that's why many alternative spectral estimation techniques have been proposed within the last decade. Some of them are presented below [12]. This technique is used to find the energy spectral density and the power spectral density of the signal. Consider a deterministic analog waveform,  $x(t)$  is a continuous function of time. If  $x(t)$  is absolute integral, i.e., the signal energy  $\varepsilon$  is finite then it is written as,

$$\varepsilon = \int_{-\infty}^{\infty} |x(t)|^2 dt < \infty \quad (1)$$

The squared modulus of the Fourier transform is often termed the spectrum,  $\delta(f)$ , of  $x(t)$ ,

$$\delta(f) = |X(f)|^2 \quad (2)$$

where,  $X(f)$  is the continuous Fourier transform of  $x(t)$ . Parsevals energy theorem, expressed as,

$$\int_{-\infty}^{\infty} |x(t)|^2 dt = \int_{-\infty}^{\infty} |x(f)|^2 df \quad (3)$$

This is a statement of the conservation of energy; the energy of time domain signal is equal to the energy of frequency domain transform. Thus  $\delta(f)$  is an Energy Spectral Density (ESD) in that it represents the distribution of energy as a function of frequency. If  $x(t)$  is a wide sense stationary, stochastic process the quantity of interest is the power distribution with frequency. The Wiener-Khinchin theorem states PSD is the forward Fourier transform of autocorrelation function of  $x(t)$ . There are various approaches used for spectral estimation, such as-

**Modeling and Parameter Identification Approach:** This technique is based on a model which is a three step procedure. The first step is to select a time series model. The second step is to estimate the parameters of the assumed model using either the available data samples or autocorrelation lags. The third step is to obtain the spectral estimate by substituting the estimated model parameters into the theoretical PSD implied by the model.

**Maximum Likelihood Method (MLM) Approach:** In maximum likelihood spectral estimation (MLSE), originally developed for seismic array frequency-wave number analysis, one estimates the PSD by effectively measuring the power out of a set of narrow-band filters.

**Other approach:** Autoregressive PSD Estimation Approach, Pisarenko Harmonic Decomposition Approach etc.

#### D. Implementation of Designed Circuit:

In our circuit, we have combined a multiplier, a filter and an amplifier circuit. In multiplier portion, we used a  $\mu\text{BC548A}$  transistor where a source generates the message to be transmitted. Its amplitude is 1V and frequency is 312Hz. Another source generates the carrier signal with 15V and 1.458 KHz. Here we have a variable gain since the transconductance varies. After filtering it with the capacitor, we get multiplied signal having frequency of 1.38 KHz. Due to elemental loss, frequency reduces. The signal is then filtered by narrow bandwidth filter using A741 OpAmp. We have designed the filter for 251 Hz signal. But, by varying resistor the signal can be filtered at any range from 100Hz-1.3 KHz. Then the signal is amplified by class-A amplifier using BD135 transistor [13] [14] [15].

A microcontroller based spectrum analysis technique is used in the experimentation. This technique involves the operation of converting the analog data into digital form by using ADC0804 and sending it to PC via serial communication using 8051 microcontroller (AT89S52). The circuit used for this operation comprises three parts: ADC0804, Microcontroller AT89S52 and Serial Port [16].

ADC0804 is a single channel A/D convertor of 8 bit resolution with the step size of 19.53mV (5V/255bit). The time taken by the ADC to convert analog data into digital form

depends on the frequency of clock source. The frequency is given by the equation,  $f = 1 / (1.1RC)$ . ADC0804 can be given clock from either an external source or an internal clock.

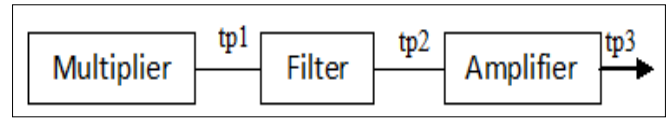


Fig. 3. Block diagram of designed circuit.

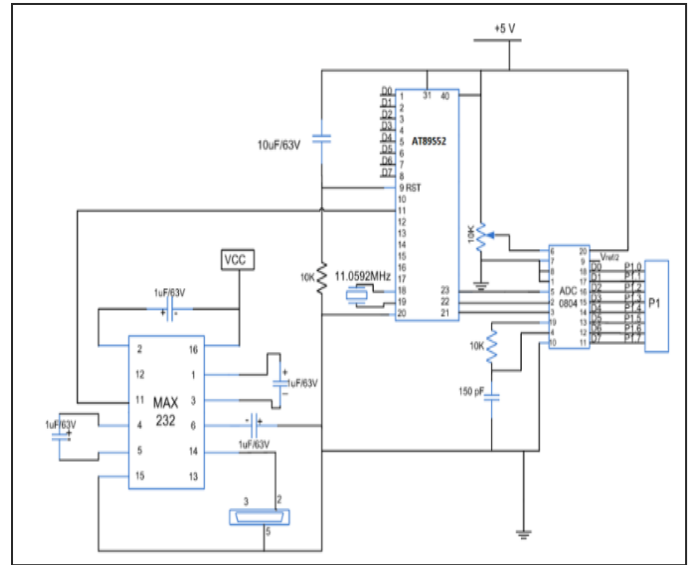


Fig.4. Circuit diagram for A/D conversion and for transmitting the data serially into PC.

However, the conversion time cannot be more than 110  $\mu\text{s}$ . In our circuit, a capacitor (150pF) and a resistor (10K) is connected to ADC to use the internal clock and to get the sampling frequency of 10 KHz.  $V_{in}$ , which is the input pin of ADC0804, is connected to the output of class-A amplifier at tp3 [17].

Microcontroller AT89S52 is used to provide control signals to the ADC. The control pins of the ADC i.e. the write, read and interrupt pin are connected to the respective pins of microcontroller. CS pin of ADC is directly connected to ground. To start the conversion, a low to high pulse is sent to pin WR. The INTR pin should be kept in monitoring. This pin goes low when the conversion is over. Finally, to bring the converted data on the output pins, a high to low pulse is sent to the RD pin. The output pins of ADC0804 are connected to port P1 of the microcontroller. The data coming on the port P1 is stored in the SBUF register of the MCU. The serial communication of microcontroller with PC is done using the TxD pin of the microcontroller AT89S52. The serial communication is done in the asynchronous mode. AT89S52 has an inbuilt UART (Universal Asynchronous Receiver/Transmitter) for carrying out serial communication.

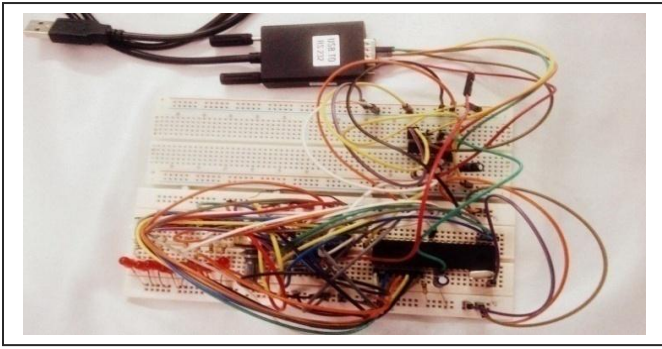


Fig. 5. Implemented circuit for A/D conversion and interfacing

TABLE I. VOLTAGE RANGES FOR RS232

Bit	Voltage Range (in V)	
0	+3	+25
1	-25	-3

A serial port is a physical interface to establish data transfer between computer and an external hardware. This transfer, through serial port, takes place bit by bit. DB-9 RS-232 version of serial I/O standard is used in our project for this purpose. In RS232, high and low bits are represented by following voltage ranges:

The voltage levels of RS232 and TTL logic are not compatible with each other. Therefore, to convert the microcontroller output voltage level to RS232 voltage level, IC MAX232 is required. The connection of MAX232 with PC and the controller is shown in the circuit diagram [18].

AT89S52 microcontroller can be programmed to transfer and receive serial data at different baud rates using software instructions. Timer1 is used to set the baud rate of serial communication for the microcontroller. In our program, Timer1 is used with auto reload setting. The baud rate is fixed to 9600bps by loading 0xFD in the TH1 register. The value 0x50 is loaded in the SCON register which will initialize the serial port in Mode1.

In our study, we have used HyperTerminal, a Windows XP application, to receive serial data through RS232. HyperTerminal shows characters corresponding to the ASCII values 0-255. The ASCII values are then converted to their corresponding decimal values. We have done this ASCII to decimal conversion by using ASCII Converter. Then we have written the program of FFT on MATLAB where we have used these decimal values as input. After running the program we have got the frequency spectrum of the input analog signal [19].

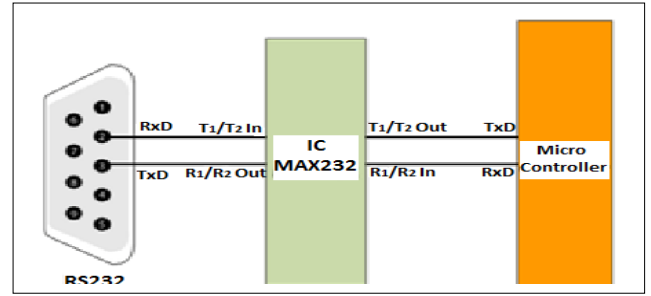


Fig. 6. Connection of MAX232 with computer and microcontroller.

## IV. RESULTS

### A. P-Spice Based Simulation Study

In the multiplier portion of our implemented circuit we have used two signals: (i) 1.45 KHz and 15 volt peak and (ii)

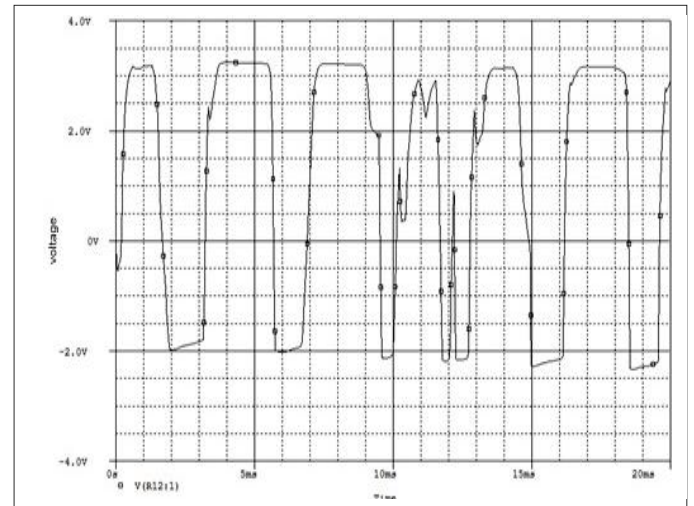


Fig.7. Wave shape of amplified signal in time domain of tp3.

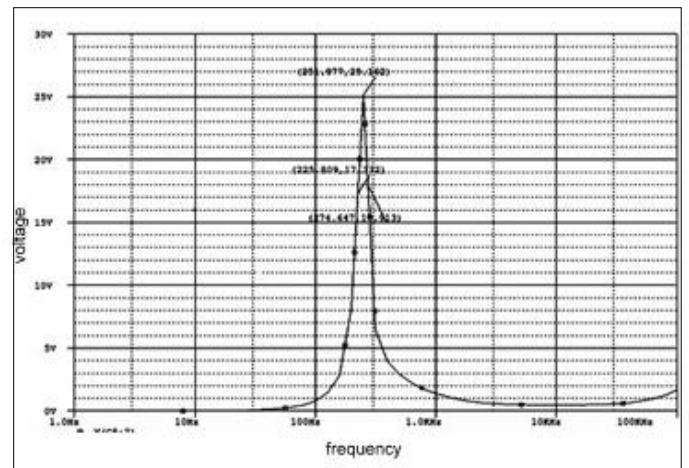


Fig.8. Wave shape of amplified signal in frequency domain of tp3.

312Hz and 5 volt peak. The multiplied output was 1.38 KHz and 1.6volt peak-peak, which was slightly different from

desired frequency. Though the output should be given 1.76 KHz signal, it gives 1.38 KHz due to instrumentation limitation. Then the signal is filtered which has 1.3 KHz and 500 mV (p-p). Our implemented circuit filters 1.38 KHz signal to 251 Hz signal as we designed a narrow band-pass filter. Last we get amplified signal whose frequency is same as filtered signal but amplitude is 3 volt p-p. We have observed time domain signal of multiplier output (tp1), filter output (tp2) and amplifier output (tp3). Fig. 7 shows the output of tp3.

**B. Experimental study on our microcontroller based spectrum analyzer system:**

The 251Hz output analog signal of implemented circuit from tp3, shown in Fig. 3, is sent to the input terminal of the A/D converter circuit, showed in (Fig. 9(a)). The A/D converter digitizes the analog signal and sends the digital data to the input of 8051 microcontroller. The microcontroller then sends the digital data serially to the computer with the help of a buffer driver and a USB to RS232 Serial Converter. In computer, the digital data is received through RS232 port in ASCII form by Hyper Terminal, a Windows XP application.

ASCII data for the signal of 251Hz: `ï ÿ ÷ p ? ó ÿ ý þ â ô ý ÷ Æ ü ÷ p Z ü ø ¶ û à ù þ þ Æ ï ý û d 7 þ þ ø □ ý þ ñ ð ü Ë ü þ 3 ü ï . x ü ñ Ì þ Ð ù þ ø î ù E _ ÷ ñ ° û ã ñ û Æ ü þ þ 1 ù ü - q û î Ì à î ù ° ù ÷ ` c ø ú - ü ý à ø þ ü ° ù û ? î ó □ ü ö ó Û ï þ ï þ 8 g ÷ ó ç ý à ù ý û ° ï ÷ P c ñ ï , ø þ Û ë û °`

This ASCII data was finally converted to decimal form by using the ASCII converter.

Decimal data for the signal of 251 Hz: 239 253 247 112 63 243 239 253 254 226 244 253 247 192 15 252 247 112 90 252 248 182 251 224 249 254 254 192 15 239 253 251 100 55 254 254 248 127 253 254 241 240 252 203 3 252 254 160 51 252 239 46 120 252 241 207 254 208 1 249 254 248 160 31 238 249 69 95 247 241 176 251 227 241 251 192 252 254 254 49 249 252 30 113 251 238 207 224 2 238 249 176 31 249 247 96 99 248 250 175 252 253 224 248 254 252 176 15 249 251 63 239 243 127 252 244 243 220 239 254 160 31 239 254 56 103 247 243 191 253 224 1 249 253 251 176 31 239 247 80 99 241 239 184 248 254 220 235 251 176

Finally, using these decimal values as the input of FFT algorithm, we found our desired signal in frequency domain, (Fig. 9(b)). We can see that our signal's cut off frequency is 251Hz as predicted for our designed circuit.

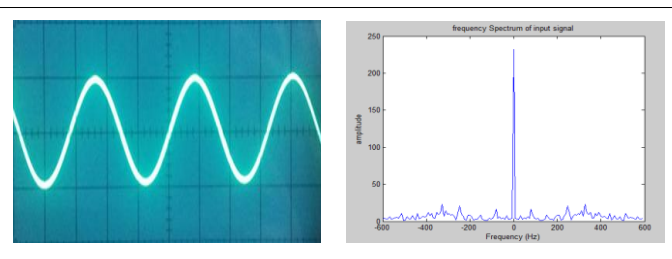


Fig. 9. Wave shape of amplified signal in time domain and frequency domain of tp3.

We have examined our system with multiple frequencies as input. We are showing the result of 400Hz as an example.

ASCII data for the signal of 400 Hz: `ÿ ÿ ÿ þ ÿ ? û ÿ ÿ ö ` ö ý ÿ ÿ ó ÿ ü ý ú Æ ? ÿ ÿ ÿ ÿ ù ÿ ÿ ÿ Æ ð ÿ ÿ ÿ þ ç û ÿ ÿ ï ù ÿ ÿ ÿ ð þ þ ÿ þ Ð □ ý ÿ ÿ ÿ ÿ ù ÿ ÿ ÿ ÿ ÿ ÿ ÿ ÿ ÿ à ß þ ÿ ÿ ð û þ ÿ ÿ ð þ ÿ ÿ ÿ Ë - ÿ ÿ ÿ ö @ ÿ ü ÿ ÿ ê ý ÿ ÿ ú ° ÿ ÿ ÿ ÿ ÿ ÿ ÿ ÿ ÿ ÿ ÿ ÿ ÿ ÿ ÿ ÿ ÿ þ Ð ç ù ÿ ÿ ÿ ó ÿ ÿ ÿ ÿ ÿ ÿ ÿ ÿ ° þ ÿ ÿ ö û ÿ ÿ ÿ à û þ ÿ ÿ ø ÿ ÿ ÿ ÿ ÿ ÿ ÿ þ î ÿ ÿ ÿ ÿ ÿ ÿ ÿ ÿ @ û ÿ þ ÿ à ý ÿ ÿ ÿ ° ÿ þ þ ÿ ÿ ÿ ÿ ÿ þ ÿ ÿ ÿ ÿ ÿ ÿ ÿ ÿ ÿ ÿ ÿ ÿ ð ø þ ÿ ÿ Ø ÿ ÿ ÿ ÿ • ö ÿ ÿ þ ÿ ÿ ÿ ÿ þ Ð □ ï ÿ ÿ ÷ P ÷`

Decimal data for the signal of 400 Hz: 6 255 255 255 254 3 255 63 251 255 255 246 96 246 253 255 255 243 15 4 255 252 255 250 192 63 4 255 255 255 255 249 4 255 255 255 229 245 255 255 255 254 191 251 255 255 239 249 255 255 255 3 244 254 254 255 254 2 208 127 253 255 255 2 255 252 255 255 255 2 255 255 255 255 255 224 223 3 254 255 255 240 16 251 254 255 255 240 254 255 255 255 200 175 1 255 255 255 245 6 64 255 252 255 255 234 15 253 255 255 250 176 2 255 255 255 255 255 255 255 255 2 255 252 3 255 255 254 208 191 249 4 255 255 255 243 255 255 255 4 255 15 250 255 255 255 176 254 2 255 255 246 251 4 255 255 255 3 224 251 254 255 255 3 248 255 4 255 251 255 1 255 255 1 255 254 238 15 6 255 255 255 255 2 160 1 255 255 255 253 64 251 255 254 255 3 224 253 255 255 255 176 255 3 254 254 255 255 255 255 254 23 1 255 255 255 249 144 255 251 255 1 255 240 248 254 255 255 216 31 255 255 255 255 144 245 255 1 255 254 4 255 255 4 255 255 254 208 127 252 255 255 247 80 247

**V. CONCLUSION**

1. In our implemented circuit there were some problems which can be sorted out by proper adjustments. Due to unavailability of required components in local market our filter circuit was not efficient enough to give the required result in experiment as expected from simulation based study.
2. The analog signal was digitized by A/D converter and was sent serially to the PC through interfacing. The problem arose here was that it cannot interface a signal with frequency greater than 600 Hz. Because, the baud rate which we are using for transmitting the data to PC is 9600 bps. As a result, for a sample consisting of 8 bits, the sampling frequency becomes  $(9600/8) = 1200$  samples/second. Thus, to maintain Nyquist rate and for the reconstruction, the analog signal should not be greater than 600 Hz. The solution to this problem lies in the selection of proper microcontroller having baud rates greater than 9600. If the baud rate increases, this circuit can interface any signal of both higher and lower frequency.
3. The method that we used in this project was simple, comprehensible and effective. The entire circuit design costs around \$25 (2000BDT), which is very low compared to other spectrum analyzers available in market. Moreover, it is compact, light-weight and can be used anywhere using any computer. Hence, it's easily available for anyone. But we have

to use computer and oscilloscope to obtain the desired spectrum in our study.

4. Any android device (for example mobile phone) can be used as an alternative to computer. The interfacing part can be further improved by using Bluetooth module. The digital data can be transmitted to Bluetooth device via UART. Bluetooth module can transfer them to android device. Java based application, installed on the android device can accept the samples by sending data request to the microcontroller and then it can perform FFT on them and display the spectrum of signal.

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# Design and Implementation of Microcontroller Based Automated Water Level and Temperature Controller System

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*Abstract*—Proper distribution and control of water at a constant temperature in irrigation and garment industries would cause increased productivity. Wastage of water occurs in residential buildings due to improper control of water pump. Therefore, this paper presents a microcontroller based system having continuous and precise monitoring of water level and temperature value, and accordingly automates water and temperature controller. The system will provide an improvement on existing systems by its use of a non-contact ultrasonic sensor for measuring the water level, maintaining the temperature of the water at the desired range and having a correction for temperature effect on sensor measurement. Thereby water cleanliness and precise water level are acquired. The output information of sensors is displayed on LCD with few seconds delay. Moreover, this approach is applicable in pool and geyser system. Some sensors are proposed to enhance the performance of the system.

**Keywords**—water level controller, temperature controller, water quality, ultrasonic sensor, heater.

## I. INTRODUCTION

Many water level controlling and monitoring system have been invented. Major drawbacks of these systems include discontinuous and imprecise value of water level notification, high cost, and not maintaining water quality [1]. Existing system lacks either any of these drawbacks [1-9]. This system has been designed and proposed future work to exclude the major drawbacks and making it feasible to use in daily life of our underdeveloped country. The main contribution of this project were design and implementation of water level and temperature controller system which has automated water pump and heater, low-cost, maintains water cleanliness, gives precise and non-contact water level measurement with ultrasonic sensor, including a correction factor for temperature effect on ultrasonic sensor measurement, accurate temperature value display, continuous water level and temperature display with only few seconds delay and simple circuitry.

In domestic sector, main wastage of water occurs due to overflowing of overhead water tank. This occurs when the water pump is not turned off as soon as the water tank gets fully filled. Overflow of water can be stopped while

maintaining the cleanliness of water by this proposed work. When water level becomes high, the system automatically turns off the water pump and levels are displayed continuously on a Liquid Crystal Display (LCD). Ultrasonic sensor is used for water level measurement which does not have contact with water. Common method of level sensing is done by dipping sensor in water [1,3,4,5,7,8]. This not only provide a way for germ contamination in water but also corrosion of wire causes damage to the sensor.

In Bangladesh, garments industries contribute a huge part of the total export revenue. Wet processing sector in garment industry consists of different processes which are related with water. Dyeing process needs to be carried out in a dye bath having certain amount of water solution at a constant PH level and temperature for dyeing a definite amount of textile goods. By this system, definite amount of water is supplied in dyebath for dyeing purpose or any wet processing method while maintaining a definite temperature. Heater is controlled based on the fixed range of temperature being programmed. Irrigation for crop production needs correct level of water for optimized crop production. Rain and temperature can affect the water level which can destroy field crops. Continuous monitoring of water level and automated pump keeps the level at definite height. Temperature sensor attached senses continuously and displays on LCD for the user to be notified.

### A. *Preceding effort on Water level monitoring system with drawbacks discussion*

Khaled Reza et al [1] introduced the concept of water level monitoring with the principle of electrical conductivity of the water and indicated levels by LED. The system is low cost and simple. A web and cellular based monitoring service protocol to sense water level was proposed in the research work. In this design, water level sensing technique had contact with water which degrades the quality of water. Water is prone to germ contamination through immersed sensor in water tank. The proposed system in [4] used transistor circuit to display four levels of water in the tank through the LCD and when the highest water level was monitored then the microcontroller produced a sound through a buzzer to notify the user to turn off the motor. Water pump automation is not achieved as

human intervention is needed. Only four levels of water is displayed and cleanliness of water is hampered as the bases of the transistor was dipped in the water tank. This same technique was followed by Poh-Kiong Teo, et al [5] in their proposed work. Water level in reserve and main tank was monitored and indicated by LED. When the water level is in critical states; buzzer gets activated, sms delivered to user using costly GSM technology and water pump operation turns on or off. This work lacks in continuous acquisition and display of water level in the tank. In [2], Wireless sensor based automation was done as the user was notified through sms using GSM module to turn on the pump when soil moisture becomes low. Made Saraswati et al [7] discussed the concept of water level measurement using ultrasonic sensor and only sending water level information through sms to the user. Automation of water pump was not done and effect of temperature on ultrasonic sensor's level measurement was not realized. A mercury float sensor was used for water level sensing in [8] with automated motor operation. Although mercury float sensor was used in the intention to maintain cleanliness of water, it is hazardous as accidental leakage may make the water poisonous. This system does not display or notify the water level. In [9], water level measurement was done using ultrasonic sensor and sent wirelessly to a webpage. The overall system works according to the server request. This remote process is applicable to larger industries with huge investment.

## II. BASIC CONCEPTS

The sensing, monitoring and controlling technique used in the system requires the integration of some electrical components. Basic description of the components used in this embedded system is given below.

### A. Central Processing Unit

Microchip's PIC18F4520 microcontroller is used as Central Processing unit in this system. It acts as a central part of the system and connects all other units of the system. This microcontroller is in a 40-pin PDIP package having features of 32 Kb of Flash program Memory, 256 bytes Data EEPROM Memory, 10-bit Analog-to-Digital Module, 5 bidirectional I/O ports with high speed operating frequency up to 40 MHz and could be programmed for High or Low Voltage detection and Brownout Reset [6].

### B. Water Level Sensor

Ultrasonic Distance Sensor HC-SR04 is used for detecting the water level in the water tank which provides non-contact distance measurements from about 2 cm to 400 cm. This sensor comes in a 4-pin small package of dimension: 45mm x 20mm x 15mm and weight of 9gm. It operates with supply voltage of +5 V DC and at an operating temperature of 0 – 70° C [13].

### C. Temperature Sensor

LM35 is used as the temperature sensor which needs a supply voltage of 4 to 30 volt and its operating voltage is from -55° C to 150° C. This sensor have linear + 10.0 mV/°C scale factor and provide typical accuracies of about 1°C [10].

### D. Pumping and Heating Unit

The microcontroller output is connected to water Pump and Heater through a relay circuit. The water pumping motor requires high power of 220 V AC whereas the embedded system circuit operates at a low voltage of 5V. A relay is an electromagnetic switch which isolates high voltage or current from low power circuits. The relay has a driving circuit to be interfaced with the microcontroller.

### E. Liquid Crystal Display

Liquid Crystal Display screen is an electronic display unit. A 20x4 LCD have four lines which has the ability to display 20 characters per line. This LCD puts the instructions given by microcontroller in its command register. The data register stores the data to be displayed on the LCD.

## III. DESIGN AND IMPLEMENTATION

The researched system mainly consists of microcontroller, water pump, heater, ultrasonic sensor, temperature sensor, LCD and LED light. The block diagram representation of this automated controller system is shown in Fig.1, the system flow chart is given in figure 2 and Table I contains product and total cost of this system.

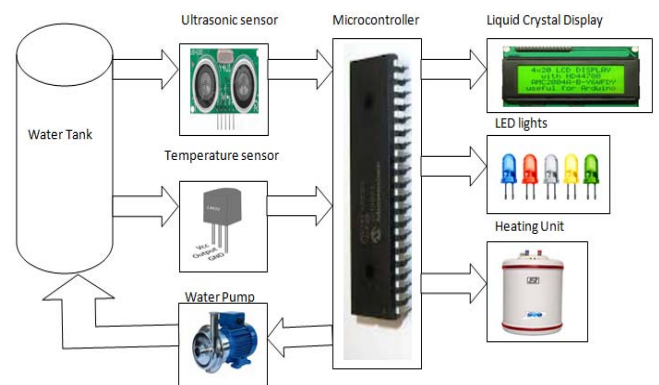


Fig.1: Block Diagram

### A. System Architecture

In this proposed system, PIC18F4520 microcontroller is the central processing unit. Water level and temperature is measured by using sensors. Microcontroller takes input from the HC-SR04 sensor and LM35 sensor. The output unit consists of LCD, water pump and heater. Microcontroller processes the input data obtained and gives resultant output.

### B. Sensor Unit

The sensing unit of this proposed design comprises of water level sensor and temperature sensor. Water level sensing is done by ultrasonic sensor whereas the temperature is sensed by LM35 sensor.

An ultrasonic distance sensor have been used to measure the water height in the tank and fixed at a position right above the water tank. An ultrasonic wave of 40 KHz is generated by the transmitter section of the sensor. A high signal is sent to the microcontroller through the input pin and makes the signal low after receiving back the wave by the receiver section. The



microcontroller calculates the time between this one high and low pulse which gives the time interval between sending and receiving the sound [13]. To measure liquid level, the sensor measures the distance to the surface of the fluid by the equation

$$Distance = \frac{\text{speed} \times \text{time}}{2} \quad (1)$$

$$Water\ level = \text{Tank height} - \text{Distance} \quad (2)$$

Temperature has an effect on the speed of sound in air that is measurable by the ultrasonic sensor. Speed of air=332 m/s and the time=the time interval between trigger and echo pulse. As the temperature is known by sensor, the following formula is inserted in software programming to have a correction for temperature effect:

$$\text{speed} = [332 + (0.6 \times \text{temp.})] \text{ m/s} \quad (3)$$

In case of temperature sensing, LM35 sensor converts temperature into its proportional analog voltage value. The output analog voltage from the sensor is converted to a 10-bit digital number using the internal ADC pin of the microcontroller [6]. For every 1 degree increase in temperature there will be an increment of 10 m volt in the output voltage of LM35 sensor. The factor for temperature to voltage conversion is 10 mV per °C. This conversion factor is needed to give in the programming part of the microcontroller to convert voltage back into temperature [14,11].

Microcontroller sends high signal to the relay circuit of the heater when the temperature become less than the prerequisite temperature. As a consequence, the heater gets switched ON. If the temperature is greater than the fixed value then the heater switches OFF as low signal (0v) is sent at relay circuit.

### C. Control Unit

The basic operation of this unit is the automatic controlling of water pump and heater by microcontroller. The controlling mechanism is defined by program being coded in the microcontroller. Water pump is connected through a relay circuit to an output pin of microcontroller. Similarly, Heater is connected with another output pin. The output of relay circuit is connected with one motor pump’s cable. The other motor’s cable is connected with AC 220V as positive voltage [1]. In this way another relay is connected to heater. When microcontroller sends high signal to pin then pump will turn on. Relays works as a switch that triggers the attached pump or heater to operate [3].

### D. Display Unit

This unit consists of Liquid Crystal Display (LCD) and Light Emitting Diode (LED). LCD served as the unit which shows the precise value of the water level and temperature of the system on a screen. LCD is connected with an output pin of the microcontroller and displays sent information. Led indicates the status of the water pump and heater.

### E. Logic Designing

The program for the execution of this system operation has been written in assembly language. This program is converted to its machine code (HEX file) by CCS C Compiler and loaded to the microcontroller using programmer for the appropriate controlling of the system [3].

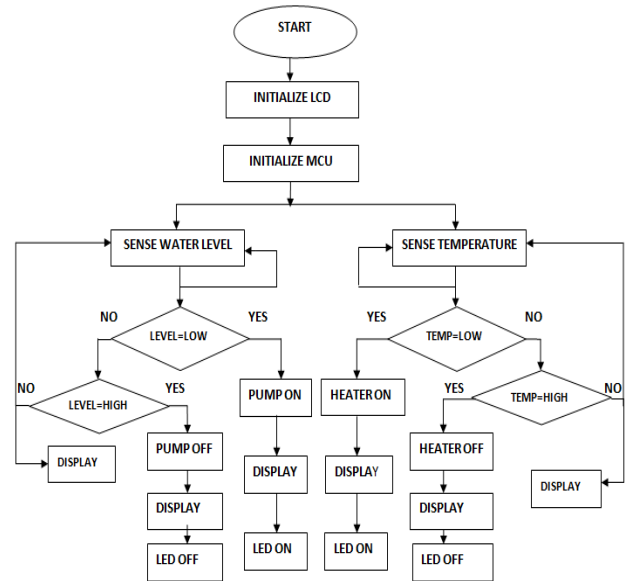


Fig.2: System Flowchart

TABLE I. PROJECT IMPLEMENTATION COST

No	Name of Component	Specification	Quantity	Cost/ Unit	Total
1	Microcontroller	PIC18F4520		280	280
2	LCD Display	4x20	1	340	340
3	Ultrasonic Sensor	HC-SR04	1	135	156
4	Temperature Sensor	LM 35	1	40	40
5	Relay	NAIS tx2-5v	2	27	54
6	Power Supply	9V-100mA	1	40	40
7	Crystal Oscillator	20.0MHz	1	9	9
8	Voltage Regulator	7805	2	7.50	15
9	LED	LED	4	2	8
10	Miscellaneous	Resistor, Capacitor,	As required	1-4	20
				Total	BDT 961

Product cost is estimated in Bangladeshi Taka (BDT). The cost of Printed circuit board (PCB) designing and manufacturing is not included in the table as it varies with both quality and quantity. Estimated cost required to build

PCB for mass production such as 1000 units would be BDT 15000. Then per unit cost would be BDT 15.

### F. Circuit Operation

The outputs of sensors are interfaced with microcontroller as input pins. The microcontroller continuously monitors the state of these input pins and, displays the water level and temperature by sending an appropriate string to the LCD. The microcontroller then processes the data received and uses it to

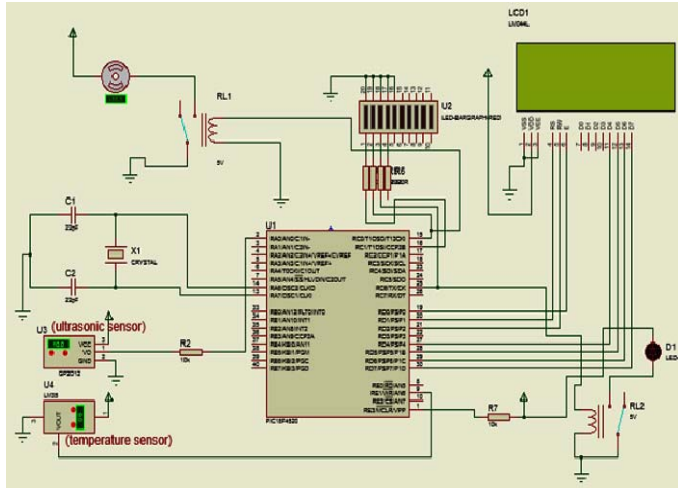


Fig. 3 : Circuit Diagram

give output based on the written program loaded in its memory. The circuit diagram of the system is as shown in Fig. 3

Ultrasonic sensor gives information to the microcontroller with a delay of 2000 ms and the water level is shown on the LCD after every 2000 ms. High and low level of water is set in the loaded program of microcontroller for the operation of water pump and heater. When the water level in the tank reaches the specified low level in program, the microcontroller sends positive signal. Relay circuit and motor pump gets ground signal (0v) at negative side and 220v ac to the other side and therefore the motor pump turns ON. A LED pin gets high signal and turns ON to indicate that the motor is ON. LCD screen displays that water level is low and motor has turned ON. When the tank water goes over the defined high level, Microcontroller sends low signal (0 volt). Therefore, the motor pump will turn OFF as it gets positive signal (+5v) at one side and 220v ac at the other end. One certain LED shows that the motor is OFF by turning ON. LCD screen displays that water level is high and motor is turned OFF. In this manner water level controlling and pump automation has been done.

Temperature sensor senses the temperature and sends the information to the microcontroller. The required temperature of the water has been coded in the program of the microcontroller. When the water temperature becomes less than the prerequisite temperature, microcontroller sends high signal to the transistor and relay circuit of the heater and the heater gets switched ON. A certain colored LED turns ON and LCD displays that the heater is ON. When the temperature increases above the fixed

value, the heater switches OFF and LCD shows that the status of the water heater has stopped operating. One of the LED lights to indicate about heater status. This action goes on continuing with a defined delay.

### IV. RESULT

This proposed system is an effective solution of the water related problems faced in residential sector, garment industry and irrigation field. Hindrance to overflow of water from tank while maintaining cleanliness and temperature has been obtained. By this system, proper level of water and temperature in crop field could be maintained for sustainability of crop as the system continuously monitors water level within short time interval and accordingly automates pump. In the wet chemical process of garment industry, specific amount of water could be supplied at defined temperature by this embedded system.

Circuit designing and implementation has been done both in hardware setup as shown in Table II and in the ISIS environment of Proteus 8 Software which provides co-simulation of microcontroller based design. This shows the accuracy of the circuit designing and microcontroller programming before implementing in physical prototype.

In the coded program, the water tank height can be set for a particular tank. In this test simulation, the water level at which the water pump turns ON is given as below 25 cm and above 400 cm for turning it OFF. High level is reached when 400 cm of tank is filled with water. The temperature range of the water has been defined from 25 to 30° C for the tank of this simulated design. The water level and temperature range could be set according to the need of the user.

In the simulation, LCD is displaying the water level and value of temperature after every 2 second. The simulation result in Fig.4 shows that the water level is 19 cm and thus the pump starts operating. A LED turns ON to show the status of the pump and LCD displays the level of water.

In the same way when water level goes above 400 cm, the pump turns OFF. LCD shows the level as high and that the motor is OFF while activating a LED to show the motor status as OFF as shown in fig.5

TABLE I. EXPERIMENTAL DATA

No	Water Level (Tank Height – Measured value) (cm)	Water percentage (%)	Water Motor Status	Temperature Value (° C)	Heater Status	LED Status (Certain LED)	LCD Display
1	19	3.8	ON	26	OFF	ON	YES
2	417	83	OFF	26	OFF	ON	YES
3	19	3.8	ON	19	ON	ON	YES
4	440	88	OFF	35	OFF	ON	YES

## V. CONCLUSION

A microcontroller based automated water level and temperature controller system has been successfully designed. This system consists of continuous water level and temperature monitoring facility, automation of water pump and heater while maintaining the temperature and water hygiene. In this way effective management of water has been achieved. This proposed system have even emphasized on low cost and simple circuit. Ultrasonic sensor is used for water level measurement in this system which does not have contact with water. Thus water cleanliness is maintained and device longevity is obtained. Accurate water level is obtained by adding correction factor for temperature effect on ultrasonic sensor measurement. Continuous value of water and temperature is displayed through LCD. Operation of water pump and heater occurs without human intervention.

This designed system is applicable at domestic, industrial and agricultural sector for efficient water management. With this system, water wastage due to improper maintenance of pump can be tackled, correct level of water and temperature in crop field can be preserved for increased productivity and an ideal medium can be achieved for various process in garment industry.

## VI. FUTURE SCOPE

The presented system could be modified further whereby adding the following sensors according to the need of the implementing sector. PH sensor, Humidity sensor, ORP sensor or Fiber Optic sensors [12] can be used as water quality sensing technique. These sensors will give added benefit in wet chemical process of garment factory, and would prevent skin disease and over fertilization of crop fields. Correct amount of fertilizer can be sprayed by monitoring the PH level of soil [2]. More sensors can be included for multiple tank system. One more sensor could be attached with the reserve tank in order that water pump motor does not get activated to pump water to rooftop tank when reserve tank is not full. In this way damage to the motor can be prevented. Both manual control of pump can be done beside automated control.

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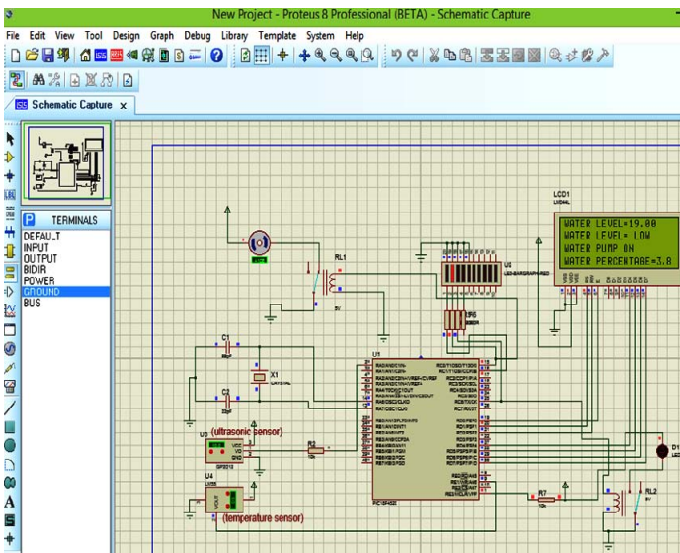


Fig. 4: Simulation Result-1

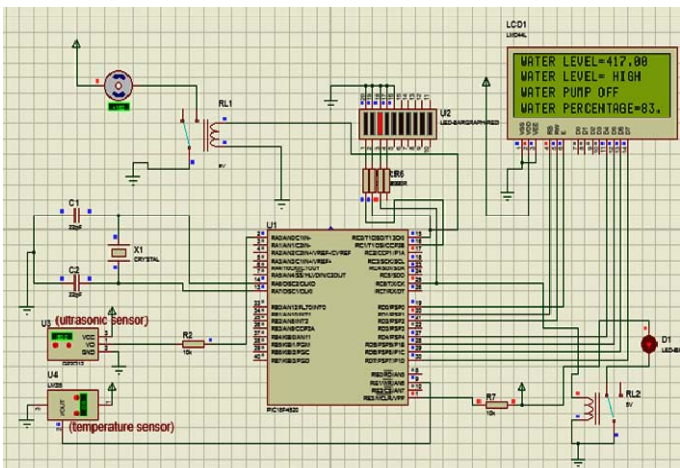


Fig.5: Simulation result-2

When the temperature of the water reaches below the predetermined range, the water Heater turns ON as shown in Fig.6. Water heater turns OFF as the temperature increases above the definite range of 30° C and status indicated by LED. Therefore successful designing and implementation has been achieved.

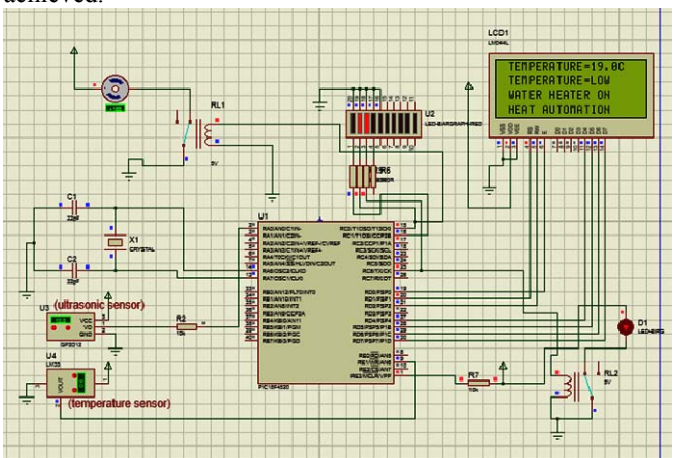


Fig.6: Simulation result-3

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# Image Enhancement Based On Evolutionary Genetic Algorithm

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**Abstract**—Genetic algorithm is most powerful unbiased optimization technique on natural solution that iteratively transform a set of mathematical object. There are a lots of applications find where genetic algorithm is applied to improve image enhancement and segmentation. In this paper, we propose new feature section method for image enhancement. We propose an easy but effective crossover and mutation method that use to get better result. We also introduce the most fundamental technique based on genetic algorithm and enhance image quality using genetic algorithm. The experimental result shows the effectiveness of our propose method.

**Index Terms**—Genetic algorithm, Image enhancement, Image Contrast

## I. INTRODUCTION

A genetic algorithm (GA) is a search technique used in soft computing to find true or approximate solution to optimization and search problem [6]. Genetic algorithm is a particular class of evolutionary algorithm that uses inspired techniques which consist of evolutionary process such as inheritance, mutation, selection, crossover. The GA was adopted to achieve better result, faster processing times and more specialized functionality. Genetic algorithms are categorized as global search heuristics [6]. It performs optimization technique through natural exchange of genetic material between parents. A genetic algorithms provide a simple and almost generic method to solve complex optimization problem. In this paper, we propose a method to enhance the contrast of a gray image using a genetic algorithm. It easily selects a string of bits of an image by measuring the fitness value of an individual parents by evaluating the intensity of spatial edges included in the image. Then we choose a logical crossover operation and mutation operation with sorting algorithm. The propose method reduces the complexity to select an individuals from a large population space for different genetic parameters.

The remaining sections of this paper are organized as follows. In section II describes related works. Section III introduces problem statement and our proposed technique has been described in section IV. The experimental results in our proposed method have been shown in section V. In section VI we conclude our proposed model with the direction of future research.

## II. RELATED WORK

There are a number of related works have been proposed. J. Xie et. al. [10] propose maximum likelihood estimation method in genetic algorithm for image segmentation. Weiqi Jin et. al. [3] introduce neighborhood pixel block operation method in genetic algorithm for restoration of an image. Genetic algorithm also use in software testing. Heinz Mhlenbein [9] use continuous parameter optimization for software testing using genetic algorithm. It also use for anatomical object recognition using fuzzy modeling method [11]. John R. Koza et. al. [5] propose automated design of genetic programming and mechatronics systems using bond graph. There are a lot of field where genetic algorithm is used. Genetic algorithm use to find out weak links in approximate computing system such as look ahead in computer architecture. It also uses to search large solution spaces of ciphers for one correct decryption, computer automated design, trading systems in the financial sector, clustering to optimize a wide range of different fit-functions. Automated design of mechatronic systems using bond graph, airline revenue management, file allocation for a distributed system, learning robot behavior, learning about fuzzy rule, mobile communications infrastructure optimization, quality control systems, stochastic optimization, digital signal processing, channel routing problem in the area of VLSI design are used genetic algorithm.

## III. PROBLEM STATEMENT

There are many image contrast enhancement techniques such as Histogram Equalization, BBHE, DSIHE, MMBEBHE, RMSHE, MHE, BPDHE, RSWHE, Global Histogram Equalization, Block-based Histogram Equalization, LHE and LGCS. First point of view, the different image enhancement techniques only give the level of quality that achieved from their proposed method. There is no clear concept about the separation of the background and the character of the image. Generally image enhancement contrast will lose the brightness that means the brightness of output image is reduced a little from the desired. Histogram equalization creates, artifacts, degraded sharpness, washed-out effect. Histogram Matching is another method for contrast enhancement but this method requires user involvement to define desired histogram. Image

generated in BBHE might have a chance of lost the natural attributes. Content aware method cannot recover the information from the dark areas. Histogram matching does not assure an independent dynamic system that produces an output image without user involvement. Histogram Equalization hold an effect of enhance the dynamic range of a given histogram since Histogram Equalization flattens the density distribution of the image. In global histogram equalization each pixel is assigned a new intensity value based on previous cumulative distribution function. Different types of statistical parameters for different distribution functions is unknown and calculation of this parameters makes the system complex. In the existing method the selection process for crossover and mutation is complex that have chance to loss the best found individuals. To solve these problems we propose an evolutionary genetic algorithm using multiple point crossover operations.

#### IV. PROPOSED METHOD

Genetic algorithm is one kind of evolutionary algorithm that uses in automatic image enhancement. A Genetic Algorithm provides the systematic random search. It provides a simple and almost generic method to solve complex optimization problems. In computer science an image can be represented as a bit of strings and selection (select an individual with better fitness) operation performed based on the return value of fitness functions. After selection operation mating of individuals takes place by crossover and mutation operations. All of these operations are the pre-processing task of image enhancement.

A genetic algorithm holds the following steps: Compute fitness of all chromosomes (individuals) while desired condition not break.

- Generate random population for input image
- Select parents with better fitness value
- Produce the next generation (offsprings) using crossover operator
- Perform mutation operation selectively on the population space
- Select new generation

In the figure 1, depicts the genetic algorithm process. This process performs several subsections. Each subsection is described below.

##### A. Pixel Block Operation

Spatial domain methods directly operate on pixels. The spatial transformation is expressed in general forms a point  $(x, y)$  in the output image to its corresponding (warped) position  $(i, j)$  in the input image [4] which is given at equation 1.

$$(i, j) = (W_x(x, y), W_y(x, y)) \quad (1)$$

Now for any given point  $(x, y)$  in the output image the coordinates of the corresponding point in the input image may be generated using the warping functions  $W_x$  and  $W_y$  respectively. We normally model each spatial warping by a polynomial function. So, we assume that, the warping functions are given by the following equations 2 and 3.

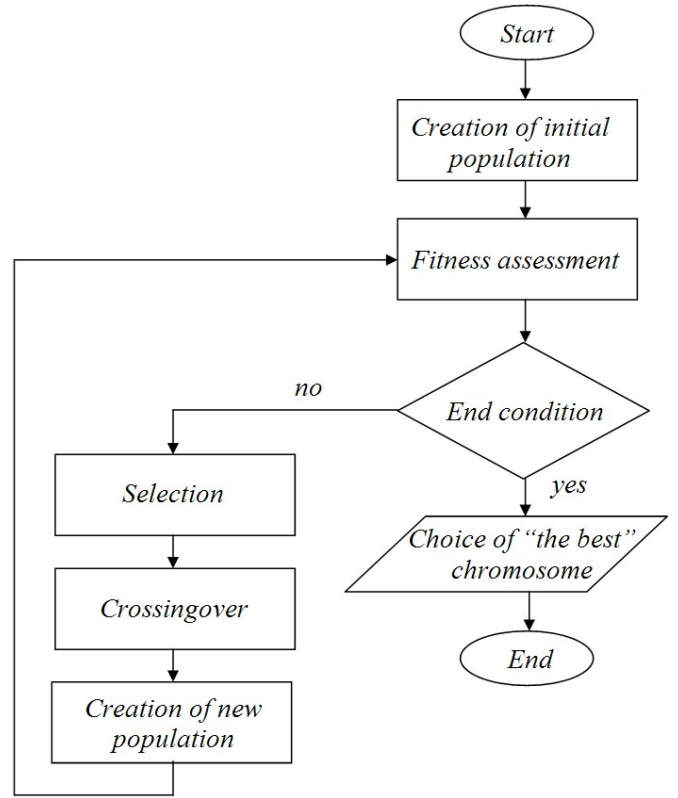


Fig. 1. Shows the genetic algorithm process

$$W_x(x, y) = \sum_p^n \sum_q^n a_{pq} x^p y^q \quad (2)$$

$$W_y(x, y) = \sum_p^n \sum_q^n b_{pq} x^p y^q \quad (3)$$

Local enhancement methods are used for transformation functions that are based on the gray-level distribution, or other properties, in the pixel group of every pixel in a given image. The method used in this paper for image enhancement belongs to the category of spatial transformation [4]. For less power waste and consuming the following transformation method applies at the location  $(i, j)$  [7] in the equation 4.

$$g(i, j) = \frac{k \times M}{\sigma(i, j) + b} [f(i, j) - c.m(i, j)] + m(i, j)^a \quad (4)$$

Where  $m(i, j)$  is the gray-level mean and  $\sigma(i, j)$  standard deviation computed in a neighborhood pixels centered at  $(i, j)$  and having  $n \times n$  pixels window size.  $M$  is the global mean of the image,  $f(i, j)$  is the gray-level intensity of input image pixel at location  $(i, j)$  while  $g(i, j)$  is the intensity value pixel's in the output gray-level, at the same location [7]. Since  $M$  is the global mean of the image then it can be expressed as the following equation 5.

$$M = \frac{1}{H \times V} \sum_{i=0}^{H-1} \cdot \sum_{j=0}^{V-1} f(i, j) \quad (5)$$

Where  $H \times V$  is the total number of pixels contained in the input image.  $m(i, j)$  is the local mean of the pixel values contained in the pixel block (window size  $n \times n$ ) of  $(i, j)$ th position, it can be expressed as the equation 6.

$$m(i, j) = \frac{1}{n \times n} \sum_{x=0}^{n-1} \cdot \sum_{y=0}^{n-1} f(i, j) \quad (6)$$

$\sigma(i, j)$  is the local standard deviation of the pixel in a  $n \times n$  (size) neighborhood of  $(i, j)$ th pixel position [4], and it can be defined as equation 7.

$$\sigma(i, j) = \left[ \frac{1}{n \times n} \sum_{x=0}^{n-1} \cdot \sum_{y=0}^{n-1} [f(i, j) - m(i, j)]^2 \right]^{0.5} \quad (7)$$

From the all equations  $a, b, c, k \in R$  are the parameters to be optimized [7]. An optimal set of values of these four parameters is found using the optimization methodology, for the image under consideration. In the figure 2 shows the spatial transformation and gray level interpolation.

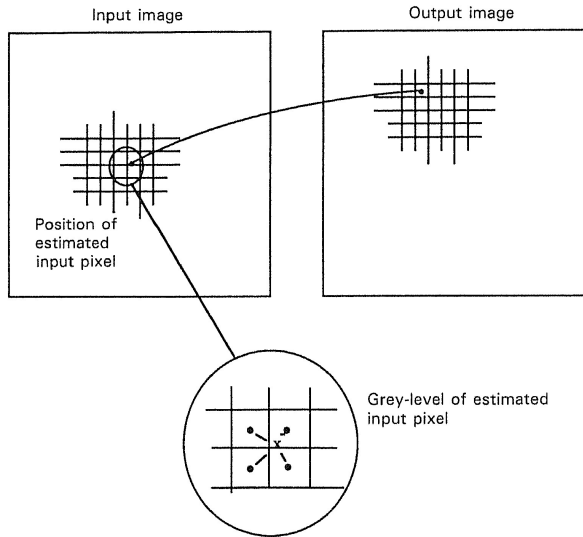


Fig. 2. Spatial transformation and gray-level interpolation

### B. Fitness Value Calculation

The parameters of this method  $a, b, c$  and  $K$  are the same for the whole output image [7]. The task for the GA is to find the best combination of the four parameters according to an objective criterion that describes the contrast of the image. The representation of the chromosomes is therefore a string of 4 real genes denoting the four parameters. In genetic algorithm the fitness function for the individuals can be represented as the following figure 3.

For the individuals, the higher the fitness, the higher the chance of being selected. The evaluation criteria for automatic

image enhancement must be capable of quantifying image quality objectively [7]. It takes into consideration all features of a good image such as high contrast, enhanced edges etc in the equation 8.

$$F(x) = In[In[E(I(x))]] \times \frac{n_{eps}(I(x))}{H_{size} \times V_{size}} \times H(I(x)) \quad (8)$$

$F(x)$  denotes the fitness function calculated for the chromosome  $x$ .  $I(x)$  denotes the original image  $I$  with the transformation  $T$  applied according to equation 1, where the respective parameters  $a, b, c, k$  are given by the chromosome  $x = (a, b, c, d)E(I(x))$  [7] is the intensity value of the spatial edges detected with an edge detector used by [2], where the detector is imposed to the transformed image  $I(x)$ . And  $n_{eps}(I(x))$  denotes the total number of edge pixels as detected by using the edge detector. The term  $H(I(x))$  is a measure of the entropy in the transformed image  $I(x)$ .  $(H, V)$  are the horizontal and vertical sizes (number of pixels in each direction) of the image. The sum of intensities of edges  $E(I(x))$  included in the enhanced image is calculated by the following expression 9, 10, 11 in the research paper [2].

$$E(I) = \sum_i \sum_j [\delta h(i, j)^2 + \delta g(i, j)^2]^{0.5}, i, j = 0 \text{ and } i, j < n \quad (9)$$

$$\delta g(i, j) = I(i-1, j+1) + 2I(i, j+1) + I(i+1, j+1) - I(i-1, j-1) - 2I(i, j-1) - I(i+1, j-1) \quad (10)$$

$$\delta h(i, j) = I(i+1, j+1) + 2I(i+1, j) + I(i+1, j-1) - I(i-1, j+1) - 2I(i-1, j) - I(i-1, j-1) \quad (11)$$

$n_{eps}(I(x))$  is the number of edge pixels detected using sobel operator with automatic threshold (another transformation of quality level).  $H(I)$  is a measure of entropy of image given below in the equation 12.

$$H = - \sum_{n=1}^G p_n \log(p_n) \quad (12)$$

$G$  is the number of gray scale levels in the image and is the frequency of pixel having the intensity  $n$ , Above evaluation function ensures a high value of fitness function, for an image, if high number of edge pixels are visible; There is greater intensity of pixels in edge image which indicates edges are more visible; There is high value of entropy that means more natural appearance by gray level are frequently collaborate.

### C. Selection Operation

Selection operation refers to better individuals allowing them to pass on their genes to the next generation. The goodness of each individuals depends on its fitness. Fitness may be determined by an objective function or by a subjective judgment [8]. For digital image processing based on evolutionary algorithm such as genetic algorithm selection has been used to

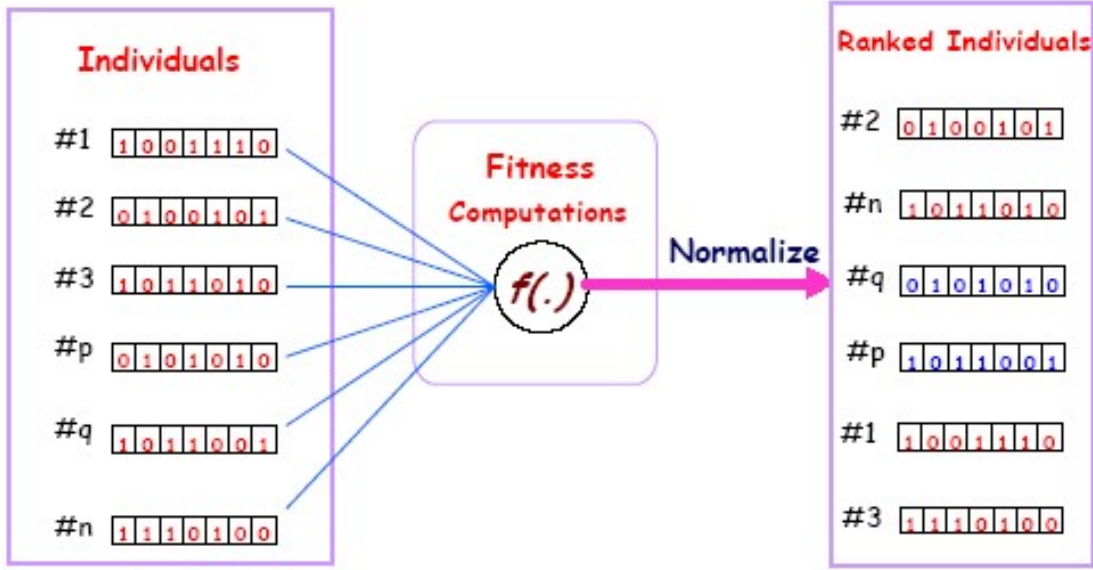


Fig. 3. Fitness value calculation and sort based on fitness value

ensure a steady convergence behavior of the genetic algorithm. In genetic algorithm the number of individuals is constant for all generation or images [6]. The number of population or individuals are generated by the random population generator function. The fitness is evaluated in each generation, and based on fitness the individuals who have higher relative fitness are more likely selected to be the parent of current generation to produce kids [7]. And the opposition the lower order fitness value carrying individuals are not selected to produce the next generation. Hence the number of individuals in the population is kept constant (unchanged) in all generation of an image.

#### D. Crossover Operation

Crossover is another parameter or operation of GA. Using those found out parents, process the crossover which is used to exchange the information between the parents to form off springs. By recombining parts of goods individuals, this process is likely to create even better individuals. In the crossover function, using the part of the two randomly selected individuals to do the exchange between each other. After such exchange, the genes from parents are combined to be inherited to reproduce next generation. At the beginning, the method of crossover is used to exchange the integral parts between a pair of parent chromosomes, such as so two children are produced for next generation and given figure illustrate how it works. The crossover frequency is controlled by a crossover probability [1]. Typically, parents are denoted as the following equation 13, 14.

$$x^{(1)} = (x_1^{(1)}, \dots, x_n^{(1)}) \quad (13)$$

$$x^{(2)} = (x_1^{(2)}, \dots, x_n^{(2)}) \quad (14)$$

In the similar way the representation is also used for the offspring are given equation 15, 16.

$$y^{(1)} = (y_1^{(1)}, \dots, y_n^{(1)}) \quad (15)$$

$$y^{(2)} = (y_1^{(2)}, \dots, y_n^{(2)}) \quad (16)$$

For crossover operation we introduce one simple logical operation between two parent chromosome to produce one child for next generation that contains the better fitness value from the parent chromosome. The logical OR operation is between two parent that holds the higher order bit of two parents. This type check for every point of the parents not only any portion of the parents. We can say this as  $i = n$ ; point operation. Now we can express the crossover operation as the follows equation 17.

$$y_i = (x_1^{(1)}, \dots, x_n^{(1)}) \vee (x_1^{(2)}, \dots, x_n^{(2)}) \quad (17)$$

Where  $y_i$  is the offspring and  $(x^1, x^2)$  are the parent individuals.

#### E. Mutation Operation

Mutation is divergence operator of genetic algorithm. Mutation operation is performed to normally break the one or more samples of a population out of a local minimum or maximum population space and potentially invented a better maximum or minimum population space. Also mutation operation has been done to assure the high level of diversity among the population [7]. For the mutation process a single bit or a set of bits is chosen from the large space from the bits. For the mutation operation if  $x$  is the chromosome before mutation then the new chromosome after mutation is denoted by  $x$  and it can be expressed by equation 18, 19.



$$x = (x_1, x_2, \dots, x_n) \quad (18)$$

$$\acute{x} = (x_1, x_2, \dots, \acute{x}_6, \dots, x_n) \quad (19)$$

This paper introduce sorting algorithm (bubble sort) before mutation operation. By following sorted order choose any number of members randomly from the first positions and taken out to do mutation operation so there is a great chance of reproducing. Then we impose general method by reversing the selected bits for mutation operation. The bit or bits that have to be reverse is selected randomly and then the bit is reversed or bits are reversed [8].

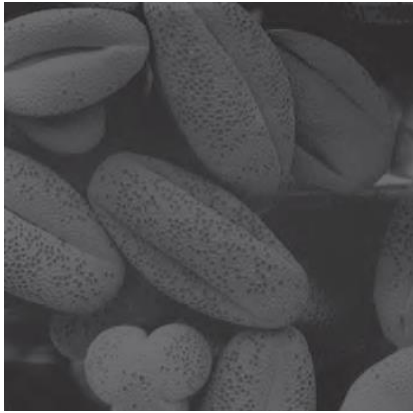


Fig. 4. Original Image

## V. EXPERIMENTAL RESULT

One image is used to describe the result for the proposed method. Among the three image figure 4 is the real image, the desired resultant image for the proposed method is shown in figure 5, and the figure 6 is the image resulted from histogram equalization. To calculate the result we take at least 70 individuals in the population space. The size of each image taking for experiment is  $348 \times 345$  pixel within the 256 gray scale (RGB color values) level. For the whole population the mutation rate 0.01%. Hence, we find the better fitness value, and the OR operation between two parents reduce the complexity to choose the portion to exchange between parents. In this case, at first we sort the string and then inverse one bit randomly to perform mutation operation that reduce the complexity.

The genetic algorithm introduces different types of parameters for local enhancement method. This parameters are help to avoid loss of the best found individuals. In the genetic algorithm, the processing time is high because the transformation of the edges must be repeated in this evolutionary algorithm. The proposed method shows the improvement of the efficiency within a short processing time limit. Figure 4 shows the original image and the figure 5 depicts the image enhance using histogram equalization that is more clear than original image. In the figure 6 we can see our proposed system



Fig. 5. Enhance image quality using histogram equalization

enhance image quality efficiently than original and histogram equalization image.



Fig. 6. Enhance image quality using our proposed method

## VI. CONCLUSIONS

In this paper, we introduce genetic algorithm based method to enhance the contrast of an image. We use the intensity to calculate the fitness of each individuals by spatial edge transformation. In this paper, every new generation takes the highest fitness value because crossover operation on each bit of the parents using logical or operator. We can reduce the complexity to select the individuals for mutation operator by using the pre-sorting based on the fitness value of all population in the population space. By using this method it enhance the contrast of an image like a natural image. It does not use extra others distribution function to select the individuals and part or parts for exchange between them.

In this paper, we did not consider others algorithm comparison. In our future work, we will try to enhance image quality using others new technique and we will compare our method to other methods.

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# Automatic Awareness Classification for Automobile Drivers

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**Abstract**—Driver’s drowsiness is one of the major causes of serious traffic accidents. The system is designed to detect the awareness (awake, drowsy, sleeping) of the driver so that, they can be made aware. We used ECG signal which can detect driver’s fatigue and calculate performing parameters. Three distinct ECG signal has been generated by changing certain parameters pertaining to different awareness states, where all the original ECG signal’s properties are conserved. These are considered as the training signals. AWGN has been added to all three signals while training to simulate the noise effect in a real wireless system. Statistical Signal Characterization (SSC) was used to classify the different states of these signals. Finally, for detecting ECG signal’s state the system was feed a new ECG signal in MATLAB which is not identical with the signals used in training phase. Simulation of this system indicated successful feature extraction and detection of awareness states.

**Keywords**- Awareness, Decision Tree, ECG signal, Drowsiness, Classification Phase.

## I. INTRODUCTION

An automatic detection system for vehicle accidents is introduced in this paper. In this modern, fast moving and insecure world, it becomes a basic necessity to be aware for safety. According to available statistical data, over 1.3 million people die each year on the road and 20 to 50 million people suffer non-fatal injuries due to road accidents [1]. Based on police reports, the US National Highway Traffic Safety Administration (NHTSA) conservatively estimated that a total of 100,000 vehicle crashes each year are the direct result of driver drowsiness. These crashes resulted in approximately 1,550 deaths, 71,000 injuries and \$12.5 billion in monetary losses [2]. In the year 2009, the US National Sleep Foundation (NSF) reported that 54% of adult drivers have driven a vehicle while feeling drowsy and 28% of them actually fell asleep [3]. There are various ways through which drowsiness can be detected, such as Vehicle-based measurement (A number of Metrics, movement of steering wheel, pressure on acceleration etc.)[4-5], Behavioral measurement (Yawning, Eye closure, Eye Blinking, Head pose etc.)[6-8], Physiological measurement (ECG, EMG, EOG, and EEG). Among these,

physiological measures are the most effective one. [9-13]. The system classifies the data from automatically estimated ECG (use 2 leads ECG system). It will classify and take a decision with the help of decision tree.

Here, we complete our simulation part using MATLAB by calculating SSC (Statistical Signal Characterization) parameters ( $A_m$ ,  $A_d$ ,  $T_m$ ,  $T_d$ ) [15] and analyze the data using WEKA by comparing with the training data. SNR (Signal to Noise Ratio) estimation is assumed for better performance of system and for better strength. This system may provide the optimum solution to decrease the road traffic accident due to driver’s drowsiness (or sleep).

## II. SIMULATION

In this system we will develop an intelligent system that will classify three different states of a driver. System overview has been shown in figure 01. At first we will simulate three ECG (Electrocardiogram) signals according to different state (Awake, Drowsy, and Sleep) of drivers. From that we will train the system and generate decision tree for classification. Then we will make the decision on the measured signal by using the decision trees in the classification [14].

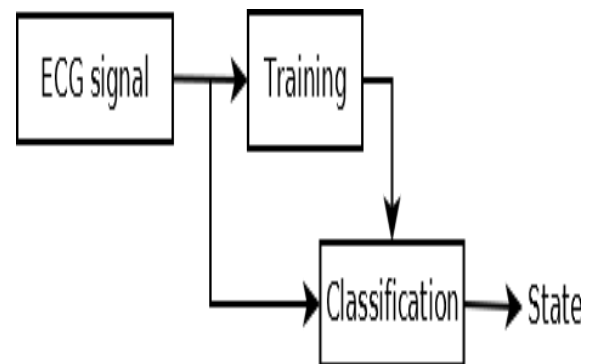


Fig 01: Simplified Diagram of Methodology

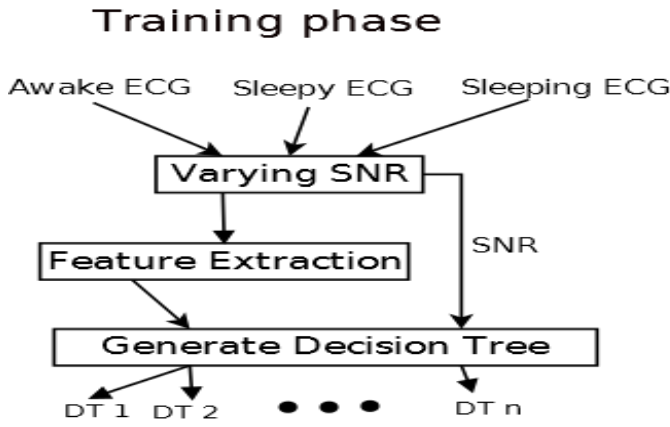


Fig 02: Training Phase of through ECG.

#### A. Training Phase:

For the training phase we simulated three ECG signal using MATLAB simulation according to different states of drivers. We use 72bpm (beat per minute), 59bpm, and 52bpm for the awake, sleepy, and sleeping state respectively. As the SNR (Signal to Noise Ratio) may vary for the measured signal, we added noise using AWGN (Added white Gaussian Noise) to the signal and varying SNR up to 40db (as our signal much better in 40db SNR) to performed the training phase. As the signal may have different SNR level and feature mostly depend on the SNR we generate multiple decision trees. Figure 02 shows the block diagram of training phase.

There are lots of features of ECG signal such as R Peak to Peak distance, QRS interval, QT interval; PR interval etc. which is varies according their states. Here we use the time interval and amplitude of the signals. To define their states we calculate SSC (Statistical Signal Characterization) parameters after varying the SNR as in the above figure 02.

Statistical Signal Characterization is a powerful technique by which certain easily-measured time and amplitude attributes of a signal may be extracted and used to calculate a set of SSC parameters. Now we shall define four quantities, called SSC parameters, as being the means and mean deviations of the segment amplitudes and periods [15]. Mathematically, this is:

$$M_a = \sum_{i=1}^{N_s} (A_i) / N_s$$

$$M_t = \sum_{i=1}^{N_s} (T_i) / N_s$$

$$D_a = \sum_{i=1}^{N_s} |A_i - M_a| / N_s$$

$$D_t = \sum_{i=1}^{N_s} |T_i - M_t| / N_s$$

Where,

$M_a$  = Amplitude Mean

$M_t$  = Period Mean

$D_a$  = Amplitude mean deviation or Simply Amplitude deviation.

$D_t$  = Period mean deviation or simply period deviation.

$N_s$  = Number of samples

$t_n$  = Elapsed time at the end of the segment.

Decision tree is a flowchart .Usually it is used for analytical purpose to make a decision. Here we use ‘WEKA (Waikato Environment for knowledge Analysis) 3.6.10 version’ software for declaring state of the driver. In WEKA we use J48 decision tree which implements C4.5 algorithm [16].To run this decision tree we need some features values of different states signals with varying SNR. So, we have to train the signals to make a decision tree, for that we generate a code to train the signal. We extract those features (four parameters  $M_a$ ,  $M_t$ ,  $D_a$ ,  $D_t$ ) of different ECG signals (Awake, sleepy, and sleeping) per SNR up to 40db. Those parameters values have been saved on ARFF file. By using ARFF files J48 decision tree makes decision tree for individual SNR value.

#### B. Classification:

In this part our system work with a new ECG signal (driver’s real ECG signal), here we assumed that we measured ECG signals from the driver. The new ECG signal is passed through in a classification phase to classify its states [14]. We also assume that our noise estimation and removing noise part is done. We generate an appropriate classification and a decision tree shown in figure 03.

SNR estimation indicates the reliability of a channel between transmitters to receivers. It is used generally to measure the quality of a signal. Here, we assume the SNR estimation is done. In adaptive system design, SNR estimation is commonly used for measuring the quality of the channel. Then, the system parameters are changed adaptively based on this measurement. Adaptive modulation that employs different level of modulation for each (or a group) of sub-carriers depends strongly inaccurate estimation of SNR value There are many other applications that can exploit SNR information, like channel estimation through interpolation and optimal soft information generation for high performance decoding alone particular interest for SNR estimation is to use it for Adaptive Orthogonal Frequency Division Multiplexing (AOFD) based wireless communication systems. Adaptive modulation that employs different level of modulation for each (or a group) of sub-carriers depends strongly on accurate estimation of SNR value [17-19].

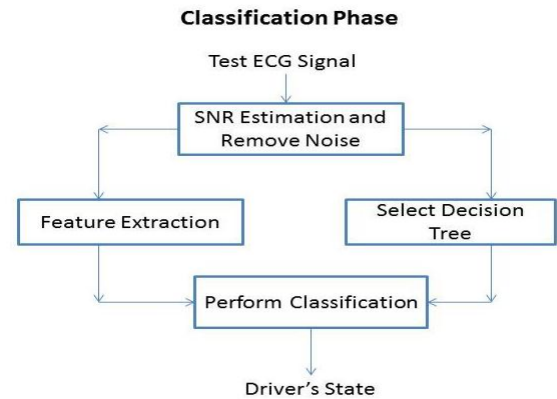


Fig 03: Classification of the states.

There are many other applications that can exploit SNR information, like channel estimation through interpolation and optimal soft information generation for high performance decoding algorithms [20-21].

### III. RESULT AND ANALYSIS

The aim of the ECG simulator is to produce the typical ECG waveforms of different leads and as many arrhythmias as possible. Our ECG simulator is a MATLAB based simulator and is able to produce normal lead II ECG waveform. The use of a simulator has many advantages in the simulation of ECG waveforms. First one is saving of time and another one is removing the difficulties of taking real ECG signals with invasive and noninvasive methods. The ECG simulator enables us to analyze and study normal and abnormal ECG waveforms without actually using the ECG machine. The Amplitude and Duration of normal ECG is given below [22]:

Amplitude	P-wave — 0.25 mV R-wave — 1.60 mV Q-wave — 25% R wave T-wave — 0.1 to 0.5 mV
Duration	P-R interval: 0.12 to 0.20 s Q-T interval: 0.35 to 0.44 s S-T interval: 0.05 to 0.15 s P-wave interval: 0.11 s QRS interval: 0.09 s

Here simulation was to add noise or vary the signal strength of our previously generated ECG signal for all three states. Therefore it's also generation of ECG where strength of the signal is varied or in a word it is varying SNR (Signal to Noise Ratio) generation of ECG signal.

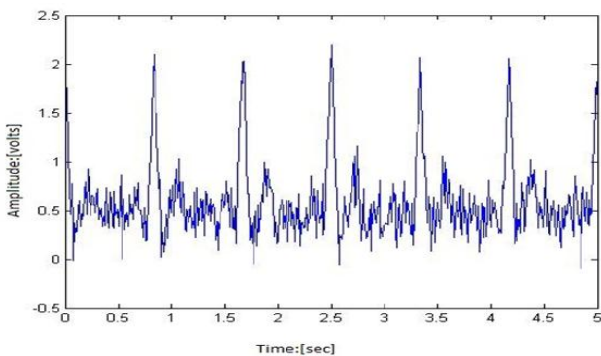


Fig 04: 15 dB Awake ECG Signal

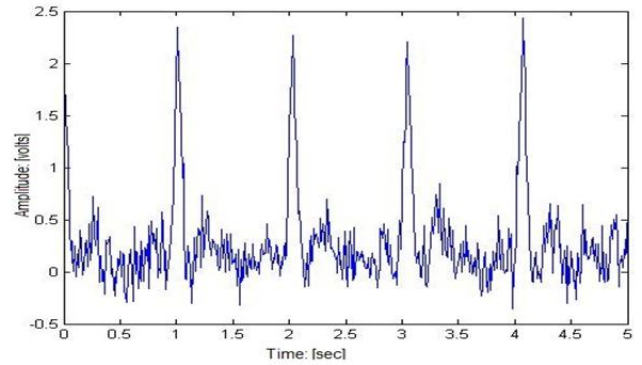


Fig 05: 15 dB Drowsy ECG Signal

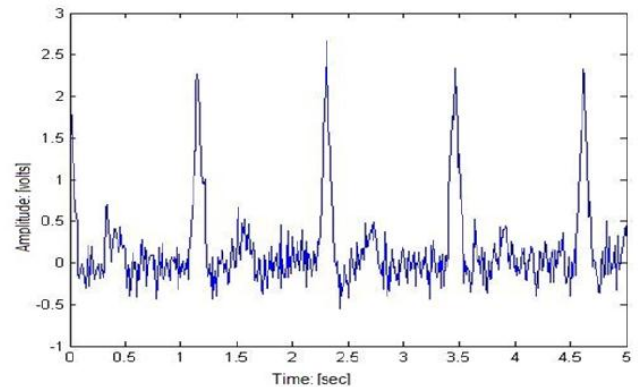


Fig 06: 15 dB Sleep ECG Signal

In our case, we have observed 1 million of samples (ECG shapes) like the Fig. 04 to Fig. 06 we further we divided that into 100 parts and calculated SSC parameters (Amplitude mean, Amplitude Deviation, Time Mean, Time Deviation) of those parts. We did that by varying SNR from 0dB-40dB and for three times for three individual states (Awake, Drowsy, and Sleep). Therefore it requires a huge calculation to get the values. To solve this problem we took help from the MATLAB we code the function and then implemented in our work. This process is used for both training and classification process. Obviously we have to program two different functions to train and classify the state. We generated values of SSC parameters using MATLAB and then used those values to form a data sheet by which the training decision tree was formed. The equations of calculating SSC parameters are shown before. Once the SSC parameters are calculated then the first thing to do is deriving decision tree to train the system. The decision tree was formed by the help of another software WEKA. The decision tree is then used for comparing to a randomly generated state and randomly varied SNR. Therefore, classification is done. This process is further automated using another MATLAB programming. An example of our task is given below.

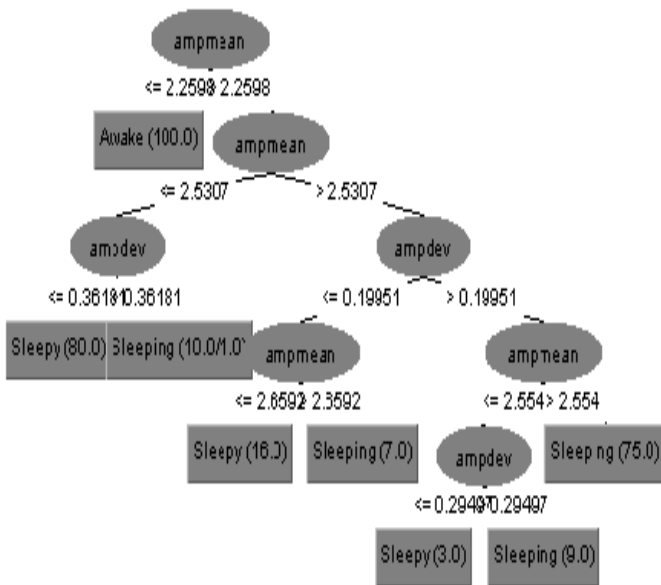


Fig 07: Decision Tree for 14 dB SNR

system which shows a relationship between the success rate of the system and SNR.

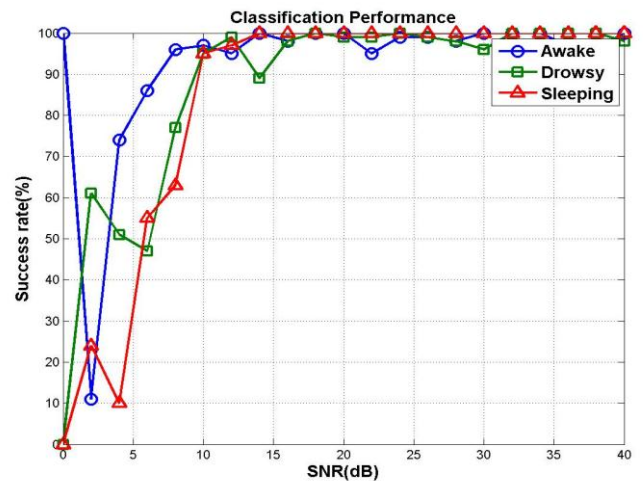


Fig 09: Performance Characteristics classified by trained values and SNR

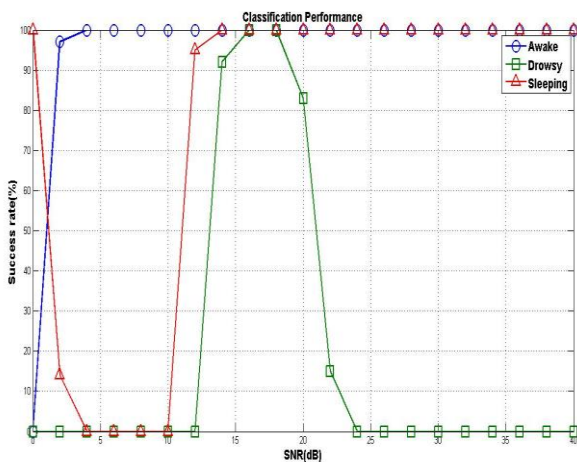


Fig. 08: Performance characteristics classified by different values and at 14db SNR

Fig 09, graph shows a how much this system is effective in detecting the state of the drivers. This is formed by comparison of data feed in training phase and randomly generated data generated by MATLAB. It generates data of SSC parameters for all three conditions varying SNR up to 40 DB of interval 2 DB each time. Therefore, this is the training phase of the system. In this phase the system is acknowledge what for which data is generate. This process is also followed in classification phase of the system. MATLAB generates values for a given condition, of same parameters that have generated in training phase. In classification phase MATLAB code is simulated in such way that, it follows the same data path used in training phase. As the data path is same the code start comparing values SNR wise with the training values. Therefore, the fig. 09 represents a relative comparative result found in both case at same SNR. Like 0dB SNR of Training is comparing with the 0 dB SSC parameters, 10 dB are with 10 dB. In a word this coding is comparing two sets of data which is generated for same SNR. The above illustration also shows a very important relation between Success rate and Signal to Noise Ratio. The more the strength of the signal increase the more we get a higher success rate. It also refers the observation that if the signal strength is above 10 dB the success rate is extremely high and it is almost 98 percent. The state of the drivers is effectively detectable by our system through good accuracy. According to the graph generated, it is clear that the system is able to detect all the three states with satisfactory result. Therefore, task of detection of driver's state or drowsy state is detected.

The fig. 08 is showing performance characteristics of signals of 78bpm 60bpm and 50bpm versus 72bpm, 60bpm and 52bpm in the SNR values of 14dB. This is quite impressive in the region of 10-20db region. Therefore, it's also giving us the indication of working the system in the same manner by which it was trained. But the performance is extremely poor in all case except in the region of 10-20dB. Which is happened we suppose is for, not applying any de-noising method in the system as mentioned above.

#### IV. CONCLUSION

Performance characterization of the system was found form our simulation. Finally we got a characterization graph for the

Our paper shows how to build an active and efficient system for the finding of driver's condition (Awake, sleepy, and sleeping) while driving to reduce accident. The system methodology is separated in three parts i.e. training, features extraction and classifying. In this system we have simulated

ECG by various SNR. We used a control signal that classified the state of the driver during the test defined by a combination of ECG figures using MATLAB which recommended with SSC (statistical Signal Characterized) parameters and defined from the observation of the driver's condition (Awake, Drowsy and Sleeping) in terms. So this paper will help to detect the state of automobile drivers easily and effectively. This detection can save a millions of life by reducing the number of accident on roads and highways.

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# Analyzing Disruption Routing Network Protocols

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**Abstract**— Flood is a very common phenomenon in Bangladesh. At the time of flood, communication network gets disrupted; therefore, many people do not get even the information regarding location of evacuation center. Disruption/ Delay Tolerant Network helps to forward messages from node to node in order to spread the message that includes the location of evacuation center. Finding out the best protocol enables faster and stable communication. Therefore, performance metrics like overhead ratio, average latency and delivery probability are scrutinized in Opportunistic Network Environment (ONE) simulator. In order to hold the experiment number of nodes and message, Time-To-Leave (TTL) is considered as a parameter in the simulator environment. On the basis of the output from the above mentioned metrics, an evaluation held to find out the most effective protocol that could be more useful in the mentioned scenario.

**Keywords**-DTN routing protocol, ONE simulator, Natural Disaster

## I. INTRODUCTION

Natural disaster like flood, earthquake, cyclone and human created turmoil such as war can cause disruption in communication services such as landline, cell phone, and internet by damaging the traditional network architecture. In such scenario, communication is still possible by the use of Delay/Disruption Tolerant Network (DTN). It is convenient to use DTN for the situation where long periods of disruption, long delays and lack of connectivity between different network nodes exist [1], [2]. Moreover, DTN tolerates delay where e-mail is too slow and video streaming is twenty-eight percent on internet traffic [3]. Delay-and Disruption Tolerant Networks mainly works in Communication Challenged Regions (CCRs) mainly in the region where connections are hardly stable. Also, delay exists among short end-to-end connections. DTN is needed in the areas with no wired and minimal wireless communication [4]. Though the architecture of DTN is designed to reduce the irregular communication, it is also used in any technical problem addressed in the “heterogeneous network”, and network that has issue with continuous connectivity [5]. Therefore, irregular communication issues and limitations have less impact on the whole network of DTN. In order to overcome problems regarding inconsistent communication, DTN architecture design includes fault-tolerant methods and technology of increasing quality of graceful degradation of adverse conditions or extreme traffic loads. This design also has the ability to prevent or quickly recover from electronic attacks and the ability to function with minimal latency even when routes are ill-defined or unreliable

[6]. DTN system has many protocols to deliver messages. The primary distinction among the DTN routing protocols is the decision making process regarding routing based on the existing amount of information. In order to determine the best routing protocols for emergency situation like flood, Opportunistic Network Environment (ONE) has been used in this research. ONE is a java based simulator which is used to simulate discrete events. It includes various movement models, concept of location, communication range and throughput for node connectivity. It sends message in unicast approach which includes a source and a destination [2]. This paper investigates the most efficient protocol for disaster scenario by examining different metrics in simulator. Consequently, the evaluation result of these metrics determines a report on message delivery during disaster in DTN.

## II. MOTIVATION

At the time of natural disaster like flood, people move to evacuation center or to rescue center. Sometimes survivors find difficulties to identify the exact place of evacuation center during flood. In this case, DTN can help to find out the location of evacuation center of a particular area. An efficiently designed DTN model can be an effective way of message passing during flood. In order to establish this, we examined some performance metrics of DTN by using ONE simulator. The performance metrics are based on Average Latency, Overhead Ratio and Delivery Probability. These performance metrics are evaluated in terms of different protocols. Thus observing the output data we tried to conclude on the most efficient protocol for DTN architecture in emergency situations like flood.

## III. ARCHITECTURE

### A. Delay/ Disruption Tolerant Network

At the time of network disturbance or at the time of difficulties to establish network between nodes DTN is used. It uses “store and forward” mechanism to move data from node to node in order to reach the destination [9]. DTN solves fundamental problems of disrupted networks and it works to serve robust network where other design of network cannot solve the fundamental network problems.



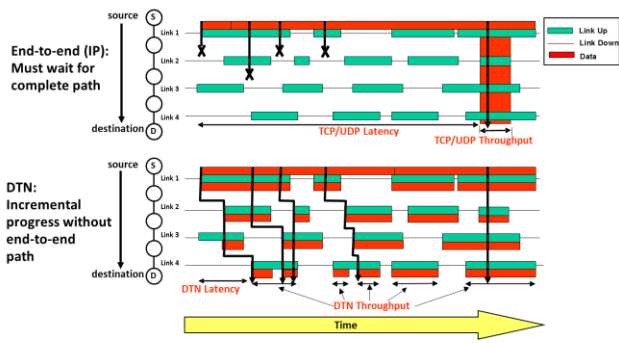


Figure 1. Example Latency and Throughput of DTN

From Figure 1, it is visible that DTN increases throughput of messages while reducing the delay in communication. DTN prefers contents while accessing any information. After accessing information, it retrieves that information and provides it to the requested local users. Rather using physical security, it chooses to use temporal security. For routing over challenged networks, DTN uses On-demand connection, Scheduled connection, Predicted connections and Opportunistic connections [7]. Delay Tolerant does not contain any end-to-end path between nodes. It can tolerate frequent division in network. Therefore, it provides various applications in emergency situations like military battlefield, disaster, deep space communication, vehicular communication. Moreover, rural areas also can get advantage of using DTN for communication. As this network cannot assure end to end path for any node-pair, its speed is unpredictable. DTN's feature of unicasting message is the base for inventing many DTN protocols through sending unicast packets. Multicasting messages are a challenge for DTN based network due to very frequent partitioning [10].

### B. DTN architecture and protocols (System Model)

In this model, a set of nodes transfers data among each other. Suppose, if one node transfers data to another node of its communication range, the sender keeps a copy of data with it and send the replicated copy to another node. It has less space for storing and limited bandwidth. However, destination node has capacity to store packets before delivering. It is assumed that nodes in one set meet for a very short period of time [11].

### C. DTN Routing Protocol

Routing in DTN follows store and forward approach. The routing algorithm finds out the next destination to forward the message. Also, this routing algorithm decides how long the message will wait before it is forwarded to the next node. The objective of DTN routing is to maximize the probability of message delivery and minimize some metrics like number of nodes. Proactive network-layer routing helps DTN routing algorithm to find out the next node which is nearer. However, Proactive routing is not able to help DTN routing when the nodes are far away from each other. Likewise, Reactive routing also helps in DTN routing by discovering on-demand routes in the environment of relatively sparse traffic [5]. Following are some of the protocols for DTN.

#### 1) Direct Transmission/Delivery

First Contact is a single-copy routing protocol as well, thus only one copy of message existed in the network. In this routing protocol the source node passes the message to the first encountered node and deletes the packet from the queue. This protocol employs First In First out (FIFO) queuing [22]. The nodes search for destination in a "random walk" approach to reach the destination. The node transfers the message to a node which is encountered at very first moment of searching nodes to pass message.

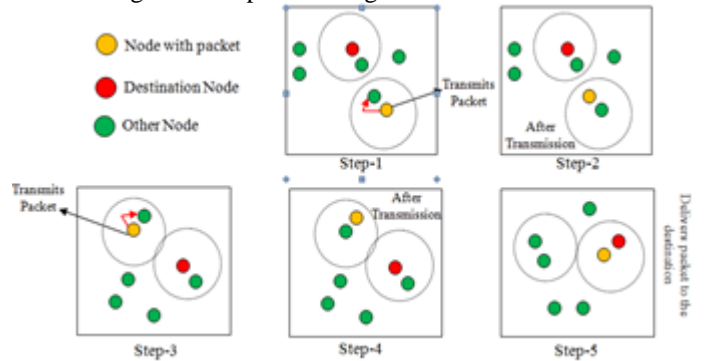


Figure 2. First Contact.

#### 2) Spray and Wait

Spray-and-Wait is an n- copy routing protocol which replicates only a limited number of copies of messages in the network [12]. It has two phases, Spray and Wait. In Spray phase a limited number of copies (L) of message are distributed (Sprayed) to the nodes nearby. In Wait phase, if the message is not reached to the destination in Spray phase, the L nodes that carry the message forward the message by following Direct Delivery routing method. Therefore, the Spray-and-Wait routing protocol is a combination of Spray and Direct Delivery (Wait) [11].

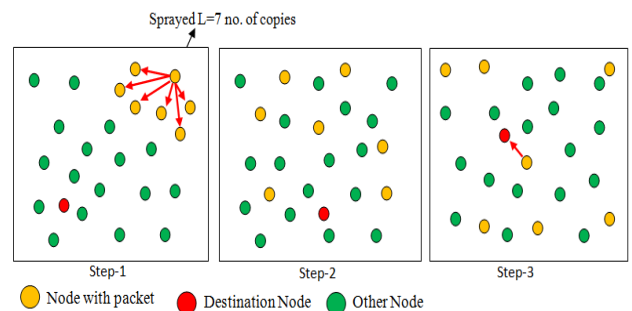


Figure 3. Spray and Wait

Figure 3 is the graphical representation of Spray-and-Wait routing protocol. In the figure yellow node contains packet, the red node is the destination, and the green node is represented as other nodes in the network. In step 1, the source node distributes the L=7 copies of messages in the network. In step 2, the node that contains a copy of messages moves forward. Finally, in the step 3, the node that contains the

message forwards the message to the destination following direct delivery method.

### 3) Epidemic Routing Protocol

Epidemic Routing is a protocol that can be routed in sparse and/or in highly mobile networks where any “contemporaneous path” may not exist between sender and receiver. Therefore, it follows “store-carry-forward” method to deliver messages. [8]. In order to reach the message to the target destination epidemic routing protocols techniques assumes that each node contains unlimited storage space and bandwidth; therefore, it ensures that the network has enough number of random exchange of messages. This routing protocol ensures that the message reaches to its destination [11]. Epidemic Routing protocol can be compared with the spread of virus. Every time a message carrier node encounters a node which is not a carrier of the message, the carrier node passages a copy of the message to the carrier which is portrayed as to infect the uninfected node. Subsequently, all the nodes transmits message in the same way. As a result, when the destination node first encounters an infected node it receives the message. When there is less traffic load in the network, Epidemic routing achieves minimum delivery delay by utilizing the resources like buffer space, bandwidth, and transmission power [8].

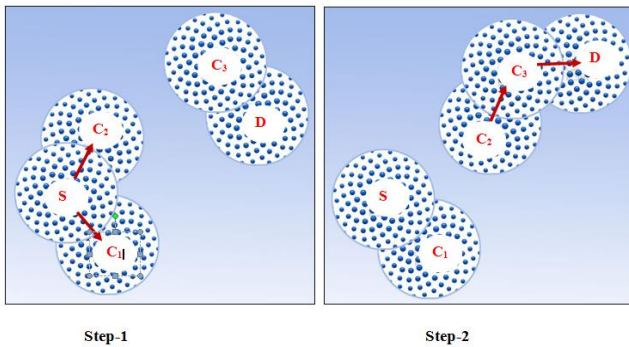


Figure 4. Epidemic Routing

In the Figure 4, step-1 source of a packet is S and destination is D. S transmits two replication of the message to the neighbor nodes C1 and C2 as they are sharing direct connection. In figure 2.5, step-2 C2 and C3 are in direct connection so C2 passage a copy of the packet to C3. Finally, as C3 is directly connected with destination node D, C3 passage the message to D [8].

### 4) MaxProp Protocol

MaxProp is a n-copy and predictive routing protocols that floods the n copies of message in the network. However, it explicitly deletes the message when a copy of the message reaches to the destination [13]. In MaxProp, every single node maintains a routing table to reach destination. The routing table contains the optimal cost to reach the destination through the current neighbors. The routing tables of the nodes are updated every time the message is forwarded [9]. Additionally, in case of MaxProp, acknowledgments are sent to all the neighbor nodes to inform about the packet delivery. MaxProp has a mechanism to reject double

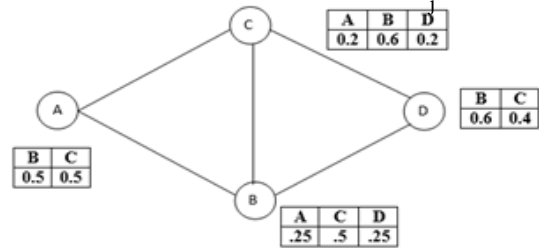
reception of a message and prioritize to new packets [7]. Since the protocol is history and replication based, it is both dependent on and independent from the destination at the same time. This routing protocol follows Dijkstra’s algorithm to find out the optimal cost path from source to destination [4].

#### Calculating Optimal Path Cost:

Let,  $s$  is the set of nodes in the network  
 Each node,  $n \in s$ , keeps track of a probability of meeting peer  $j \in s$ .  
 The estimated probability of  $f_i^n$  is initially calculated as  

$$f_j^n = 1 / (|s| - 1)$$

When node  $j$  is encountered, the value of  $f_i^n$  is increased by



$$ABD = (1-0.5) + (1-0.25) = 1.25$$

$$ACD = (1-0.5) + (1-0.2) = 1.3$$

$$ABCD = (1-0.5) + (1-0.5) + (1-0.2) = 1.8$$

$$ACBD = (1-0.5) + (1-0.6) + (1-0.25) = 1.65$$

For example, if a DTN contains four nodes, a peer  $j$  has values for  $f_1^1 = \frac{1}{3}$ ,  $f_2^1 = \frac{1}{2}$ ,  $f_3^1 = \frac{1}{3}$ ,  $f_4^1 = 0.25$ . Based on encountering

node 2, the peer sets  $f_2^2 = 1 + 0.25 = 1.25$ . After re-normalizing  

$$f_1^2 = \frac{f_1^1}{2} = \frac{1}{6} = 0.125$$
 and  $f_2^2 = 0.625$  [20].

### 5) Performance Metrics:

Though there are many protocols exist for DTN, only First Contact, Epidemic, Spray and wait and MaxProp are chosen to do the experiment in ONE simulator environment predicts which node has the most “likelihood” of delivering packet to the final destination using the information of previously encountered nodes [4]. This estimation is done by avoiding sending packets to paths that have low probability of reaching the packet to the destination [7]. Every node has a record of deliver that can be used as “predictability estimates”. We use Overhead Ratio, Average Latency, and Delivery Probability as performance metrics to experiment the efficiency of each protocol and to analyze the protocols. Overhead Ratio is used to calculate the extra number of required packets for actual delivery of the data packets. It is calculated as:

$$\text{Overhead Ratio} = \frac{\text{Number of Packets Relayed} - \text{Number of Packets}}{\text{Number of Packets Delivered}}$$

Delivery Probability is the fraction of created messages that are correctly delivered to the destination within limited time duration.

$$\text{Delivery Probability} = \frac{\text{Number of packets delivered}}{\text{Number of packets created}}$$

Number of packets delivered means number of packet received by the node.

Average Latency: Average Latency is the average time duration between message generation and message reception by the destination. [8].

#### IV. METHODOLOGY

Type of disaster defines the specific scenario for the disaster based on its post and aftereffects, severity and type of loss. If there is a hurricane, the disaster scenario is entirely different from the scenario of earth quake. This research considers flood as the scenario and that the place is Chittagong. We assume that all the victims or people around Chittagong city carry a mobile DTN node with them. With that specific node, people can transfer data regarding the location of evacuation center to each other. Moreover, we assume that DTN in vehicle performs a significant role in this case as it ensures that node can reach to each other in short period of time when they move along with vehicle. By changing Time-To-Live parameter, the time of forwarding packet each time is counted. After reaching to a pre-determine boundary value, the packet stops communicating [9]. Therefore, we change TTL to get different values of the metrics while evaluating DTN protocol for an assumed disastrous scenario

##### A. Scenario:

Let's assume a flood has occurred in a small city or town. The city includes people and vehicles including rickshaw, car and bus. When flood occurs people start to move from their own places in order to find out the rescue center or evacuation center. However, it is assumed that not all the people have knowledge regarding the location of evacuation center. In this situation, DTN devices are used to pass messages regarding location of evacuation center. Suppose, DTN devices are also installed in different vehicles like cars, rickshaw and buses. Rescue team passes the message from one DTN device to another. An evacuation center is explored through message passing in one neighborhood. As there could be many evacuation centers for different area, a device can receive more than one message. Then, the device holder chooses the nearest evacuation center to get shelter. This research examines which protocol shows better performance in terms of Overhead ratio, Average latency and Delivery Probability metrics. Then one particular protocol is suggested to be used in the DTN device during flood in that city in that specific disaster scenario and for our research flood is considered. In order to experiment the whole scenario, ONE simulator has been used.

##### B. ONE Simulator:

Opportunistic Network Environment (ONE) is a simulation environment where different movement models are responsible to create movement of nodes. Also, several DTN routing algorithms ensure routing messages between sender

and receiver nodes. Moreover, ONE simulator is able to visualize real time mobility and the process of message delivery in its graphical user interface. Node movements, message delivering and other general statistics can create various reports in ONE simulation [12]. The Java based ONE simulator supports events like mobility, DTN routing and application protocols, message exchange, basic notion of energy consumption, visualization and analysis, interfaces of exporting and importing mobility traces. This well-defined interface of simulator ONE allows to implement all real time functions virtually [13].

##### C. Simulator Scenario:

We start experiment in the chosen part of Helsinki downtown area 4500\*3400 (m2) as shown in Figure 3.1. In the roads of map, we include people for pedestrians and vehicle routes in another path

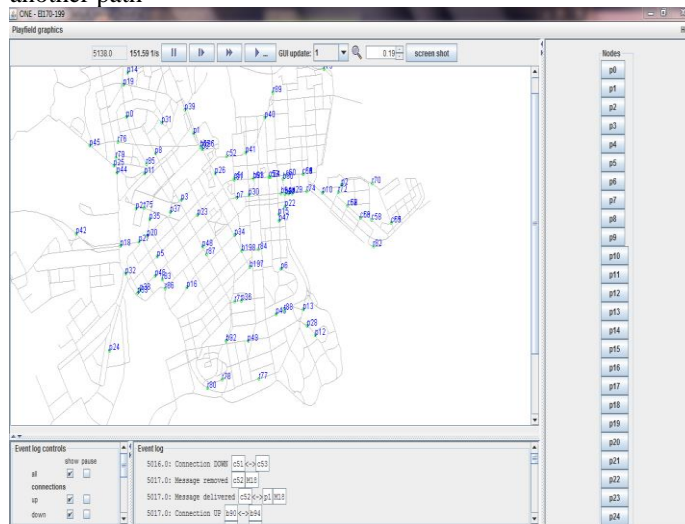


Figure 5. ONE Simulator

As people and vehicles are having installed DTN in their devices, these can be counted as nodes. Therefore, the number of nodes, speed of the assumed nodes and movement models for them are selected and given below:

##### D Group Setting:

Group Name	No of Nodes	Speed (m/s)	Movement Models
People(p)	50	0.5, 1.5	ShortestPathMapBasedMovement
Rickshaw(r)	20	5,10	MapRouteMovement
Cars(c)	20	7,20	MapRouteMovement
Bus(b)	5	7,20	MapRouteMovement
Bus(b1)	5	7,20	MapRouteMovement

In this group setting, different movement models are used for people and vehicle. In case of bus, as there are two different

roads in simulator, so we use two different group of bus such as Bus (b) and Bus (b1). However, both of the groups use same MapRouteMovement model.

#### IV. RESULT AND ANALYSIS

In the simulator Opportunistic Network Environment we compare the performance metrics of First Contact, Epidemic, Spray-and-Wait, and MaxProp routing protocol. We conduct two experiments. For that reason, in one experiment we consider message Time to Live (TTL) as independent variable and in another experiment we consider number of nodes as independent variable. The following tables and graphs represent the result of the simulation run.

##### A. Average Latency:

When the independent variable is Message Time-To-Live, then the protocol shows below results

Message TTL	Epidemic	FirstContact	SprayAndWait
60	1969.221	2178.6111	2027.0982
120	2420.361	3684.9444	3284.9532
180	2491.029	5067.2951	4604.1737
240	2461.578	6395.2763	5228.9565
300	2446.222	8032.6701	5595.1345
360	2458.636	8727.4021	5801.9
420	2429.438	10391.7075	5934.0702
480	2440.697	10770.8727	5929.9378
540	2408.873	10634.4393	6036.6667
600	2455.659	10701.0183	6117.0496

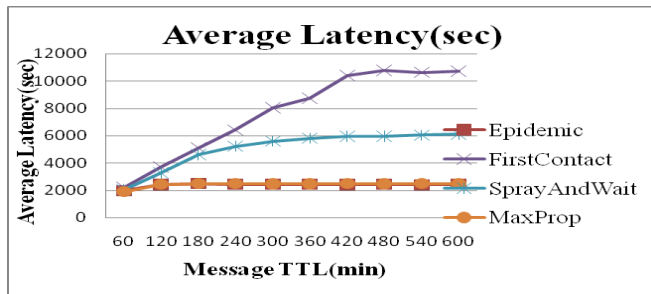


Figure 6. Average Latency vs. MessageTTL

Figure 6. shows that for First Contact routing protocol as the TTL increases the average latency increases tremendously till the TTL 420minutes comparing to the other protocols. However, after Message TTL 420minutes it does not changes significantly. The graph illustrates that till the TTL is 360 minutes, the average latency of Spray-and-Wait routing shows increment. After message TTL 360, the average latency of Spray-and-Wait tends to remain nearly constant. For Maxprop and Epidemic routing protocol the average latency remains constant after the message TTL 120 minutes. By analyzing the above graph we can see that for Epidemic and Maxprop routing protocol the variation of message TTL does not have effect on average latency. The graph also illustrates that Epidemic and Maxprop has the least average latency. However, when the independent variable is number of nodes,

No of Node	Epidemic	FirstContact	SprayAndWait	MaxProp
50	5935.193	8594.9688	5758.6445	2759.739
75	5727.8378	7332.4125	6082.9016	2272.621
100	2712.4465	6156.8365	5674.8264	1438.145
125	1927.9184	7002.7561	4882.1358	1252.393
150	1206.7353	6363.7143	4059.5485	1307.45
175	958.4351	6749.8828	3814.5078	1066.12
200	927.1505	6258.2437	3065.3172	989.34
225	917.3786	7120.8763	3096.5321	909.9789
250	919.3	7091.2241	3409.7839	706.3554
275	831.331	6863.0909	4225.378	690.8944

then the average latency for the protocols are:

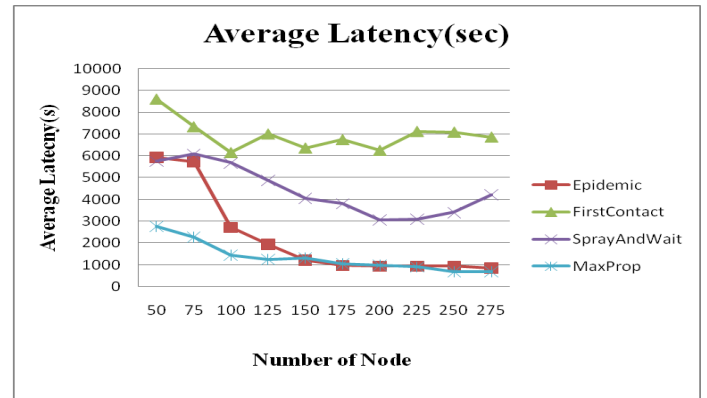


Figure 7. Average Latency vs No. of node

The graph in the Figure 7. shows that First Contact routing protocol has the highest average latency but with the change of number of nodes sometimes it decreases and sometimes increases. In Spray and Wait routing protocol at first as the number of nodes increases till 200 nodes the average latency decreases but after 200 the average latency increases. As the number of nodes increases the average latency decrease in Maxprop and Epidemic routing protocol, but after 150 nodes the decrease is not that significant. However, comparing with all routing protocols Epidemic and Maxprop have the lowest average latency

##### B. Overhead Ratio:

If we change Message Time to live, the Overhead Ratio changes in a following way:

Using similar data-table like Average Latency we get the following graph for overhead ratio.

Message TTL	Epidemic	FirstContact	SprayAndWait	MaxProp
60	83%	6%	39%	82%
120	94%	12%	59%	94%
180	94%	21%	73%	94%
240	95%	26%	79%	94%
300	95%	33%	82%	94%
360	95%	33%	83%	94%
420	94%	37%	83%	94%
480	94%	38%	83%	94%
540	95%	37%	83%	94%
600	95%	38%	83%	94%

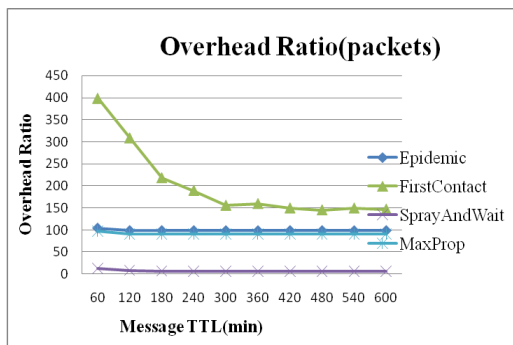


Figure 8. Overhead Ratio vs. MessageTTL

According to the Figure 8, the overhead ratio of First Contact routing protocol decreases significantly till message TTL 300 minutes as the message TTL increases. After message TTL 300 the decreasing trends of overhead ratio decreased and it seems almost constant. For Maxprop and Epidemic routing protocol the overhead ratio almost remain same as the as the message TTL increases. The graph illustrates that although the overhead ratio of Spray-and-Wait remains same with the change of Message TTL, it has the least overhead ratio. Considering the overhead vs. number of nodes we get the following graph

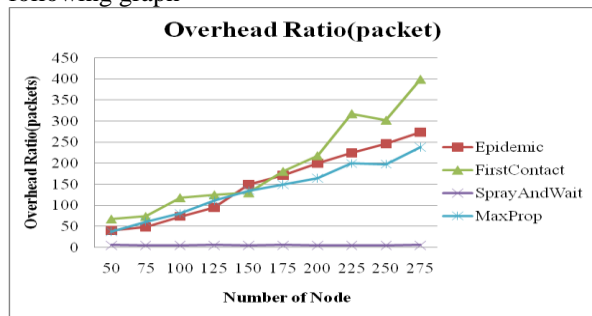


Figure 9. Overhead Ratio vs. No. of Node

Figure 9. illustrates that overhead ratio of all the routing protocols except Spray-and-Wait increase with increment of nodes. Spray-and-Wait has the lowest overhead ratio.

### C. Delivery Probability:

When Message Time To Live is independent

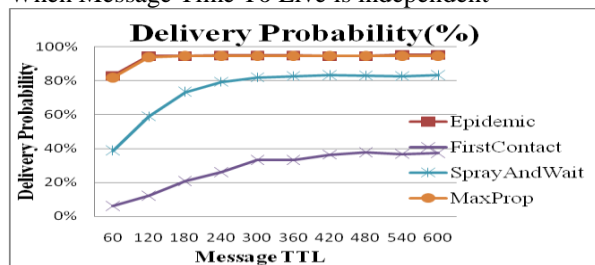


Figure 10. Delivery Probability vs. Message TTL

The graph in Figure 10. illustrates that Epidemic and Maxprop tends to remain same with the change of message TTL. However, Epidemic and Maxprop has the highest delivery probability. Spray-and-Wait routing protocol shows the increment in delivery probability when message TTL increases till 240minutes, and after that the delivery probability of Spray-and-Wait does not show any significant

change. On the other hand, First Contact routing protocol increases with the increment of message TTL, but it has the lowest delivery probability.

### VI. Conclusion

After analyzing the results of the simulator we come up with the conclusion that if we consider delivery probability and average latency, Epidemic and Maxprop routing protocol works better for both independent variable message TTL and number of nodes. Message TTL and number of nodes do not have significant effect on message delivery of Epidemic and Maxprop. However, number of nodes has some effect on the change of average latency. On the other hand, if we consider overhead ratio, Spray-and-Wait routing protocol works better. In disaster scenario Epidemic and Maxprop works well, because during flood it is important to make sure that the message is received. Therefore, in that scenario we do not need to concern about overhead ratio.

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# An Approach for Detecting Passive Image Tampering using DCT and Correlation Methods

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**Abstract**—An image is more powerful than thousands of words. Images have diverse benefits in different aspects of our life. Earlier, images were presented as an evidence but due to rapid growth and availability of image editing software, the credibility of images have been questioned. It becomes very easy to modify an image without leaving any vivid traces of adding or removing important features. As a result, to regain the authenticity of images, tampering detection has become a demand of time. Tampering is classified into two categories: active and passive. Copy move of content is very common in passive tampering. In the present work, we focus on copy-move technique of passive image tampering. At first we employ Discrete Cosine Transform (DCT) by dividing the image into square-sized blocks and then apply correlation to detect the tampering. Experimental result confirms the effectiveness of the technique.

**Index Terms**— Image tampering, copy-move technique, discrete cosine transform (DCT) and correlation.

## I. INTRODUCTION

Image is a common communication media and considered as a source of information. Image contributes a vast applications in our daily life ranging from military to medical diagnosis. The worth of images cannot be expressed in a word but due to the spontaneous use of low cost hardware and software, images can be edited, altered, modified and tampered easily. Image tampering is a term to indicate the analysis of the authenticity of an image by evaluating the presence of forgeries. The tampered image may totally convey different information than that of the original image. Digital image tampering or forgery has become a growing problem in criminal and public cases [1]. Sometimes these types of crime makes many people's life miserable. Hence it becomes very important to verify the authenticity of an image. There are different ways an image can be tampered. The common tampering methods are shown in the Fig. 1.

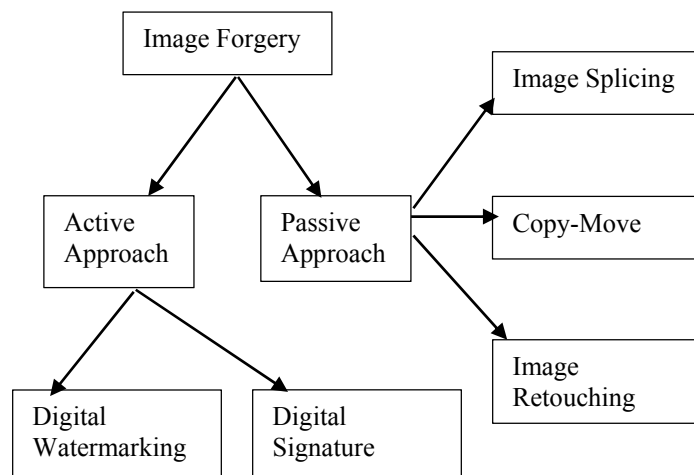


Fig 1: Techniques of image tampering.

Passive image tampering is conceptually considered as a blind tampering technique since no one knows where the tampering occurred and which technique might have been used. Among the different techniques copy-move of content is widely used as a tampering mechanism. Copy-move is a technique where a portion of object is copied and pasted somewhere in the image and is considered as the easiest and common way to forge an image. For this reason we put emphasis on copy-move technique.

In the present paper we tried to find an effective way for identifying this passive tampering employing DCT and correlation coefficient. DCT is similar to the discrete Fourier transform: it transforms a signal or image from the spatial domain to the frequency domain. Correlation coefficient is a fundamental concept regarding matching measures. Correlation is a method representing the degree of probability that some relationship exists between two measured quantities.

The rest of the paper is organized as follows: Section II describes a literature review. Section III presents experimental methodology. Section IV shows results and discussions. Finally, Section V draws the conclusion of the paper.

## II. RELATED WORK

This section provides an immediate review of some of significant research works.

Shivakumar and Baboo [2] describes a technique to detect copy-move forgery detection using on block-based method. They proposed to divide the RGB image into overlapping blocks and extracted features by frequency based method like DCT, DWT, PCA, FMT. The features or blocks are lexicographically sorted to localize the duplicate region.

Dirik and Memon [3] introduced an artifacts created by Color Filter Array (CFA) processing. The techniques are based on computing a single feature and a simple threshold-based classifier. They proposed two methods: One is based on CFA pattern number estimation and another is based on CFA-based noise analysis. Kumar [4] proposed a method where they applied discrete wavelet transforms (DWT) and created image blocks. Each block of the image is iteratively compared to every other block and calculates shift vector that produced the detection result.

Analysis and detection of image forgery methodologies proposed by Vidhi [5] introduced a method where an input image is converted to gray scale image and then it is divided into overlapping blocks. The characteristics of each block are calculated by different approaches (DWT, DCT and PCA). Lexicographically sort the values to find the similarity of blocks.

Another method for exposing digital forgeries by detecting duplicated image regions proposed by Faridy and Popescu [6]. They describes a technique applying principal component analysis (PCA) to reduce the dimensionality. Duplicated regions are then detected by lexicographically sorting all of the image blocks.

Sun [7] used the low frequency subband of discrete wavelet transform (DWT) output and then applied singular value decomposition (SVD) approach for dimensionality reduction.

An approach was proposed by Fridrich [8] to detect copy-move forgery detection based on an exhaustive search by comparing the images in cyclic-shifted versions. Since this approach requires 2 steps for an image of size  $M \times N$ , it is difficult to use in practice. The main drawback of this technique is that it can give false positive when the image has large identical textures. Therefore, an effective approach is an ultimate necessity.

## III. EXPERIMENTAL METHOD

The flow chart of our method is described in Fig. 2.

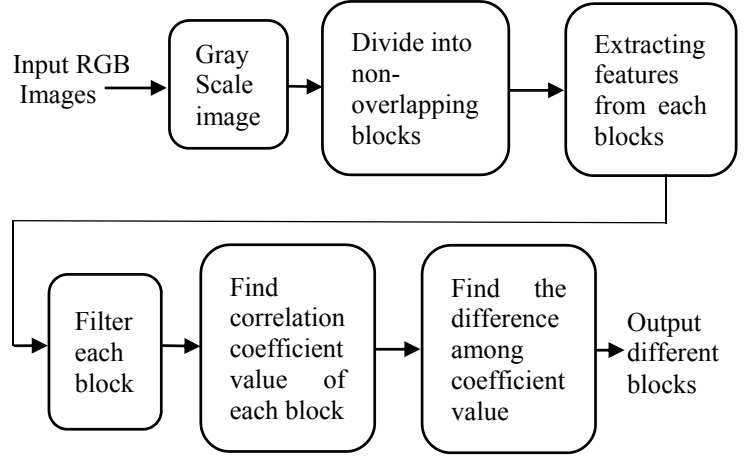


Fig 2: Flow diagram of our image tampering detection approach.

### Detection algorithm for copy-move technique

One primary assumption to detect copy-move forgery is breaking an image into blocks of size  $N \times N$  pixels and comparing the blocks for matching. The condition in this case is that the block size should be smaller than the minimum size of the tampered region [9]. The discrete cosine transform (DCT) represents an image as a sum of sinusoids of varying magnitude and frequencies and the predefined Matlab function *dct2* calculates the two-dimensional DCT value of an image. In DCT, the significant information about an image is concentrated in few coefficients of its DCT [10].

The two-dimensional DCT of an  $M \times N$  matrix is  $Q$ . The values  $P_{ab}$  are called the DCT coefficients of  $Q$  is defined as follows:

$$P_{ab} = \alpha_p \alpha_q \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} Q_{mn} \cos \pi \frac{(2m+1)a}{2M} \cos \pi (2n+1)b/2N \quad (1)$$

The term  $\alpha_p$  and  $\alpha_q$  used in equation 1 are defined by using the following equation:

$$\alpha_p = \begin{cases} \frac{1}{\sqrt{M}}, & p = 0 \\ \sqrt{2}/M, & 1 \leq p \leq M-1 \end{cases} \quad \alpha_q = \begin{cases} \frac{1}{\sqrt{N}}, & q = 0 \\ \sqrt{2}/N, & 1 \leq q \leq N-1 \end{cases} \quad (2)$$

This algorithm employs a block-matching procedure, which first divides the image into the same size blocks, then uses DCT to all of the image blocks and finds the correlation coefficient to yield a reduced dimensional representation. After that an exhaustive matching step is operated to figure out the forged portion of the image based on the coefficient values.

#### IV. RESULTS AND DISCUSSIONS

The training dataset used in the experiment consists of the real and tampered images of different sizes. To make a uniform size we have done a preprocessing (resizing) operation. After resizing to a size of  $512 \times 512$  pixels we convert the color image to grayscale.

As stated earlier we deploy DCT and then autocorrelation to differentiate the presence of similarity. To calculate the autocorrelation the following equation is used.

$$R_{xx}(l) = \sum_{n=-\infty}^{\infty} (x + a)^n = \sum_{n=-\infty}^{\infty} x(n) x(n - l) = R_{xx}(-l)$$

Where  $l=0, \pm 1, \pm 2 \dots$  (3)

Here  $R_{xx}$  is the autocorrelation coefficient value. If the two images are absolutely identical then the correlation coefficient has the value  $R=1$ ,  $R=0$  if they are completely uncorrelated and if they are completely anti-correlated then  $R=-1$  [11].

We have performed our experiment using 80 images from MICC-F220 database. In addition, we have worked on 20 images from Matlab Toolbox.

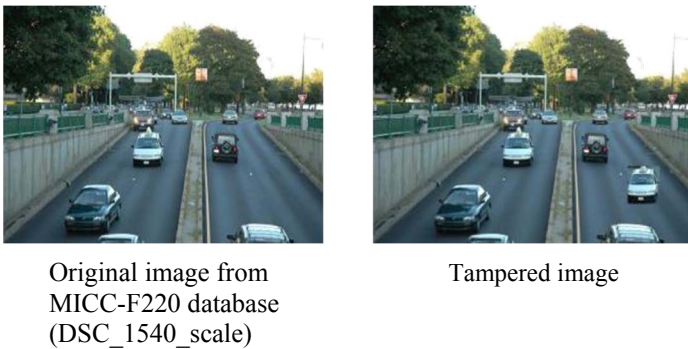


Fig 3: Original and tampered images.

In Fig. 3 we represent an image where a car is copied and pasted somewhere in the image and thus make the image tampered.

The image of Fig. 3 are divided into  $8 \times 8$  pixels non-overlapping blocks. The original and tampered blocks are shown in Fig. 4.

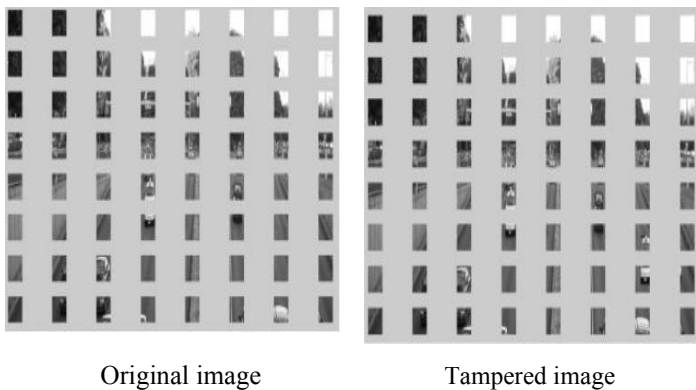


Fig 4:  $8 \times 8$  pixels non-overlapping blocks of the images.

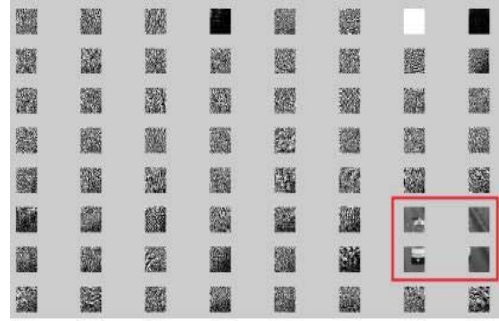


Fig 5: The DCT coefficient with duplicate region (marked using a colored rectangle).

Fig. 5 represents the DCT coefficients of the non-overlapping blocks of Fig. 4. Here the DCT coefficient with duplicate region is marked by a colored rectangle. Fig. 6 shows the detected tampered region of the image.



Fig. 6: The tampered region.

In addition we have worked using images from Matlab Toolbox. An image (peppers) is shown Fig. 7. In this figure, tampering is done by copy and pasting a garlic.



Fig 7: Original and tampered images.



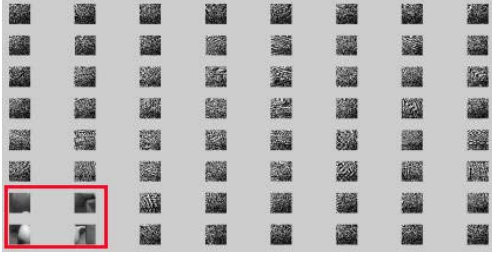


Fig 8: The DCT coefficient with duplicate region (marked using a colored rectangle).

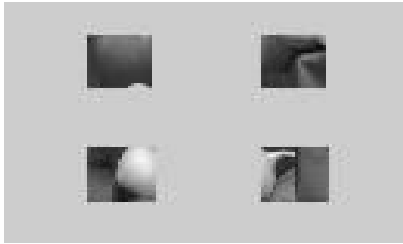


Fig. 9: The tampered region

Fig. 8 shows the coefficient values with duplicate region and Fig. 9 shows image blocks where tampering is occurred.

TABLE 1: TAMAMPERING DETECTION PERFORMANCE FOR IMAGES FROM MICC- F220 DATABASE.

ID	No. of tampered blocks	Result
DSC_1540_scale	4	Detect & localize the region
CRW_4853scale	6	Detect & localize the region
DSC_0812_scale	6	Detect & localize the region
DSCF8_scale	6	Detect & localize the region
DSC_1568_scale	6	Detect & localize the region
DSCN41_scale	2	Detect & localize the region
DSC_1535_scale	4	Detect & localize the region
CRW_4901_JFR_scale	2	Detect & localize the region
DSC_0535_scale	5	Detect & localize the region
CRW_4838_scale	4	Detect but cannot localize the region

TABLE 2: TAMAMPERING DETECTION PERFORMANCE FOR IMAGES FROM MATLAB TOOLBOX.

ID	No. of tampered blocks	Result
Pears	4	Detect and localize the region
Toyobjects	3	Detect and localize the region
Peppers	4	Detect and localize the region
Onion	6	Detect and localize the region
Fabric	6	Detect and localize the region
Toy	4	Detect and localize the region
PillsetC	9	Detect and localize the region
ColoredPic	4	Detect and localize the region

Table 1 shows the tampering detection performance for images from MICC-F220 database and Table 2 shows the performance for the images from Matlab Toolbox.

The effect of different block sizes is given in Fig.10. The block size has complexity  $O(n^2)$  for a 2D DCT of size  $N \times N$ . Though  $2 \times 2$  and  $4 \times 4$  block sizes have taken lower computation time than  $8 \times 8$ ,  $12 \times 12$  and  $16 \times 16$  block sizes. However, lower block sizes often fails to detect the forged region. Our experimentation confirms that  $8 \times 8$  is the optimal block size.

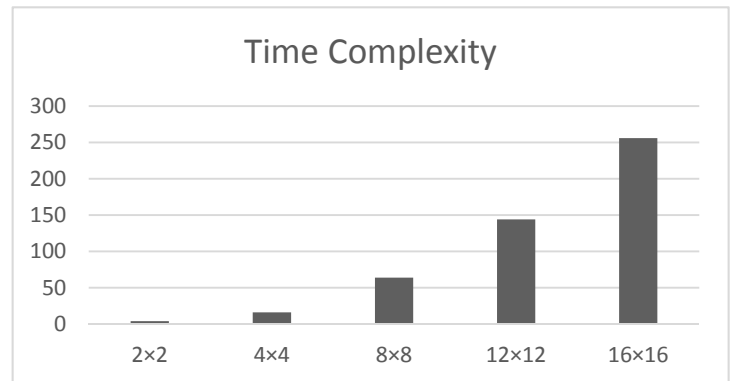


Fig. 10: Time Complexity of different block size.

The performance of our algorithm is quite good though the calculation of correlation coefficient is computationally expensive.

## V. CONCLUSION

Now-a-days, image tampering is very common. This paper investigated the detection and localization of a copy-move image tampering using DCT-based correlation method. Experiments are performed using tampered images from standard MICCF220 database and Matlab image processing toolbox. Our approach is quite successful in detecting the copy-move image tampering.

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# AutoSecSDN: Automated End-to-End Security in Software-Defined Networks

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**Abstract**—The complexity of modern communication networks and innovative cyber-attacking methods makes it difficult to automatically detect and prevent attacks. Software-Defined Networking (SDN) separates the forwarding of network traffic from the decision plane of the network and offers a central and programmable interface for the configuration of the network. In this paper, a novel approach to integrate end-to-end security into an SDN is developed. It improves the security of a network through automated defense mechanisms and is able to reduce the time needed for a response to a threat.

## I. INTRODUCTION

Today's networks are steadily growing in size and complexity. An example for these networks is data centers, which are operated by large enterprises including Facebook and Google. Some of these enterprises run up to several hundreds of thousand of servers [1]. The size of the data centers makes the management of the hosted servers and the underlying network infrastructure more and more complex. This is the reason, why Software-Defined Networking (SDN) is introduced to modern data centers. Google, for example, is using a software-driven mechanism for the management of their data centers [2]. It enables the administrators to manage the network from a central component within the network and is also used to automate tasks like routing. Data centers have the largest adoption rates of SDN, but branch and campus networks are also popular for the deployment of SDN [3].

The internal networks of companies contain many highly valuable assets, like internal or customer data, which can be a valuable target for an attacker. Some attackers have no interest in the valuable assets of a company. All they want, is to disrupt the business operations. Attacks from outside the network are well known and there are many security measures, like firewalls, to overcome the threat. But new threats from within the network showed up during the past few years. An attacker is able to use compromised machines within a network like before, but now there are more possibilities to get access to the network [4], an example is Bring Your Own Device (BYOD). BYOD is a challenge for the network security, because it allows the use of employee-owned devices, like computers and smartphones, within corporate networks. This supports for example, the spread of custom tailored malware. Malware is malicious software, for instance rootkits, and aims to damage its target. Attackers use rootkits to gain remote access to the

attacked computers. Recent malware is also used for targeted attacks. The malware is highly specialized and is designed to attack only a single computer or network [5].

The damage of an attack can be tremendous. Depending on the kind of attack and the sector of the company, a broad range of consequences can occur, some can even lead to the bankruptcy of the company. In most cases, the companies face a loss of reputation, but some companies need their network infrastructure for the business operations. For these companies, an outage for a few hours can result in financial losses in the magnitude of several hundreds of thousands of US Dollars [6], [7]. In the end, every attack is dangerous for the existence of a company.

Network connections between two endpoints, such as servers or workstations, are secured by using end-to-end security. There are different measures to secure the network connections. One example for these security measures is encryption. It is used to protect the exchanged data against eavesdropping and modification. Both endpoints of the encrypted network connection need a key to encrypt or decrypt the data.

SDN is a potential technology to automate many tasks in the network and to reduce the effort for the configuration. The combination of both approaches, end-to-end security and SDN, could enable the development of automated security measures to overcome current and future threats for networks. This paper proposes AutoSecSDN, which shows how end-to-end security can be integrated in SDN to improve the overall network security. The evaluation shows that the overall network security is improved without stressing the network and that flexible and effective security measures can be integrated easily.

A set of solution requirements have been derived and discussed in Section II. Based on the requirements, AutoSecSDN has been proposed in Section III and evaluated in Section IV. At last, a conclusion is drawn in Section V.

## II. SOLUTION REQUIREMENTS

A novel approach is needed to mitigate network threats and to improve the overall network security. Internal attacks are especially hard to mitigate, because they circumvent the traditional security perimeter of a network, like a corporate firewall.

In the following, a set of requirements have been defined which should be fulfilled by the proposed network security solution.

**Adaptation to new Threats:** Solutions targeting only a single or a small range of threats was a viable approach in the past, but the range of possible attack vectors is constantly increasing [8]. The current approach to mitigate the risk of an attack is to implement more independent countermeasures. However, the development and implementation of countermeasures is a time consuming task.

A suitable approach has to support the adaptation to new threats with little effort. This will significantly help to mitigate future threats.

**Short Response Time For Attacks:** It is critical to respond promptly to attacks on a network [9]. The detection of such an attack is only the first step. Other important points are to get an overview of the affected devices as fast as possible and to initiate appropriate countermeasures to mitigate the damage. The last two points are especially important in large networks, because the attack may spread through the network and can cause huge damage. A manual or semi-automatic approach to prevent the spread through the network can be slow in this case. However, if the network itself detects an attack and is able to react with the right countermeasures, it is possible to mitigate the damage to a minimum.

**Transparent for Clients and Assurance of usual Network Operations:** Important for the acceptance of a security solution is the seamless integration into the daily workflow of the users and the administrators of the network. In the best case, the users will not notice the implementation of additional security measures. The need for special briefings or a change of the current workflow can reduce the acceptance among the users. This is difficult for the administrators as they have to implement and maintain security solutions. However, the needed effort can be reduced to support the administrators. Changes on the network infrastructure, like new hardware, results in additional effort for the administrators and additional costs for the company and should be avoided.

**Provide Security Against Internal Threats:** It is not sufficient to secure the Internet access of a network [10] with a firewall, which filters most of the malicious network traffic. This single point of defense strategy is still widely used and is providing security for a network. But many devices, with Internet access, were integrated into corporate networks during the last few years. Every smartphone is able to share its Internet connection with other network devices and allows them to circumvent the security strategy of a company. Another threat for the security of a company's network are external storage devices, like memory sticks. These devices can be used for espionage and can also spread malware in the network. These new threats, which emerge within the network, are growing day by day. For this reason, it is important to take them into account while implementing a security strategy. It is not sufficient to setup a corporate firewall, which acts as single point of defense. The risk of internal attacks can be mitigated for example, by using the SDN to turn every switch

of the network into a firewall. The switches are then able to detect and filter malicious flows.

**Selective Application Of Security Measures:** It is important for servers with thousands of opened connections at the same time, that the security measures are efficient. This can be achieved by applying the security measures on a per-flow-base, similar to Hyper Text Transport Protocol (HTTP) connections, which can be secured using Transport Layer Security (TLS). The application of security measures has to be done by the respective host, for example a server, to reduce the load on the network infrastructure. This enables the host to secure flows, which use an otherwise insecure protocol, like File Transfer Protocol (FTP). With the implementation of this criterion, the security measures can be fine-tuned for the security requirements of a network. Even the countermeasures for specific threats can be adjusted to mitigate the risk of an attack. In addition to the above requirements, the following two use-case scenarios should be considered as they concentrate on the end-to-end security of connections and provide additional security through measures provided by the SDN for example, by managing the permitted flows.

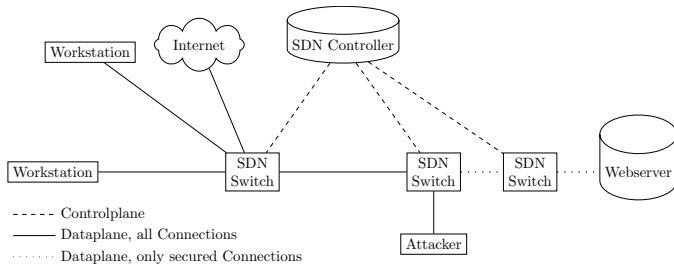
**Scenario 1: Flow-Based Security:** The first scenario is about the security between two hosts. The aim is to secure a single connection between both hosts by encrypting the connection and eventually add necessary routes to all involved network participants. The implementation of additional routes is necessary if the network operates with a minimal set of routes to improve the overall security.

The encryption and decryption of the connection is done by an agent, a special software for this task, on both end-points. This approach is transparent for all applications and works without an additional modification of any application, like a locally installed proxy server. There are several advantages over a locally installed proxy server. Instead of handling all HTTP or FTP connections on the same way, the agent can handle several connections of the same protocol in a distinct way. Also the handling of the connections is highly customizable.

A basic corporate network, as shown in Figure 1, is used as example for this scenario. The relevant network participants are some workstations and an internal web server for the Intranet. It was detected by an Intrusion Detection System (IDS) or a security solution based on a Trusted Platform Module (TPM), that one of the workstations is compromised. This workstation is shown as attacker. The Intranet web server is located in a secured sub-network at the right of the figure and has no routes to other sub-networks or to the Internet.

All employees can access the Internet from their workstations. But the access to the Intranet web server is handled by the agent and the SDN. If the employee of a workstation is authorized to access the Intranet web server, a route is implemented in the network and an encrypted connection is established. In any other cases, the employee has no access and is not even able to discover the web server by any means. If an attacker gains access to the network and compromises a workstation, he can start man-in-the-middle attacks, like eaves-

dropping. In this scenario, the attacker is not able to gather any information from the Intranet, because the connections are encrypted and only authorized workstations have access to the Intranet.

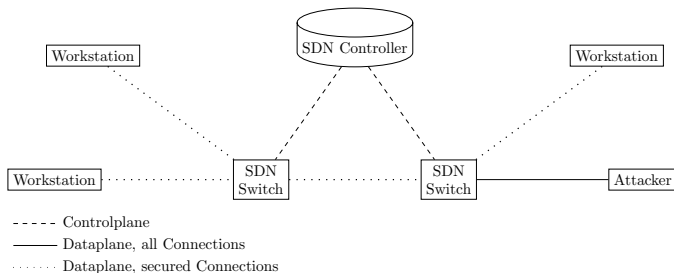


**Fig. 1: Setup of Scenario 1: Flow-Based Security**

**Scenario 2: Host-Based Security:** The second scenario is about the overall security of a network. While only a single connection is encrypted on demand in the first scenario, this scenario presents an approach to encrypt all network traffic and minimizes the damage of an attack.

This scenario is centered around the SDN controller. The SDN controller instructs all network participants via an extension and an agent to use a specific configuration to stay part of the network. The extension uses the Application Programming Interface (API) of the SDN controller for this task and the agents are installed on the network participants. The configuration can be a specific encryption or any other kind of security measure. If this is impossible for a network participant, it is isolated from the remaining network. This isolation can happen passively through the lack of the correct configuration of the agent or actively, for instance by removing network routes.

The SDN controller needs an external event as trigger to instruct the network. There are several possible events, which can serve as trigger. The most basic event is a network administrator, who enables for example the network encryption. Other events can be generated by an IDS, anti-virus-scanner, TPM and other sources, which can detect a security breach of a computer or network. If a computer is compromised, the SDN controller can take further steps and isolate the computer from the remaining network i.e. by deleting all routes from and to the computer or putting it into a quarantine network. This will effectively prevent a threat from spreading in the whole network.

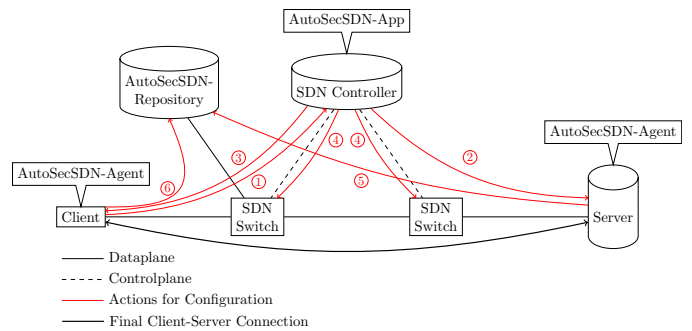


**Fig. 2: Setup of Scenario 2: Host-Based Security**

Figure 2 shows the scenario including three workstations and an attacker besides of the SDN infrastructure consisting of an SDN controller and two SDN switches. The workstations were instructed by the SDN controller to use secured connections. So all connections between the authorized workstations are secured. The attacker is not an authorized network participant and is not able to use the same security measures. Due to the missing security, the attacker is not able to establish a connection to other workstations. This isolates the attacker from the remaining network without changing any flows. To increase the level of isolation, the SDN controller can instruct the SDN switches to remove all flows related to the attacker. This will render the attackers network connection useless. The novel approach should use a combination of end-to-end security and SDN to secure the internal network and automate the response to attacks.

### III. PROPOSED APPROACH: AUTOSECSDN

AutoSecSDN is a new approach, which is developed to meet the requirements described in the last section. A basic setup of AutoSecSDN is shown in Figure 3. One aim of AutoSecSDN is, to keep the configuration effort to a minimum. For this reason, AutoSecSDN introduces one new network device, a repository, which hosts files which are needed by the hosts to fulfill the security policies. A client and a server are included in this example for showing how a connection between both could be secured. An agent, which is called AutoSecSDN-Agent, is installed on the Client and the Server. It is fetching required files from the repository and is doing the configuration of the respective network device. The whole configuration is managed by the AutoSecSDN-App which is designed as an extension for the SDN controller.



**Fig. 3: Architecture and Initialization of AutoSecSDN**

Besides the basic network configuration, Figure 3 shows how does AutoSecSDN configure itself for securing a connection between the Client and the Server.

In this example, the connection attempt originates from the Client, which tries to send the first network packet to the Server. At the same time, it keeps a copy of the network packet for later use. If no flow rule of the receiving SDN switch matches the network packet, it is intercepted by it and the network packet is sent as configuration request to the AutoSecSDN-App in step 1. The AutoSecSDN-App searches

for the connection details of the network packet in a database. The database is managed by the administrators of the network and contains the necessary rules of the security policy. The response depends on the result of the database lookup. If no matching entry is found, the AutoSecSDN-Agent is instructed to forward the network packet without further measures. If an entry is found, the AutoSecSDN-App instructs the AutoSecSDN-Agents of both connection participants to load the Agent-Configuration, which is specified in the entry. The AutoSecSDN-Agents use the provided information to conduct the configuration. This is shown in step 2 for the AutoSecSDN-Agent of the Server and in step 3 for the AutoSecSDN-Agent of the Client. At the same time the SDN controller installs the appropriate flow rules for the connection on the involved SDN switch by using the OpenFlow protocol, as shown in step 4. This ensures, that the connection is forwarded by the SDN switch. In steps 5 and 6, the AutoSecSDN-Agents of the Client and Server retrieve the needed Agent-Configuration from the Repository. After loading the Agent-Configuration, the AutoSecSDN configuration is completed. The AutoSecSDN-Agent can now process the copy of the network packet using the new configuration. Then, the network packet is sent to the Server, where the AutoSecSDN-Agent processes the network packet using its new configuration. After the processing, the network packet is forwarded from the AutoSecSDN-Agent to the actual Server, which receives the original network packet sent by the Client.

The process, which was described before, covers the first scenario. The aim is to secure a single connection and the Client initiates the configuration process, because it is the origin of the connection. In the second scenario, the AutoSecSDN-App initiates the configuration process and instructs all network participants to reconfigure. It is necessary, that the AutoSecSDN-App initiates the configuration process, if a threat was detected and reported to the AutoSecSDN-App. In this case the first step in Figure 3 is omitted and the AutoSecSDN-App sends the instructions immediately to the network participants, as shown in steps 2 and 3. After this has happened, the configuration of the network is done as described before.

#### A. AutoSecSDN-Configuration-Protocol

The configuration is done by exchanging messages between the AutoSecSDN-App and AutoSecSDN-Agents. Therefore a bidirectional messaging protocol is needed and the AutoSecSDN-Configuration-Protocol was developed as solution. OpenFlow is perfectly suitable for configuring SDN switches, but AutoSecSDN introduces new features, like rules, alerts and the distribution of Agent-Configurations and these features are not covered by OpenFlow. A rule is similar to the flow rules of an SDN switch. It consists of a matching part and a Config-ID instead of an action or instruction. The matching part is used to identify matching flows and the Config-ID determines, which Agent-Configuration has to be loaded by the AutoSecSDN-Agent. While a rule operates on a single flow and enables the AutoSecSDN-Agent to secure a single

Category	Message	Category	Message
<b>Configuration:</b>	ClientHello	<b>Data:</b>	DataRequest
	ConfigurationRequest		DataReply
	ConfigurationReply	<b>Alerts:</b>	SetAlert
	ConfigurationInstruction		ResetAlert
	StatusReply		GetAlertsRequest
<b>Rules:</b>	GetRulesRequest	GetAlertsReply	
	GetRulesReply	AddAlert	
	AddRule	EditAlert	
	EditRule	DeleteAlert	
	DeleteRule		

**TABLE I: Overview of the Messages of the AutoSecSDN-Configuration-Protocol**

flow, the alerts operate on all flows and secure all flows, they encounter.

The AutoSecSDN-Configuration-Protocol is based on messages, which enclose the needed data. Table I shows the categories of messages and an overview of the available messages. The messages are divided in four categories and each category contains the related messages. The first category is Configuration and it is used to configure the AutoSecSDN-Agent. The ClientHello message is used by the AutoSecSDN-Agent to notify the AutoSecSDN-App about its presence. This is important, because the AutoSecSDN-App has to know, which AutoSecSDN-Agents have to receive a ConfigurationInstruction message, if an alert occurs. The ConfigurationRequest and ConfigurationResponse messages are used for the configuration of the AutoSecSDN-Agent, if a new flow is detected. All messages in the Rules category are used to manage the available rules on the AutoSecSDN-App and provide the necessary Create, Read, Update, and Delete (CRUD) operations. The same applies for the messages in the Alerts category, but there are two exceptions. The SetAlert and ResetAlert messages are used to activate and deactivate a network-wide alert. The messages of the Rules and Alerts categories should not be used by the AutoSecSDN-Agent, because this would allow the AutoSecSDN-Agent to manage the network. The last category, Data, contains two messages for the retrieval of the necessary files from the AutoSecSDN-Repository. They are used by the AutoSecSDN-Agent during the configuration.

**Error Codes:** The AutoSecSDN-Configuration-Protocol uses a number of error codes. They are used to notify the sender of a message, if the operation was successful. In case of an error, the error code yields the reason for the error. Table II shows error codes along with their description.

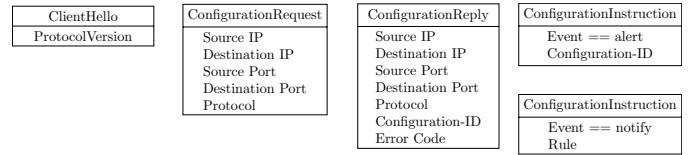
**Configuration Messages:** The ClientHello, ConfigurationRequest, ConfigurationReply, ConfigurationInstruction and StatusReply messages, shown in Figure 4, are exchanged between the AutoSecSDN-Agent and the Auto SecSDN-App. The ClientHello message is used by the AutoSecSDN-Agents to register itself at the AutoSecSDN-App. After the registration, the AutoSecSDN-App is informed about an additional network participant, which has to be managed. The Configura-

Error Code	Mnemonic	Description
0	SUCCESS	The operation was successful
1	FAILURE	A generic error has occurred
10	APP_SHUTDOWN	The AutoSecSDN-App shuts down
20	ALERT_NOT_FOUND	The specified alert was not found
21	ALERT_STILL_ACTIVE	An alert is already active
30	RULE_NOT_FOUND	The specified rule was not found
40	CONTROLLER_ERROR	The AutoSecSDN-App can not connect to the sdn controller
50	FLOW_NOT_INSTALLED	The flow rule was not installed on the sdn controller
60	REPOSITORY_ERROR	The AutoSecSDN-Repository encountered a generic error
61	REPOSITORY_FILE_NOT_FOUND	The AutoSecSDN-Repository can not find the Agent-Configuration

**TABLE II: Overview of the Error Codes**

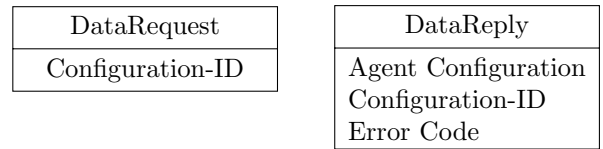
tionRequest message is also sent by the AutoSecSDN-Agents and requests the Configuration-ID of an Agent-Configuration related to a flow. This message contains several parameters used to specify the flow. These are the source and destination Internet Protocol (IP) address as well as the source and destination port and the used protocol. Due to the implementation of common transport protocols, the source port of a network connection is chosen randomly [11]. While it can not be used to determine the purpose of a flow, it is still needed to identify the flow. The ConfigurationReply message is the AutoSecSDN-App's reply to the Configuration-Request message. It contains a complete rule, which consists of the source and destination IP address as well as the source and destination port, the used protocol and the related Configuration-ID. The Configuration-ID identifies an Agent-Configuration, which has to be used for the flow specified by the remaining information of the rule definition. There is also an Error Code included, which indicates if an error occurred. The AutoSecSDN-App is the only one, who sends the ConfigurationInstruction message. This message is used for two purposes. The first one is, to notify all AutoSecSDN-Agents about an alert, which was activated or deactivated. Therefore the parameter Event has the value alert and the parameter Configuration-ID indicates, which Agent-Configuration has to be loaded. And the second purpose is, that an Agent-Configuration has to be loaded according to a network connection. This is needed for example by servers for incoming network connections, because they do not initiate these network connections. The parameter Event is set to notify and the parameter Rule contains a complete rule definition, with all needed information to configure the AutoSecSDN-Agent. The StatusReply message is a reply for all messages, which configure the rules or alerts and it contains an error code, which indicates, if the configuration was successful. If it was not successful, the error code can be used to determine the type of error, which occurred.

**Data Messages:** Between the AutoSecSDN-Agent of a network participant and the AutoSecSDN-Repository the DataRe-



**Fig. 4: Configuration Messages of the AutoSecSDN-Configuration-Protocol**

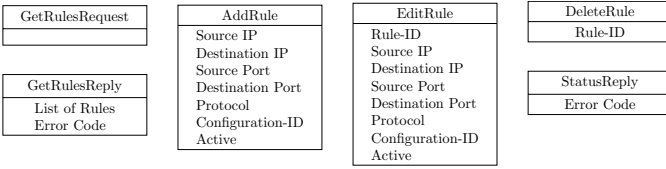
quest and DataReply messages are exchanged. Figure 5 shows an overview of the messages. For the communication of an AutoSecSDN-Agent with the Auto SecSDN-Repository is the DataRequest message used. The Configuration-ID parameter specifies the Agent-Configuration, which the AutoSecSDN-Agent needs. The second message is the DataReply message, which is the reply of the AutoSecSDN-Repository to the DataRequest message. The reply contains the files required by the Agent-Configuration along with the Configuration-ID to the AutoSecSDN-Agent. It contains also an error code to notify an AutoSecSDN-Agent of an error.



**Fig. 5: Data Messages of the AutoSecSDN-Configuration-Protocol**

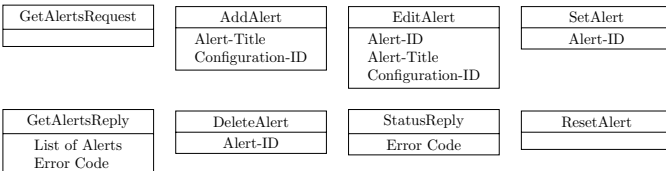
**Rule Messages:** The AddRule, DeleteRule, EditRule, GetRulesRequest and GetRulesReply messages are for the configuration of the rules within the AutoSecSDN-App. This messages are not used by an AutoSecSDN-Agent of a network participant and are only for configuring the AutoSecSDN-App. Figure 6 shows an overview of the messages. The AddRule, EditRule and DeleteRule messages are used to modify the set of rules stored in the AutoSecSDN-App. The AddRule message has all information as parameters included to add a new rule. These information are the source and destination IP addresses and ports as well as the protocol, the Configuration-ID and a flag, which indicates if the rule is active. This set of information is defined as rule definition. The purpose of the EditRule message is, to modify a single rule. Therefore, the Rule-ID of the affected rule is used along with a complete rule definition. The DeleteRule message removes a rule from the set of rules of the AutoSecSDN-App. The Rule-ID is the only needed parameter. The reply for this configuration messages is the StatusReply message. The GetRulesRequest message requests a list of all installed rules, that the AutoSecSDN-App has. The corresponding reply is the GetRulesReply message, which contains a list of all rules. The rules are sent as rule definition along with their respective Rule-ID, which is needed by other messages. In case of an error, the error code field is used to notify the receiver.

**Alert Messages:** The following messages are used to configure the alerts, which are known to the AutoSecSDN-App. There are the SetAlert, ResetAlert, AddAlert, EditAlert,



**Fig. 6: Rule Messages of the AutoSecSDN-Configuration-Protocol**

DeleteAlert, GetAlertsRequest and GetAlertsReply messages, as shown in Figure 7. The SetAlert message is used by an external system to notify the AutoSecSDN-App of an incident. The external system can be an IDS or some other kind of trigger. By specifying an Alert-ID, the AutoSecSDN-App can determine, how to respond to the incident. The ResetAlert message deactivates a currently active alert. Using the AddAlert, EditAlert and DeleteAlert messages, the list of available alerts can be modified. The AddAlert messages has two parameters. An alert title, which is a short name of the alert and a Configuration-ID. The Configuration-IDs for alerts and rules are the same to enable the use of the same Agent-Configurations. Using the EditAlert message, it is possible to change the Configuration-ID of an alert. Therefore, the Alert-ID is needed for identifying the correct alert as well as the new Configuration-ID and Alert-Title. For deleting an alert, the DeleteAlert message is used. The only parameter is an Alert-ID. All the mentioned messages are acknowledged by the receiver using the already presented StatusReply message. If an error occurs, the Error Code parameter of the StatusReply message indicates the reason. The GetAlertsRequest message is used to ask for a list of all available alerts. The reply for this message is the GetAlertsReply message. If it contains a list of the available alerts and an error code, which indicates that some errors have occurred. Each entry of the list of alerts holds an Alert-ID, an Alert-Title and a Configuration-ID of an alert.



**Fig. 7: Alert Messages of the AutoSecSDN-Configuration-Protocol**

### B. Agent-Configuration

The ConfigurationReply message of the AutoSecSDN-App notifies an AutoSecSDN-Agent, which Agent-Configuration is required to handle a flow. Therefore, the reply specifies a Configuration-ID and a rule for filtering flows. The Configuration-ID is used by the AutoSecSDN-Agent to retrieve the Agent-Configuration from the AutoSecSDN-Repository. An Agent-Configuration is used to alter the configuration of an AutoSecSDN-Agent. It consists of a configuration file and the required binary files. The configuration file determines the modules, which have to be loaded and their

parameters. A module is a processing unit which has at least one port for the input and output of network packets. When a module is loaded, it can be configured using the options given in the configuration file. The rule and the configuration file are used by the AutoSecSDN-Agent to load the modules.

The configuration file uses JSON [12] as format. It has a top-level object, which stores all information. The object has two attributes, which are both of the type array. The first attribute is called modules and it contains a list of objects. Each of them represents a module. Therefore the object has several attributes of string type:

- name Unique name for the module
- type Type of the module
- options Options as comma-separated key equal value pairs

The second attribute of the top-level object is called links. It is also of the type array and stores the links between modules. Links are represented by an object with two string attributes:

- port1 First port, to which the link is connected to
- port2 Second port, to which the link is connected to

The port specification is done using the unique name of a module and the port name. Both are separated by a colon. There are two special keywords, for specifying a port. That are the filter\_net and filter\_host keywords. They are used to attach the link to the filter, which routes the network packets according to the obtained rules.

The structure of a configuration file is specified using JSON Schema [13].

### C. AutoSecSDN-Agent

This section presents the AutoSecSDN-Agent more detailed. The AutoSecSDN-Agent is a software, which is running on the Client's machine. It is able to intercept all incoming and outgoing network traffic and configures the set of loaded Agent-Configurations.

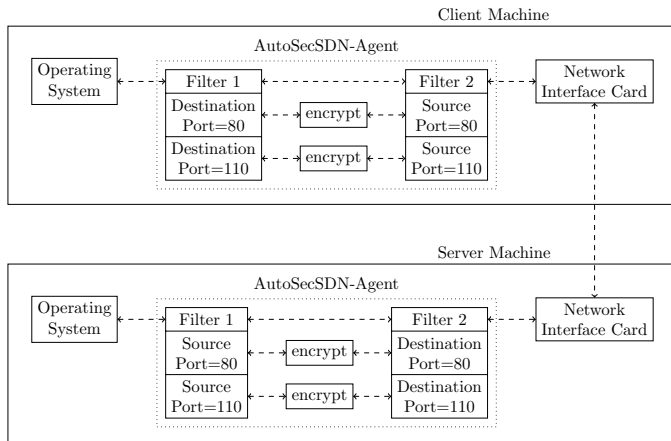
While running, the AutoSecSDN-Agent intercepts all outgoing network traffic and analyzes its metadata. If a network packet is intercepted, which belongs to a known flow with a loaded Agent-Configuration, then the network packet is handled by it. In case of an incoming network packet, it is then forwarded to the operating system. Outgoing network packets are forwarded to the network. If the network packet belongs to no known flow, it is forwarded without further action.

Figure 8 shows a simplified illustration of two AutoSecSDN-Agents, with two loaded Agent-Configurations, which are installed on a client and a server. One Agent-Configuration on the client encrypts and decrypts all network connections to an external web server (port 80) and the other Agent-Configuration on the client handles the network connections to an external mail server (port 110). If the client visits a website of the server, the network packets come from the operating system and enter the first filter. The filter has a rule for all network packets with the destination port 80. So the network packets leave the filter through this port and pass the encryption. Then, the network packets pass the second filter and leave the machine through the Network Interface



Card (NIC). The reply of the web server takes the same route back, because its source port is 80 and the second filter has a matching rule. Then, the client receives decrypted network packets and is able to visit the website.

If the client establishes a network connection using another port, then the connection is not encrypted. The network packets enter the first filter and the filter finds no matching rule. So the network packets are only forwarded and not modified. The same happens for incoming network packets, which have to pass the second filter.



**Fig. 8: Architecture of the AutoSecSDN-Agent, installed on a client and a server**

#### D. AutoSecSDN-App

The AutoSecSDN-App is the center of AutoSecSDN. It runs on the SDN controller of the network and coordinates the configuration of the network and all its participants. Therefore, the AutoSecSDN-App has two databases to store all available rules and alerts.

The database for the rules is used, when an AutoSecSDN-Agent asks for an Agent-Configuration for a specific flow using the ConfigurationRequest message. Then, the AutoSecSDN-App searches for the connection in the database. If a matching rule is found, which is active, then the AutoSecSDN-App sends a ConfigurationReply message containing the found information to the AutoSecSDN-Agent. If no matching rule is found, the ConfigurationReply message contains an empty Configuration-ID field, to indicate, that no Agent-Configuration is needed. There is no way to directly interact with the database. All CRUD operations are performed by the AutoSecSDN-App. The messages of the Rules category have to be used to configure the set of rules. The following list describes the structure of an entry in the database related to the rules.

**Rule ID** Unique identifier of the rule which is a sequential integer

**Source IP Address/Range** The source IP address or range in Classless Inter-Domain Routing (CIDR) suffix notation of a network packet, example, 10.0.0.0/24, 192.168.128.64/32

**Destination IP Address/Range** The destination IP address or range in CIDR suffix notation of a network packet, example, 10.0.0.0/24, 192.168.128.64/32

**Source Port** The source port of the network packet, example, 21 (FTP)

**Destination Port** The destination port of the network packet, example, 21 (FTP)

**Protocol** The layer 3 protocol of the network packet, example, 1 (ICMP), 6 (TCP), 17 (UDP)

**Agent-Configuration ID** ID of an Agent-Configuration, which is stored on the AutoSecSDN-Repository, example, encrypted\_v1.conf

**Active** Marks a rule as active/inactive, example, true, false

An external system can notify the AutoSecSDN-App about an alert and initiates a network reconfiguration. This is done by the SetAlert message, which contains an Alert-ID. The assignment of an Alert-ID to a Configuration-ID is done with the help of the second database. This database stores the alerts using their Alert-ID along with a Configuration-ID and the Alert-Title. It is not possible to access the alert database directly. All CRUD operations are performed by the AutoSecSDN-App. For the configuration of the alerts, the messages of the Alerts category are used.

After receiving the notification, the AutoSecSDN-App looks up the Alert-ID in the database. Then it sends a ConfigurationInstruction message to all known AutoSecSDN-Agents to initiate their reconfiguration. If a new AutoSecSDN-Agent connects to the AutoSecSDN-App, its reconfiguration is initiated immediately, using the ConfigurationInstruction message. The sender of the alert notification gets a reply from the AutoSecSDN-App, which indicates if the alert was successfully activated or if an error occurred. The following list shows the structure of an entry of the alert database:

**Alert-ID** Unique identifier of the alert using sequential integer

**Alert-Title** Short title of the alert, for example, FullNetworkEncryption

**Agent-Configuration ID** ID of an Agent-Configuration stored on the AutoSecSDN-Repository, for example, encrypt\_everything\_v1.conf

#### E. AutoSecSDN-Repository

The AutoSecSDN-Repository is used to host all available Agent-Configurations in a network. Its only purpose is to distribute the Agent-Configurations and the associated files. The AutoSecSDN-Repository is only accessible via the AutoSecSDN-Configuration-Protocol and thus depends on the security of it. By using its DataRequest message, an AutoSecSDN-Agent can request an Agent-Configuration using the corresponding Configuration-ID. The AutoSecSDN-Repository answers with a DataReply message, which contains the Agent-Configuration.

#### F. Security Considerations

The proposed approach introduces new software and a new protocol to the network. This means also the introduction of

new attack vectors and an increased risk of an attack. To mitigate the risk, the components of AutoSecSDN have to ensure a certain level of security. For the identification of threats and their mitigation, there are threat categories. The main threat categories, according to Microsoft’s STRIDE Threat Model [14], are: Spoofing, Tampering with data, Repudiation, Information disclosure, Denial of service, and Elevation of privilege. The main countermeasures to encounter the threat categories are presented in [15].

The architecture of AutoSecSDN is examined in the following with regard to the threats. The only component, which can be attacked directly is the AutoSecSDN-Agent. It requires access to the network interfaces of a machine, thus it has to run with elevated privileges. This makes the AutoSecSDN-Agent a valuable target for attackers. They can use the AutoSecSDN-Agent to elevate their privilege. To mitigate the risk, the AutoSecSDN-Agent has to run with the privileges of a regular user. By using an user group, the AutoSecSDN-Agent can get the privilege to access the network interfaces, without the need of being an administrator or root user. Then, the additional privilege of an administrator can not be misused by an attacker. All other components are not directly accessible and communicate only using the AutoSecSDN-Configuration-Protocol. For this reason, the AutoSecSDN-Configuration-Protocol is a critical component, which has to be secured. It is vulnerable to spoofing, tampering, repudiation, information disclosure and denial of service attacks. To encounter these vulnerabilities, the AutoSecSDN-Configuration-Protocol has to use several countermeasures. The usage of a combination of an authentication and authorization mechanism ensures, that only authorized systems or users can communicate with each other. The modification and injection of malicious data is prevented by using encryption and digital signatures. By throttling the bandwidth of the communication between the participants, the risk of a denial of service attack is further mitigated.

#### IV. EVALUATION

The concept of AutoSecSDN is compared with four existing approaches MalwareMonitor [16], FlowGuard [17], Openflow Random Host Mutation [18], Network Iron Curtain [19] which were also developed to improve network security. The comparison result is shown in Table III.

**Adaptation to new Threats:** AutoSecSDN is highly extensible and configurable. It makes use of Agent-Configurations, which are stored in a central place. It is easy to add new Agent-Configurations for encountering new threats or to modify existing ones for further enhancing the mitigation of existing threats. The central storage of Agent-Configurations reduces the needed effort for the maintenance. A set of rules defines, which Agent-Configuration is used for a connection. These rules are stored at a different central location and ensure an easy maintenance. Using the rules, it is possible to assign different connections to the same Agent-Configuration.

Both, the Agent-Configuration and the set of rules, ensure fast adaptation cycles to new or changing threats, while provid-

	Malware-Monitor	FlowGuard	OF-RHM	Network Iron Curtain	Auto-Sec-SDN
Adaptation	x	x	-	-	x
Short Response Time	x	x	-	x	x
Transparent and Performance Impact	Low x	x	x	x	x
Internal Security	-	x	x	-	x
Selective Application of Measures	-	-	-	-	x
Scenario 1: Flow-Based Security	-	-	-	-	x
Scenario 2: Host-Based Security	-	-	-	-	x

TABLE III: Summary of the Evaluation of Criteria and Scenarios

ing a low effort approach for their maintenance. But the administrators have to prepare the necessary Agent-Configurations and rules to encounter the threats. This can also involve the development of new modules.

**Short Response Time for Attacks:** A short response time for attacks is essential for the operation of networks, whether the attack was successful or not. As long as an attack is detected, but no countermeasures were initiated, the attack can go on and cause damage. To minimize the response time, AutoSecSDN provides an interface for external IDS. If an attack is detected by an IDS and the detection is reported to AutoSecSDN, the countermeasures can be taken immediately. AutoSecSDN relies on a broad selection of countermeasures. Starting from loading certain Agent-Configurations up to the capabilities of the SDN, like flow management.

The response time is reduced to a minimum using an automated approach. But the automated response is more than just logging the attack or notifying a responsible person. It is able to secure the network according to the detected attack, by increasing the level of security.

**Transparent for Clients and Ensure Usual Network Operation:** AutoSecSDN uses the AutoSecSDN-Agent on a client’s machine. The AutoSecSDN-Agent is doing all security related actions in the background, for example encryption or authorization. The user of the machine will not notice anything and the applications of daily use do not need any special configuration. If additional security measures are required, the AutoSecSDN-Agent takes the necessary actions to provide the needed security, for instance by securing unprotected protocols, like FTP.

The effort for the administrators is kept low. They have to install the AutoSecSDN-Agent, to maintain the set of rules stored in the AutoSecSDN-App and the repository of Agent-Configurations. The additional costs for introducing

AutoSecSDN are low, because of a very low performance impact and only one additional server for Agent-Configurations. The low performance impact is a result of the ability of the AutoSecSDN-Agent to secure only the necessary flows.

**Provide Security Against Internal Threats:** The aim of AutoSecSDN is to improve the internal network security. This is done by applying different security measures on the network traffic. The AutoSecSDN-Agent is able to secure a single network connection or to secure all network connections of a host. The level of provided security is determined by the current threat status. During regular operation, only special connections are secured. But if an incident occurs, all connections of the network are kept secure, regardless of their relevance. Even if the attack continues, the secured environment will hinder the attacker. If any host is not able to meet the security requirements, for example because no AutoSecSDN-Agent is installed, it will not be able to communicate with other hosts.

With a careful configuration of AutoSecSDN, the attacker will not be able to modify any transferred data or to eavesdrop on any network participant. By using authentication mechanisms for the AutoSecSDN-Protocol, also the theft of identities and spoofing can be prevented.

**Selective application of security measures:** AutoSecSDN is able to secure the flows in a network, using Agent-Configurations either on a per-flow-base or on a per-host-base. Former secures only a single flow using an Agent-Configuration and latter secures all flows with an Agent-Configuration. And it is also possible to combine both methods. With this mechanism, the security measures can be customized to meet the security requirements of the network. The performance impact is at the same time reduced, because only the important flows are secured.

## V. CONCLUSION

AutoSecSDN has been proposed in this paper which provides measures to secure a network by implementing end-to-end security and utilizing the infrastructure of SDN. Due to the high level of automation, AutoSecSDN is able to reduce the time needed for a response to an attack regardless of an internal or external attacker. It also provides an interface which can be used by network monitors like an IDS or DPI tools. A high level of flexibility is achieved by using a modular system for securing the network traffic. This is supported by the AutoSecSDN-Agent, which is installed on each host within the network by utilizing simple configuration files and a combination of modules to secure the network connections. The assignment of these configurations to network connections is done by the AutoSecSDN-App, as a central management point. The AutoSecSDN-App is designed as an extension for the SDN controller.

AutoSecSDN is also working efficiently, because it is also able to apply security measures to specific network connections instead of only applying it to all network connections equally. The migration of SDN to AutoSecSDN is cost efficient because no expensive hardware is needed. AutoSecSDN needs some efforts for the introduction, because the

AutoSecSDN-Agent needs to be installed on all workstations and servers. The effort for the maintenance of AutoSecSDN and the adaptation to new threats are reduced by clearly structured configuration files and a simple interface for the configuration.

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# Real Time Analytics with Big Data

## Analytics and Real-time Processing for Enterprise Ready Hadoop

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**Abstract**—Real-time Analytics and streaming is becoming very popular in the field of computer science and information technology due to massive amount of data processing. Data processing is expected to be fast enough to process these big volumes of data. It is important for companies to react to the business conditions that are changing in real time. This research is based on Big Data Analytics Using Hadoop and Data Warehouses in case of Real-time Analytics. Some products and technology that has been widely used in recent days using Hadoop architecture in real time analytics and enterprise class support for security, compliance and manageability can be used to get real-time results for big data analytics. This paper represents a framework using Apache Storm and Hadoop's MapR inside DWH to perform enterprise class real-time big data analytics.

**Index Terms**— Real-time analytics with Big Data, Stream Analytics, Hadoop, Apache Storm, SME, Enterprise Systems

### I. INTRODUCTION

With the emergence of modern technology, the amount of data is increasing in an extreme scale which has led enterprises to adapt to this trend as they have to deal with huge amount of data daily. Thus, the use of real-time big data analytics in enterprises is becoming popular. Enterprises are performing several tasks such as capture, store and analyse petabyte or zettabyte of data. Later they extract the insights of those volume and variety of data to support near real-time processes. This was totally unimaginable a few years back, but now it is possible in many fields of business including finance, manufacturing, research, government, healthcare etc. (Purcell, 2013)

Implementing big data analytics in real-time can be difficult and challenging. In recent time only open source solutions are available for this platform and they don't fulfil

the requirements of enterprise system. (Shahrivari, 2013) Organisations might face several complex challenges including integration, compliance, and security to ensure necessary resources to make the system ready for processing sensitive data in order to support ROI in business. (Marcos, 2014)

### II. METHODOLOGY

With the context of enormous big data and IoT, the volume that is generated daily is becoming very difficult to handle. Thus, enterprises face many known and unknown problems that can hamper their business process. (Oracle, 2013)

That is why in order to face the amount of big data wave that every enterprise faces; a new solution should be emerged and developed. This solution will help to face the big data and real-time analytics with streaming possibilities. This can be done with Hadoop and real-time distributed system using data warehouse.

By this research, it is expected to find an effective solution that will help the SME to process data in real time using streaming analytics system. Using Hadoop is not helping with petabyte and zettabyte of data. Using other open source distributed computing and combining it with Hadoop, a solution can be developed.

For this research, Deming Cycle methodology is being used. This is a model based on four continuous logical repetitive steps. This four sequential steps Plan, Do, Study and Act can effectively help to conduct any research and come up with critical findings to solve the overall problem.

### III. REAL-TIME BIG DATA ANALYTICS IN SME

According to Mike (2013), The phrase real-time analytics implies on the use of resources such as enterprise data effectively at the time of their necessity. Basically, real-time

analytics is a dynamic analysis which can be done within a few seconds before the original time. It contains several phases including entering data, dynamic analysis, data integration and reporting. (Thibaud, 2013)

Real-time big data analytics is an effective design that can perform several activities including ingest, store, integrate, and analyse structured or unstructured enterprise data effectively. (Informatica Corporation, 2013)

Some uses of real-time analytics in SME are stated bellow, (Cloudera, 2014)

- 1) Cost effective data storage to store petabytes and zettabyte of data.
- 2) Data integration in a transparent level with advanced SQL models to ensure advanced analytics (Jacob, 2013)
- 3) Support including manageability, compliance and also security in an enterprise level
- 4) Reduced cost and less risk level

### A. HADOOP & DATA WAREHOUSE (DWH) FOR REAL-TIME

Stream processing is required for real-time analytics and Hadoop is required for computation as well as storing of all kinds of data. Hadoop is a programming framework that is used to process big data sets. In big data architecture another part is required and it is data warehouse which is used to store structured data. DWH is very important in case of big data as it can help to combine data from different sources. The Hadoop Distributed File System (HDFS) is a software-based data-intensive distributed applications distributed file systems. While the rapid processing of data written large amounts allows Hadoop cluster compute nodes of large applications. The work is done by MapReduce parallel map function is independent of the input data set is divided into sub-process. This action mapping is a move that should be followed in order to reduce litigation. These tasks can be reduced using the output of the map to obtain the final results. (Russom, 2013)

Big data is not only about Hadoop, combining it with stream analytics is the key to success. Hadoop is not suitable for real-time analytics as it was never built for this purpose. It is a java-based solution that was sponsored by Apache Foundation. (Dhruba, 2014)

MapReduce was the initial starting of Hadoop. Batch processing is offered by MarReduce. This requires hours and sometimes minutes to process the queries. This is suitable for complex computation of huge volumes of big data and IoT. But in case of ad hoc query and real-time analytics, it is not effective at all. Improvements have been done by different

vendors by adding more features to Hadoop to make it capable of more than batch processing. (Neil, 2012)

In the above circumstances, Apache Hadoop alone cannot process real-time analytics and stream analytics. This has made the enterprises all over the world struggle to deal with the massive amount of big data they have to process. Thus, they need something new, that can help them to process these huge data and data warehouse that can work with Hadoop architecture. (Chen, 2012)

### B. DEMAND OF REAL-TIME ANALYTICS

Continuous query to analyse poly-structured data in real-time is used in streaming analytics. In this process, the calculation of mathematical and statistical analytics can be done in real-time. For this a fault tolerant architecture is required to ensure scalability and availability. In the recent years a new development has been done which is known as live data mart. It is able to perform continuous query that can enable streaming analytics in memory. Enterprises can view live data using this architecture. (Global IT Report, 2012)

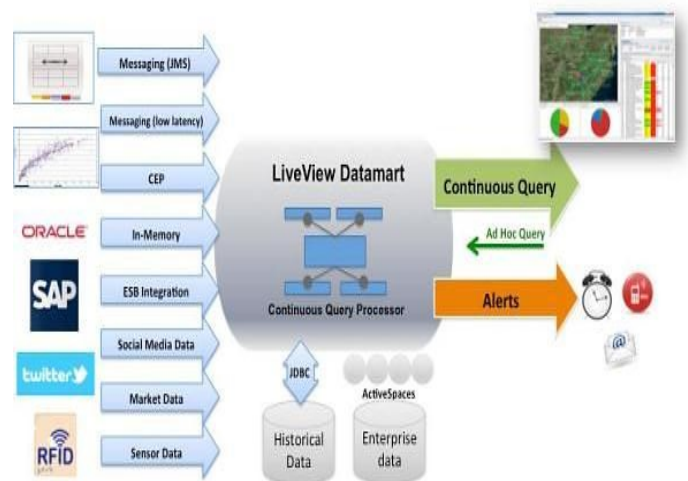


Figure 1- Architecture of stream processing and analytics (Intel, 2013)

According to ESG Research Report (2012), real-time fraud detection can be considered as an example of streaming analytics. Enterprises use algorithms that are machine-driven. They search patterns that are suspicious. These patterns need five streams which are required for correlation in real-time data. 10-30 seconds are needed to perform the patterns. In the meantime, enterprises can lose thousands of pounds as attacks could come simultaneously.

Data warehouses were loaded with data to locate these patterns in the earlier years. For this checking of reports and decisions were made each day. Thus, the previous attempt to find patterns was not effective. In order to comply with new

regulations stream processing and real-time analytics is required. (HP Business, 2012)

### C. APACHE STORM

In order to bring real-time analytics in big data platform, a new framework should be introduced that can work with Hadoop and DWH effectively. Apache Storm is the best suitable framework that can perform near real-time processes and analytics inside big data. It is an open source framework with the capability of providing scalable event collection in a massive scale. Twitter initially created Storm. Storm has different components such as ZooKeeper, ZeroMQ and Kafka. They are used for management of cluster, messaging with multicast and queuing. (Mike, 2013)

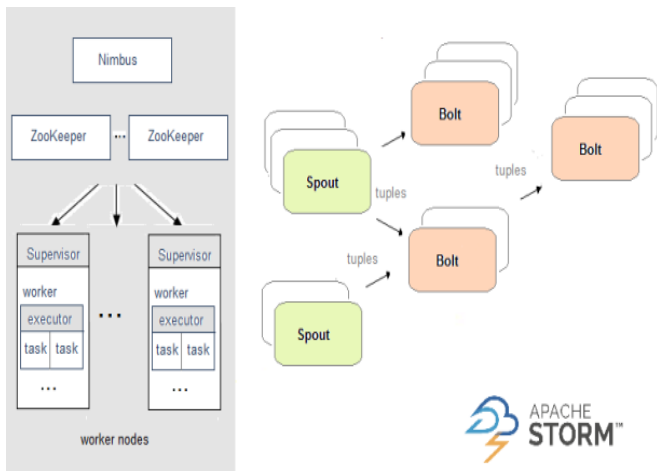


Figure 2- Architecture of Apache Storm (Tony, 2015)

Apache Storm lets its user to design topology (real-time computation graphs). They can be feed to cluster. In the cluster there are master node and worker node. The code is distributed by master node and executed by worker nodes. Data in the topology pass around spouts which emit streams of data. They become tuple and bolts. The tuple is immutable sets of key value pair. In the processing pipelines bolts can emit data by themselves optionally to other bolts. (Tony, 2015)

Apache Storm can reliably perform different process containing massive data streams and produce real-time results. This is just like Hadoop’s batch processing. Thus, Storm is called the Hadoop of real-time analytics. (Dibyendu, 2013)

Scalability in massive scale, fault-tolerance supporting, strong guarantee of processing every tuple is offered by Storm. Its design is perfect for doing what it was meant to do. (Hortonworks, 2014)

Storm is a top-level project of Apache Foundation. The current stable version is 0.9.4 which was released on 25 March, 2015. No commercial support is currently available for Storm. But it can be adopted by SME’s. Hortonworks is adding Storm

to its Hadoop platform slowly. Storm stream processing in case of real-time analytics has been adopted by several companies such as Twitter, Yahoo, Groupon, Alibaba, Spotify, HolidayCheck etc. (Hortonworks, 2014)

### D. APACHE SPARK

Apache Spark is another project that is built with a view to provide real-time computing at AMPLab, University of California. Later it joined with Apache Incubator and become a top-level project in 2014. Spark supports stream processing just like Storm. However, it is considered as a general purpose distributed platform of computing. (Rassul, 2016)

Spark can be replaced with MapReduce of Hadoop as it has can run on an existing Hadoop cluster. By this it can reply on YARN in case of scheduling resources. Spark can run stand alone as cluster while using scheduler that is built-in. In case of not running with Hadoop, nodes in the cluster will have access to the underlying data.

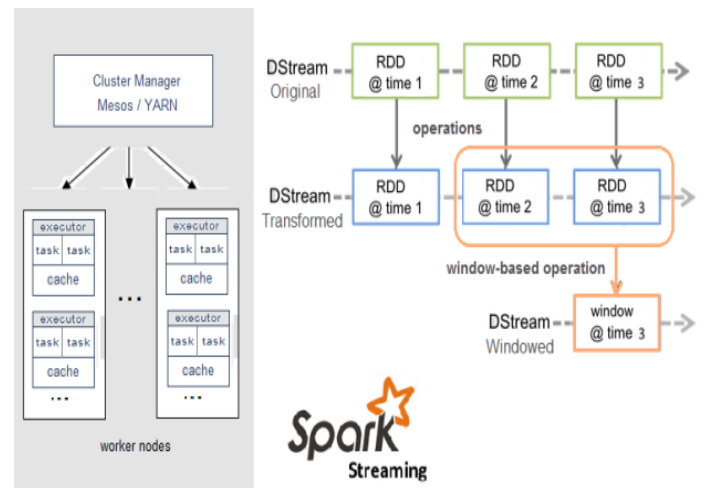


Figure 3- Architecture of Apache Spark (Tony, 2015)

Unlike Storm, Spark Streaming uses core Spark API and the stream is doesn’t processed one at a time. The stream is sliced into small batches before processing as time intervals. Discretised Stream is the abstraction of Spark for continuous stream of data. It is a micro batch of Resilient Distributed Datasets (RDD) which is distributed collections that is parallel operated by arbitrary functions. This helps transformation of data over a sliding windowed computation. (Tony, 2015)

The worker nodes of Spark buffer the streaming data in their memory. The short tasks are run with the spark engine in tens of millisecond with latency being optimised to process the batches and provide results as output. Spark tasks are not like traditional models. It is assigned dynamically to the workers based on available resources and locality of data. It helps to get better load balancing and fast fault recovery. (Rassul, 2016)

#### IV. RESEARCH FINDINGS

The research finding shows that enterprises have to deal with massive scale of data and only batch processing cannot fulfil their enterprise ready requirements. In this case stream processing and real-time analytics can be the key to capture real-time results. (IBM, 2014)

Using comparative analysis process, it is possible to determine whether Storm or Spark can be the best choice to work with Hadoop. After going through the details, architecture and other information, a hypothesis can be presented where the comparison between Storm and Spark will be shown in the following table.

Table 1: Comparative Analysis of Storm and Spark

Comparison Factors	Apache Storm	Apache Spark
Delivery Semantics	At Least Once With Trident it is Exactly Once	Exactly Once But there are some failure scenarios
State Management	Stateless Using Trident own states can be rolled	Writes state to storage
Latency	Sub-Second	Seconds
Language Support	Any Language Mainly JVM, Ruby, Python, Javascript, Perl	Scala, Java and Python
Processing Models	Micro Batching Event Streaming	Micro Batching
Platform	Storm Cluster, YARN	YARN, Mesos, Standalone, DataStax EE

From the above analysis it is clear that Storm will be the best choice would be Apache Storm. Traditional big data analysis like Hadoop cannot provide stream processing in real-time. Storm supports multi language and it is great at fault tolerance. Using SAS or R for big data analytics can be done with Storm. Apache Spark does not have this functionality.

Apache Storm can effectively fulfil these requirements when working with Hadoop and DWH. This solution can be up for the following challenges of critical issues, (Ibrahim, 2014)

- a) Low latency server that is optimized for stream events such as predictions, act, alert, logs, sensor, filter, rule, aggregate etc. processing
- b) Response to real-time in order to change condition of market
- c) Better scalability and performance along with the increase of data volume and complexity
- d) Data integration rapidly in the existing infrastructure and sources of data including input and output (Mike, 2014)
- e) Changing requirements with the change of development to adopt with market
- f) Offering better support using IDE and rapid development
- g) Continuous query processing with data discovery along with live monitoring (SOL stream, 2012)
- h) Providing training as limited number of contributors are available on open source (NESSI, 2012)
- i) Interface and visualisation in order to manage monitor, manage and view live data streams
- j) User management, query access, dynamic aggregation for graphing, stream visualisation and charting
- k) In database and in memory analytics
- l) Appliances of data warehouse

Overcoming the above challenges is possible if Apache Storm is used with Hadoop and DWH. Being very fast, scalable, fault-tolerance, Storm is perfect for open source distributed computation in stream processing. Storm can effectively compute and calculate data streams in real-time. Theoretically, Apache Storm can be enabled with generic distributed RPC to assemble complex computations easily.

Apache Storm's fault tolerance feature is very impressive for real-time analytics as it automatically restarts the workers when a node or workers threads stop working. Besides that easily manageable clusters, guarantee of processing every message and Hadoop's Zookeeper for cluster coordination makes it possible to accomplish real-time environment. The network topology of Storm can be defined with any kind of programming language, but basically Java is used as Hadoop can be managed with Java too. The most popular Storm solutions insides Hadoop's MarpR are, (1) Clickstream Analysis, (2) Real-time Threat Detection & (3) Enhanced Network Service Quality.

#### V. SOLUTION & RECOMMENDATIONS

Using Apache Storm and Hadoop in DWH, it is possible to get results near real-time analytics in SME. Using the fast data architecture of Apache Storm and the distribution for Hadoop processing big data is possible in real-time analytics of big data.

## Acknowledgements

This paper represents a theoretical framework of Apache Storm inside Hadoop and DWH which can perform high end real-time and near real-time analytics. Using this framework managing Big Data and processing it with a combination of both batch and real-time view, getting real-time results can be possible. The framework is based on completely the research findings of the author. This work would not be completed without the supervision of Afsar Uddin Chowdhury, who has given enough scope to continue this research.

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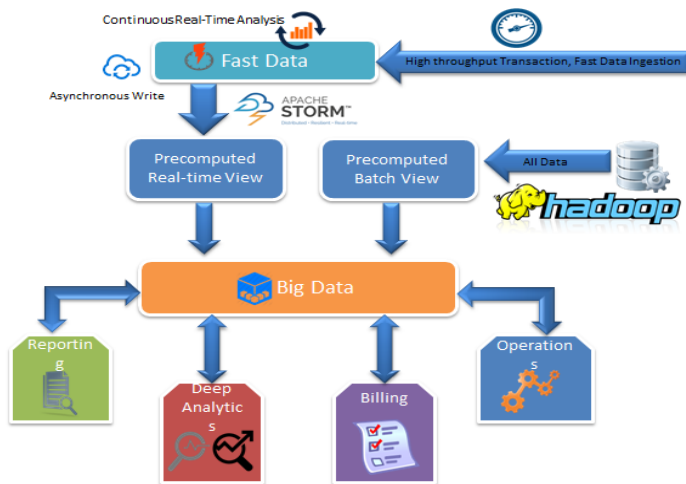


Figure 4- Architecture of Suggested Framework combining Storm, Hadoop & DWH

The framework suggested below shows that new fast stream data can be computed by Storm and all structured processed data stored in DWH can be computed with Hadoop. Combining both of the pre-computed batch view and real-time view, the big data real-time analytics can be possible. Thus generating reports, deep analytics, billing etc. can be done in real-time in SME.

## VI. CONCLUSION

With the explosion of IoT, big data analytics have advanced so much in the recent years. Hadoop has been used as the best platform to capture, store and process these huge amount of data in case of analysis. With the increase of volume, variety and velocity, the batch processing framework provided by Hadoop is not capable of coping with new SME requirements for real-time analytics. Thus, enterprises have to keep track of these huge data sets and store them in DWH. But processing and analyse them in real-time is impossible at this rate. To solve this problem, stream processing is required.

There are many frameworks and products available for solving this problem. But all of them are not effective as commercial vendor for developing such framework with efficient support is very limited. Apache Storm is the best suited solution for real-time big data analytics with stream processing in SME. However, it is required to evaluate the cost of the framework and figure out whether return on investment is viable. Although, custom coding is required for Storm, but using it with Hadoop and DWH, it is possible to get a new distributed computing framework that can process data in real time and real-time analytics will be possible.



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# Design and Implementation of a Painter Robotic Arm With Graphical User Interface

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**Abstract**—Recent research on robots has been trying to develop intelligent robots that can match human behavior on high level intelligent tasks that require sensing, complex motion and intelligence. In the recent few years robot is given some artistic behavior that robot can sing, dance even robot can play games. This paper presents a control method for a robotic arm to let the robot to acquire another human artistic behavior “drawing”. In the proposed design MATLAB has been used for image processing interface and trajectory calculation. Value of co-ordinate position of a pixel of binary image is converted into joint angle applying inverse kinematics and servos are controlled with Arduino Mega. Sobel and Canny are applied for edge detection method and authors showed comparison between the output images after applying Sobel and Canny edge detection method. Image is given input through Matlab GUI, which is user interactive.

**Keywords**—*Matlab; GUI; Robot Kinematics; Edge Detection; Image Processing, Arduino Mega*

## I. INTRODUCTION

Robotic industry has become a giant sector in the recent world. Scientists and technologists have been trying to add different dimensions in robot behavior. Modern developments on robotics have different types of applications in a wide range of industries, including education, health care, household services, military, entertainment, etc. Drawing is an art which requires high degree of artistic and innovative mentality of human mind. So it is a complex and challenging task to habituate a robot with this innovative art. Our research work is to add a different shade of robotic behavior in artistic manner that is eye catching, human friendly and inspiration to the general people to know about the robotic activities. Basically, Sketcher Robotic Arm is a 2 degree of freedom robotic arm that can sketch human face. It performs few basic actions of robotic control system that were intended to design with highly possible precise way with the locally available equipments. We built a Matlab Graphical User Interface to take the input image. Image is filtered with several filtering tools to make it a binary image which is suitable for the robot to understand.

## II. RELATED WORK

There have been few researches on the human portrait generation system. Some researchers have conducted the study of drawing robots. ZKM laboratory created the first real-time robot portraitist system, in which an industrial robot drew the face portrait for the human sitting in front of the camera [7]. Switzerland LASA-EPFL laboratory developed the most complete cartography robot system integrating Fujitsu’s humanoid robot HOAP-2 with a new image process technology to draw the portrait [1]. Reference [2] presents a behavior-based robot control method of brush drawing where differential movement was adopted instead of traversal points. Reference [3] presents a 3 DOF robotic arm used for drawing on a paper sheet Which is constructed using LEGO NXT bricks. The research in [1] aims to develop a human portrait generation system that enables the two-armed humanoid robot, Pica, to autonomously draw the face portrait of the person sitting in front of Pica. Betty, a portrait drawing robot was developed using modified Theta-graph, called Furthest Neighbour Theta-graph [4].

The different controlling methods were applied in the stated references. Some of them are too complex, some are expensive, some are extensive, although every research tried to find the finest way to draw. We wanted to make the robot free of complexity that’s why we used 2 DOF arm. We tried to give the robot an easy interface and scope to be modified easily, that’s the reason of using Matlab and it’s GUI .

## III. SYSTEM DESIGN

### A. Working Procedure

The block diagram of working procedure is given in Fig.1. Image is taken input to the system through Matlab GUI. Image can be acquired by a camera connected to serial port or can be picked from a specified path in computer. The taken image is RGB, so the system converts the image into grayscale. Then the grayscale image is converted to a binary image by edge detection method. Binary image is nothing but a combination of black and white pixels. Matlab calculates the necessary inverse kinematics calculation taking black pixel’s coordinate position and sends joint angle for the servos to the

controller. Arduino receives the joint angle through serial communication and controls the servos.

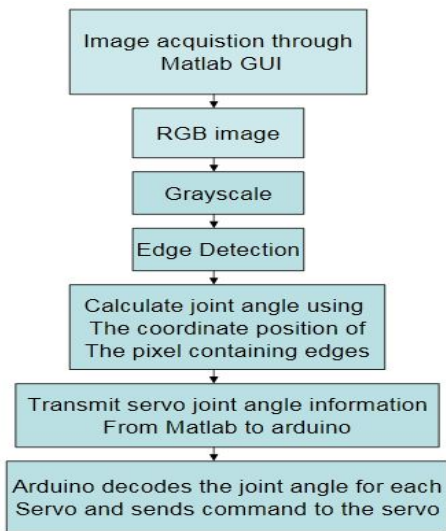


Fig.1. Block Diagram of Working Principle

### B. Robot Arm

The designed arm is basically a 2 DOF planer robotic arm placed on a wooden board. The arm consists of two links made of aluminum sheet, one servo mount, two servo motor and a pen holder as an end effector. A suitable length of arm is maintained so that it can sketch on a A4 size paper sheet . Here end effector is a pen holder attached with a servo motor.

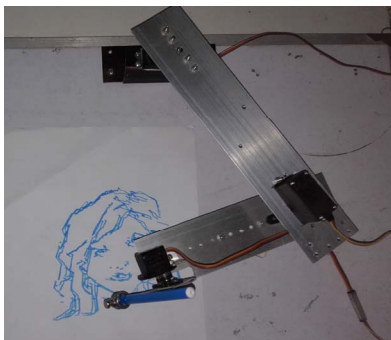


Fig.2(a). Robot drawing image

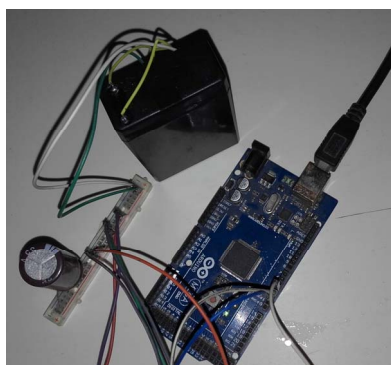


Fig.2(b). Controller Section

During line drawing pen is kept down and after drawing a line pen is kept up.

### C. Matlab Interfacing

Matlab is an interactive software system for numerical computations and graphics. It is specially designed for matrix

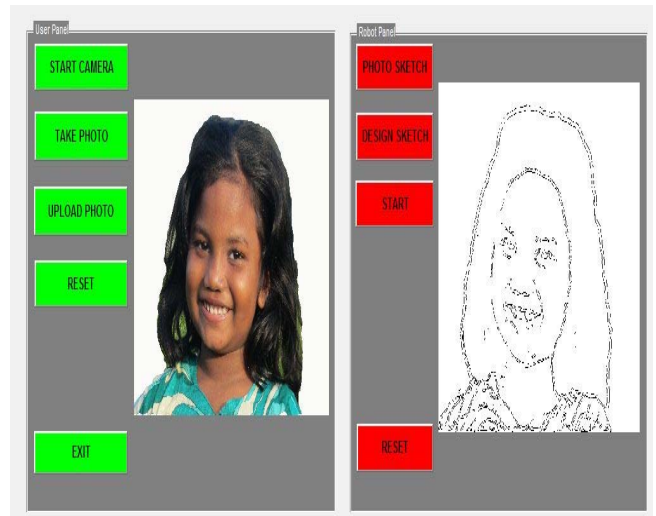


Fig.3. Matlab GUI

Computations, solving systems of linear equations. Matlab has a very large database of built in algorithm for image processing and computer vision applications. It provides many functions for image processing and other tasks. Most of these functions are written in Matlab language and are publicly readable that can be customized. Matlab can write serial data to serial port in different baud rate which are arduino readable. Serial communication between arduino and Matlab is a lot easier than any other system. Because of these advantages we choosed Matlab for image processing and inverse kinematics calculation.

Due to easy access to the image representing matrix Matlab makes it easy to apply the inverse kinematics to translate the pixel coordinate information to the robot joint angle. There is another fantastic part in Matlab, which is Graphical User Interface (GUI). Graphical User Interface can be designed easily in Matlab. GUI gives an user advantages to interact with the system architecture.

Fig.3 is our designed Matlab GUI which has been used to give an image as input. GUI has two input feature, acquiring an image by a web cam or from a folder inside computer.

### D. Arduino Mega

Arduino is an open source physical computing platform based on a simple i/o board and a development environment. The Arduino Mega 2560 is a microcontroller board based on the atmega2560. Arduino Mega has been used for servo motor controlling. Arduino receives joint angle information as a serial data. After decoding the joint angle data arduino sends command to the servo how much should it rotate.

### E. Servo Motor

Servo motor is an actuator that can be controlled precisely for linear or angular position. A servo motor consists of electric motor, feedback device and electronic controller. Servo is needed to feed a signal pulse to rotate for a particular angle. We used MG 996 servo motor which is high torque servo. To use the servo, firstly it needs to be calibrated. For 544us pulse MG 996 servo stays at its zero position and for 2400us that servo stays at 180 degree position.

## IV. THEORITICAL ANALYSIS

Inverse kinematics is the method for determining the joint angle when the position of the end effectors is known. Tasks to be performed by a manipulator are in Cartesian space whereas actuators work in joint space. The conversion of the position

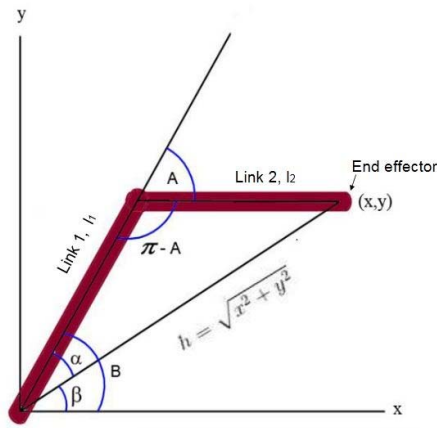


Fig.4. Geometry of Inverse Kinematics

and orientation of a manipulator end-effectors from Cartesian space to joint space is called as inverse kinematics problem.

Let's establish few expressions to solve the inverse kinematics problem. In Fig.4, link 1 and link 2 forms a triangle with the joining line of the starting point of link 1 and ending point of link 2. So we can apply few equations from the concept of geometry. B is the angle of link 1 and A is the angle of link 2.

So, we can write,

$$\cos(\pi - A) = \frac{l_1^2 + l_2^2 - h^2}{2l_1l_2} \quad (1)$$

(2)

$$\pi - A = \cos^{-1}\left(\frac{l_1^2 + l_2^2 - h^2}{2l_1l_2}\right) \quad (3)$$

$$A = \pi - \cos^{-1}\left(\frac{l_1^2 + l_2^2 - h^2}{2l_1l_2}\right)$$

A is the desired angle for link 2. The reference line for link 2 to form angle is the line parallel to the link 1. Now we will go for the angle of link 1.

$$\tan \beta = \frac{y}{x}$$

$$\beta = \tan^{-1} \frac{y}{x}$$

$$\cos \alpha = \frac{l_1^2 + h^2 - l_2^2}{2l_1h}$$

$$\alpha = \cos^{-1} \frac{l_1^2 + h^2 - l_2^2}{2l_1h}$$

$$\text{Now, } B = \alpha + \beta$$

So, if we know the length of the arm and the position of the end effectors, we will find how much the servo motor should be rotated to reach the end effectors in desired position.

## V. IMAGE PROCESSING AND EDGE DETECTION

Image processing is one of the vital segments of the designed system. The input image is a RGB image which a combination of millions of shed that is too complex to understand for a robot. So we need to convert an RGB image to grayscale where different color combinations are reduced to only black and white intensity. Then grayscale image is converted into a binary image. The process of converting a grayscale image into a binary image is performed by edge detection method. Edges characterize boundaries and are therefore a problem of fundamental importance in image processing. Edge detection significantly reduces the amount of data and filters out useless information.

Few consecutive steps must be followed to implement the canny edge detection algorithm. The following steps are followed to perform canny edge detection. Firstly smooth the image with a Gaussian filters. Then compute the gradient magnitude and orientation using finite difference approximations for the partial derivatives. Then apply non maxima suppression to the gradient magnitude. Then use the double threshold algorithm to detect and line edges.

The sobel edge detection algorithm use two masks with 3\*3 sizes, one estimating the gradient in the x-direction and the other estimating the gradient in the y-direction. The mask is slid over the image, manipulating a square of pixels at a time. The algorithm calculates the gradient of the image intensity at each point and fives the direction to increase the image

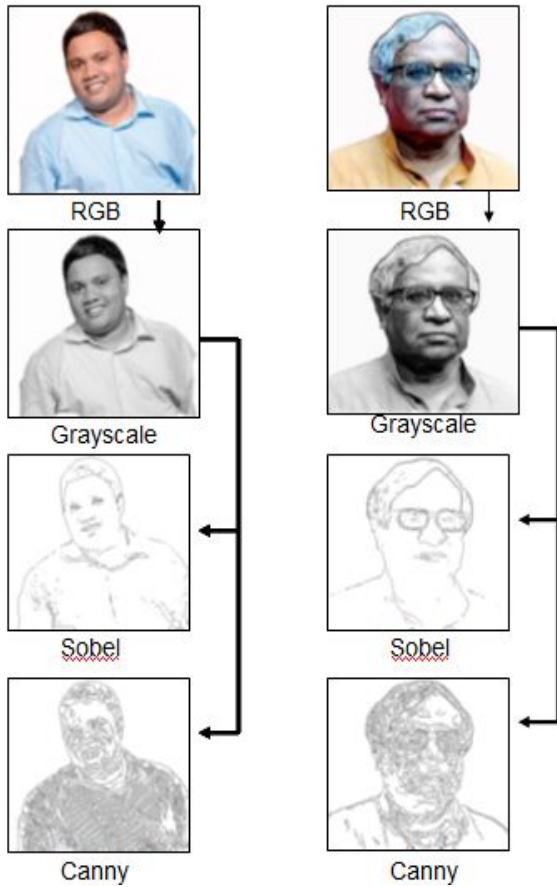


Fig.5. Canny and Sobel Edge Detection

intensity at each point from light to dark. Edges areas represent strong intensity contrasts which are darker or brighter.

Canny and sobel both are popular edge detection method but their working procedures are different. In Fig.5 we showed binary images after executing Canny and Sobel.

### VI. PATH DRAWING ALGORITHM

A binary image is a combination of black and white pixel. When an edge detection method is applied an image is turned into a binary image where few lines or paths indicates the input image. Every line in the binary image contains black pixels attaching one with another. In Matlab a binary image represents a 2D matrix where every element contains the information of the pixel. White pixel represents 1 and black pixel represents 0. The first thing to draw a line is to detect the line from the edges after performing edge detection method. The basic idea is to search the image containing matrix for the black pixel from the first element of the matrix. Whenever a

black pixel is found that is the beginning of the line and then path drawing algorithm is applied. Path drawing algorithm is a simple algorithm where the system search for the availability of a black pixel around another black pixel and calculate the joint angle from the black pixel coordinate value through inverse kinematics equations and transmit the joint angle

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

Fig.6. Neighbour Pixel Searching Method

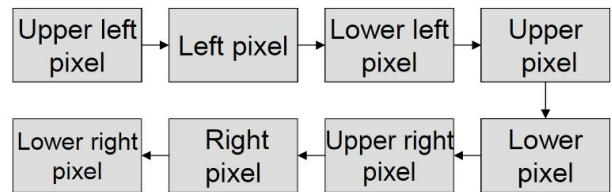


Fig.7. Pixel Searching Precedence

information to the controller to control the servo . Let it be described with the Fig.6.

Fig.6 represents a binary image after performing edge detection. There is a single edge consists of black pixels touching one after one makes a chain. The system starts to search from the first pixel if there is a black pixel available and the system finds it in 12 number element of the image containing matrix. Now the system knows that 12 number pixel is the beginning of the edge. Then the system calculate the joint angle from the coordinate value of the 12 number pixel and transmit the joint angle to the controller to reach the end effector in that coordinate point position. Then it searches around the 12 number pixel i.e. 1, 2, 3, 13, 23, 22, 21, 11. If there is a black pixel available and 13 number element is found as black pixel and transmits it joint angle information to the controller. Again the system searches around the 13<sup>th</sup> pixel for a black dot and so on till the last black pixel of that line.

There is followed a procedure (Fig.7) to search a pixel by its position priority. First, a pixel searches around itself for upper left pixel following by left, lower left, upper, lower upper right, right, lower right.

## VII. RESULTS AND DISCUSSIONS

That robotic arm sketched few image of different peoples. After the thorough design of the robot hardware, we obtained a structure that was mechanically strong and got a stable control. Edge detection was performed by Canny and Sobel, In Fig.8 there are few sketches by robot.



Fig.8. Input Image and Output Image drawn by robot

both of method has it's own advantages and limitations. Although Canny is an efficient method for edge detection in the sense of keeping the characteristics of input image but it picks a lot of edges which is tedious and time consuming to perform for a robot. On the other hand, Sobel detects less edges that makes robot faster to perform but sometimes it can not represent the input image due to the lack of enough edge.

## VIII. CONCLUSION

In this paper we developed a robotic arm which can sketch human face with a 2 DOF robotic arm. Our research work will motivate the peoples about robots through an interesting behavior of robot. Our designated system has few advantages such as,

- It is a cost effective, frugality of complexity and user friendly robot.
- Graphical User Interface gives user more interaction to control the robot.
- Capable of producing higher quality output depending on efficiency of edge detection.

Our designed robot has a versatile application in entertainment and educational purpose. It's a great fun to watch that a robot is sketching image. It's an inspiration to the general people to know about the robotic activities.

Our future research is to develop the drawing quality by increasing the edge detection efficiency. Our target is to modify the current edge detection method to get finest drawing with less possible amount of edges.

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# Green Software Engineering Adaption in Requirement Elicitation Process

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**Abstract**—A recent technology investigates the role of concern in the environment software that is green software system. Now it is widely accepted that the green software can fit all process of software development. It is also suitable for the requirement elicitation process. Now a days software companies have used requirements elicitation techniques in an enormous majority. Because, this process plays more and more important roles in software development. At the present time, most of the requirements elicitation process is improved by using some techniques and tools. So that the intention of this research suggests to adapt green software engineering for the intention of existing elicitation technique and recommend suitable actions for improvement. This research, being involved qualitative data. I used few keywords in my searching procedure, then searched IEEE, ACM, Springer, Elsevier, Google scholar, Scopus and Wiley. Find out articles which published in 2010 until 2016. Finding from the literature review, Identify 15 traditional requirement elicitations factors and 23 improvement techniques to convert green engineering. Lastly, The paper includes a squat review of the literature, a description of the grounded theory and some of the identity issues related finding of the necessity for requirements elicitation improvement techniques.

**Keywords:** *Software Engineering, Green Software systems, Requirements Elicitation Technique.*

## I. INTRODUCTION

Requirements elicitation is the initial stages in the software development life cycle. It is the instant analysts elicit to understand many methods and techniques which are validating the requirements of a system from practitioners. If the system failure is owing to poor communication with analyst and users. Therefore, the objective of elicitation process is required to solve problems [1] [2]. At present technology has introduced many Requirements elicitation (RE) techniques and provided with various possible options. Requirement engineer can use the option of adopting green methodologies for

developing software. The Green software development technique is trying to discover as many troubles as possible so that it could become easier to produce premium software along with expected plans by applying elicitation techniques tools. In certain, requirements elicitation is getting more and more important for its multidimensional and iterative movement that deeply depends on the communication skills of software requirement engineers. Usually requirements elicitation technique can shift the green software engineering [3]. Green elicitation processes encourage the use of reusable design frameworks, patterns only when it is clear that it can save power or increase quality. It is only indicated by some eminence indicators, either directly or indirectly [4].

Nowadays, most of the software has been driven by green. Over the last decades, research has emerged green software model design and RE should focus on green environment, how to achieve this green environment on earth. In the literature, found that the different elicitation technique depends on time and resources. So, elicitation technique depends on time and resources and green software engineering is also giving this thing with more and more features for developing software. Analyzing all these studies need to include some essential fact that can develop and maintaining green software system or environment friendly software system. According to requirements elicitation techniques in the past, green software system has technologically advanced little. For the purpose of literature review the extent of requirement elicitation process, this paper following the research question:

**RQ:** How to convert traditional requirement elicitations in green software requirements elicitation techniques?

**-Motivation:** To identify and convert traditional

requirement elicitation in green software requirements elicitation techniques.

**Problem:** Traditional requirement elicitation technique has not fully supported green software requirement elicitation technique [5]. Though several researchers proposed how analyzed documents, interface and interview design in the traditional way [6] [7]. In existing literature is proven green requirement elicitation technique is yet not established. So green software engineering method can support the character and this approach classify and turn green RE. This method also allows for supporting tools, to support process design. For example, green IT, efficient algorithms, smart grids, agile practices and knowledge management [8].

**Contribution:** In this paper describe the requirements elicitation process and this process can adapt the new atmosphere of green software systems using some of existing technique and demonstrate.

## II. RELATED WORK

With the increase of technology development number of software system has developed to give a good performance like requirement phase. In the requirement elicitation process it is necessary to consider the environment friendly software system to help current and future perspective. Greenpeace International and Liu et al. define green software is less harmful for people and the environment [9] [10]. Because a green software system is to reduce unsafe materials, endorse the recyclability and plug-in architecture making the system efficient. In literature review researcher provided some approaches such that some efforts are focused on green software, some intend software processes to assist all stakeholders in building green software products, focused on some tools and the application can save operating system energy with effectiveness and help control the power consumption. Including virtualization, closing applications no longer in use, energy estimation of nested loop programs [11] using for loops and conditional on power consumption, programs efficient algorithms writing for compact design of codes and data structures, reduction of parallelism overhead of developing efficient load balancing algorithms, fine grained green computing, and creating energy allocation algorithms for routing data. According to Mahauxetal.declaration green innovation is altering IT significant effect [12] yet the use of the green it as exposed in existing literature to have been useful in developing for a software system.

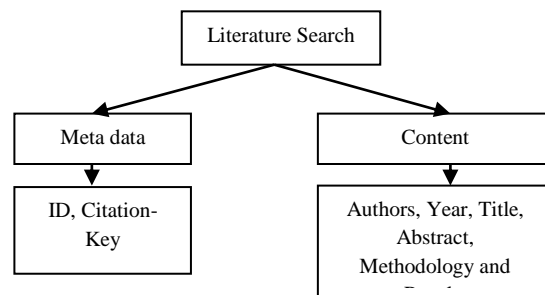
The eminence of the requirement elicitation process provided a good basis for the software system. Such techniques also present inherent factor in terms of document analysis is using paper, interview is using hard copies, some custom hardware use and it generate large amounts of data [13], interface analysis sometimes it is using complex and long algorithms [14] and hence, these would be key requirements techniques to be considered in adapting a sustainable green software system.

## III. RESEARCH METHODOLOGY

In this study, this research design method is using qualitative research and adopts the guidelines of Kitchenham and Charters [15]. Paper collect, process using Systematic Mapping Study [16] for searching publication. Basically, snowballing use for paper selection. I used a few keywords in my searching procedure. These papers are searched in “requirement elicitation”, “green it”, “green software engineering”, “requirement engineering”. Using and/or/not. By using those keywords I have made a search string, which used in different databases such as

- IEEE Computer Society Digital Library
- ACM Digital Library
- SpringerLink
- Elsevier
- Google scholar
- Scopus and
- Wiley

Figure 1: Searched Databases: Collection



Following this search, find out journal articles published in the English language between the years 2010 to 2016. Search engine find practical related articles 182,137. Then 39 articles find out that have published in reputed journals or conferences.

I applied inclusion and exclusion criteria proposed by the Kitchenham et al. in this study. After that, I have included 30 studies in this study as major findings



from the literature. I have also used an open coding technique to analyze the collected data. Both researchers reviewed the findings from the literature, which helped to mitigate the validity threats.

#### IV. GROUNDED THEORY

##### A. Green Software Engineering

In the literature the process of green software engineering has reduced waste, reuse and recycles for developing software [17]. Green software must support sustainable process to develop environment and give solution to improve, fixed, strengthen, reduce the error-failure, improve data protection etc. in a way of software engineering. In global software development is inspired by the green software engineering establishment. It is an energy efficient software development system and it does not consume time. It is also efficient for software space allocation, efficient in memory capacity, availability, usability and storage of data and information also parallel task can develop.

##### B. Requirement Elicitation Techniques

The perception of requirement elicitation will be defined key statements of preferred functions. This is usually referred to collecting requirements. There are different classic requirement elicitation processes; I have taken three processes to convert green requirement elicitation: interviewing, document analysis, interface analysis. First, Interviewing is the most common technique for requirement elicitation. Interview starts to question and answers, then discover the problem. Sometimes interview can be open discussion or meet in physical and some of the time is can be use paper base with different types of environments. Secondly, Document analysis always eliciting the requirement. Basically, it is use of existing system and implement a required system. Document analysis typically includes market studies, request for proposals, statement of work, memos, existing guidelines, procedures, computing product literature. It is hard to find, out existing relevant information and it is a time-consuming work process. Thirdly, Interface analysis is the way of user interacts with an application. It can be conducted with both internal and external systems and users. This can require one or more interfaces with external parties, systems or devices and helps to clarify the boundaries of the system. For examples user interface, system-to-system interface, external hardware device interface, to external applications, to internal applications.

#### V. RESULT

In this section I have identified 15 traditional techniques with 23 improvement techniques from the literature review. In this study, I have divided into three categories such as Interview, document analysis and interface analysis.

##### A. Traditional Requirement Elicitations

The traditional requirement elicitation process uses a variety of techniques. Table: 1 Show exists three processes of requirement elicitation technique such as: interviewing, document analysis, interface analysis.

**Table 1: Traditional Techniques: Challenges**

Techniques	Description	References
Interview	Using hard copy	[18]
	Generate large amount of data uses	[19]
	Physically interview is performed	[18]
	Computer hardware usages	[19]
	Brainstorming, design a diagram to asking questions	[21]
	Use technical environment network.	[21]
	Use cognitive structural analysis	[23]
	Data flow diagram, Entity relationship diagram	[24][25]
Document Analysis	Use paper base work	[22]
	Use chart and diagram	[22]
	Memory usage and it is consuming the cost	[28]
	Use CPU and other devices	[20]
Interface Analysis	Use bright colors or colors that harm the eye of the user	[20]
	Use computers and devices with high power that consume large amounts of power	[20]
	Installation package which is the larger size	[20]

Following this table scenario, identify some traditional practices which are used in requirement elicitation technique for software development process.

##### B. Requirement Elicitation Process Adaptation

The requirement elicitation process development, can adapt a variety of practices. Table:2 proposed to existing three processes of requirement elicitation technique can adapt green requirement elicitation such as: interviewing, document analysis, interface analysis.

**Table 2: Adaptation Techniques: Control**

Techniques	Description	References	
Interview	Using paperless forms, questionnaires, collect requirements through electronic means	[26]	
	Need to be added to the non-functional requirement	[26]	
	When physically interview is decided considered and usage virtual meeting	[26]	
	Determine exact CPU usage of specific components of the application and optimize them to reduce CPU usage	[27]	
	Reduce transportation means and instead uses the internet for communication and use cloud computing	[27]	
	Necessary activities reuse	[27]	
	Using a computing center cooling and airflow. Introducing paperless environment, optimizing resource utilization, and minimizing e-waste	[28]	
	Computer hardware reuse of the project.	[28]	
	The focus should shift in paperless work	[28]	
	The focus should shift Nuance's PaperPort, OmniPage, and PDF Converter	[29]	
Document Analysis	Memory usage has a minimal cost	[28]	
	Determine exact CPU usage of specific components of the application and optimize them to reduce CPU usage	[27]	
	Reduce the number unnecessary activities in the system and must use environmentally approved products	[27]	
	Use of service oriented software and requirements collecting, using some alternative energy sources such as wind or solar energy	[27][30]	
	Using a computing center cooling and airflow, introducing paperless environment, optimizing resource utilization, and minimizing e-waste	[28]	
	Software and hardware which use less energy resources and eco- friendly, improving operational efficiency, improving operational efficiency and close the application when it is not in use or switching off the computer and compute turn it on when it is needed again otherwise turn of the application when it is not needed	[26][27] [28]	
	Interface Analysis	Programmers should write efficient algorithms via writing a compact design of codes and data structures based upon the application, programming language and the architecture of the system	[26]
		The effect of reuse and application development environments specific frameworks	[26]
		Designs must include specific measures and practices that relate to environments – using fewer hardware, use of virtualized systems	[26]
		The challenge is to meet the non-functional requirements using a minimum of system resources	[26]
Reduce the number unnecessary activities in the system and run the system on computers with powerful profiles		[27]	
Finding out the possibility of server virtualization		[26]	
Improving operational efficiency and use computer hardware recycling of the project	[27][28]		

Following this table scenario, this table suggests some good practices which will ensure a better green requirement elicitation technique for software development process.

## VI. CONCLUSION AND FUTURE WORK

This extended abstract defined this aspect of green requirement elicitation technique in software development. This paper defines its form of exemplary descriptions on how to adopt these aspects in green requirement elicitation technique process development.

As future work, I will visualize and building a green requirement elicitation model for software engineering.

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# *PUMP IS USED IN OUR EVERYDAY LIFE, SMART TECHNOLOGY MAKES OUR LIFESTYLE EASIER*

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**Abstract**— In this project, a smart water pump control system for residential and commercial buildings has been designed and implemented successfully. This prototype presents the detailed mechanical and electrical design, software simulation, operation, analysis, and hardware implementation of a smart water pump control system. In this system, water sensor has been used to gather information about the physical environment and characteristics. By processing that information, the control unit of the smart water pump control system commands the automation parts of the smart water pump. The smart water pump is controlled from long distance and it can be obtained from smart water pump with the help of the control unit contains a GSM module of all kinds of necessary information as well as specific notifications. A water sensor has been attached in water tank of the pump for maintaining the position of water in the tank. The control system sends a mobile notification through GSM module to maintain the water level as well as reduce the electricity. When there is an unauthorized activity or over water flow or anything unexpected circumstances detected by the sensors, it contains a LCD display and for manual command. As there is a keypad contains in the function which takes power from the battery. The main difference of this smart water pump from the existing one is as an ordinary water pump. On the other hand it does not operate in cloud operating system such as it saves the electricity as well as reduces waste of water designed in low cost. The display unit in the circuit is used to show the current positions physically of water in the tank, where the properties of seven segments display have been used.

**Index Terms**—Smart Product, Water Pump.

## I. INTRODUCTION

Pump is used in our everyday life. Smart technology makes our lifestyle easier. Recent innovations in smart things like GSM and Sensor technologies allow for creating a digital representation of almost any physical entity and its parameters over time at any place. In general, physical worlds and digital representations become tightly interconnected, so that manipulations in either would have effect on the other. This effect is seen on this water pump that can make our daily life easier and comfortable [1].

Water is commonly used for agriculture, industry, and domestic consumption. Therefore, efficient use and water monitoring are potential constraint for home or office water management system. Moreover, the common method of level control for home appliance is simply to start the feed pump at a low level and allow it to run until a higher water level is reached in the water tank The smart water pump system means, a water pump which has control unit to control the pump automatically, ability of sending and receiving command as well as ability of sensing the water level in the tank. For example, in a residential and commercial building, when we want save the waste of water and save the waste of Electricity by the GSM and Microcontroller control system.

Proper monitoring is needed to ensure water sustainability is actually being reached with disbursement linked to sensing and automation, such programmatic approach entails microcontroller based automated water level sensing and controlling the water pump system. This is the concept of smart water pump control system [2].

## II. FEATURES OF SMART WATER PUMP

For the demonstration of Smart Water Pump System, it is control through GSM. It is also an automatic system. It has built-in power backup unit. It is a efficient system. It contains two tanks one is main tank and other is reserve tank. Reserve tank contain motor and battery and in the other hand main tank contain whole circuit. Whole circuit is include LCD module, GSM module unit, power backup unit, relay unit, microcontroller unit, sensor unit etc. we used here four sensors; they show 25%, 50%, 75%, 100%. When water level is in 25% motor turns on and when it is in 100% motor turns off.



Fig. 1 Complete Prototype.

## III. LIMITATION OF THIS STUDY

Because of the automation unit, proposed system will consume more power than existing similar systems. When, the power backup unit will be fully discharged, the system will not get any power to operate. If there is no power, the water pump the automation system is completely off. Because of the automation unit, proposed system will consume more leakage than existing similar systems. It is significant to know that this design is limited to 12v, 5amps electric pump and cannot be use to control industrial water pump above 5 amps.

#### IV. RECENT AND EARLIER RESEARCH

Koshin, kishor pump, Blagdon Pump, and many other companies started developing different types of Smart water pump Systems at the beginning of this century with different names. KISHOR PUMPS is a reputed Indian centrifugal pumps manufacturing company having strong presence in all sectors of industry like Chemical, Petrochemical, Refineries, Power, Pharmaceuticals, Infrastructure, Public Health and many more [3].

Recently, very few companies in the world are manufacturing smart products for smart water pump commercially. AFM and its sister company, in Penn West Coast stainless, in California are the largest pump focus foundries in North America [3].

#### V. CONTROL SYSTEM

When the system is **on**, microcontroller check the water level by the sensor, if it is 100% then system ends and motor turns **off**. If it is not 100% then it will check 75%. If it is 75% then system ends and if it is not 75% then it will check 50%. Again if it is 50% then system ends and if it is not 50% then it will check 25%. If it is 25% then system ends and if it is not 25% then check 0% and motor turns **on**, motor turns **on** till the water level is 100% and again check water level from first. If it is not 0% then system ends and start from first. All the process we can see in the LCD screen. We can control the system by GSM, by sending SMS we can turn **on** or turn **off** the system anytime from anywhere. We can know the system present condition by GSM in anytime.

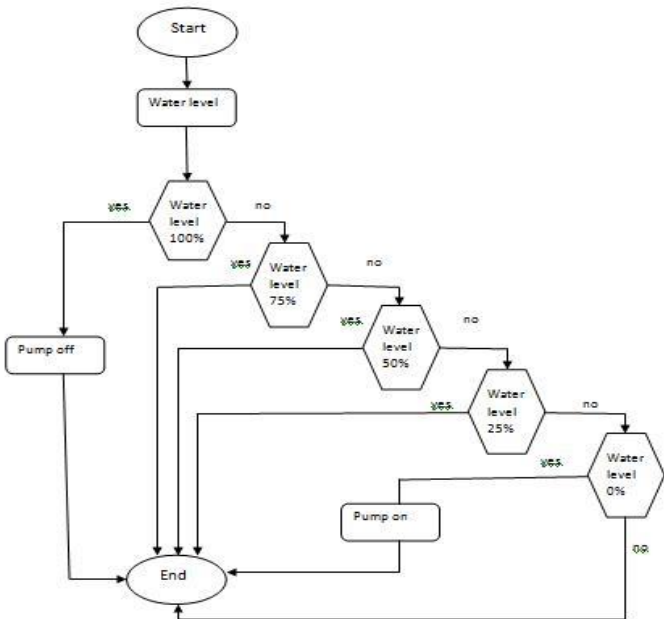


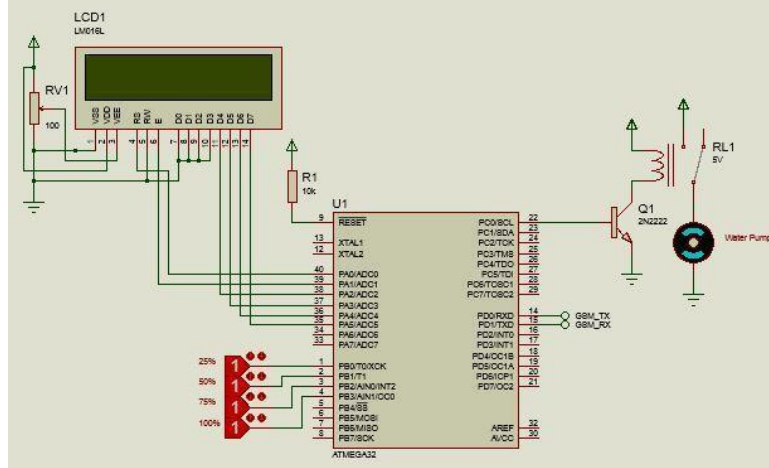
Fig. 2 Flow Chart.

#### VI. CONTROLLER UNIT WITH PROTEUS SIMULATION

One AVR microcontroller have been used in this project, it is ATmega32. It is the main circuit in this project which control the whole circuit of this project, which is 8 bit [5].

#### a) ATmega32

ATmega32 is an 8-bit high performance microcontroller of Atmel's mega AVR family. ATmega32 is based on enhanced RISC (Reduced Instruction Set Computing) architecture with 131 powerful Instruction. In this project ATmega32 is the main controller. It controls some devices are connected directly or indirectly. Only LCD and GSM modules are directly connected with it. The circuit diagram of ATmega32 is given below



### c) Sensor Unit

A comparator is used for analog output converted to digital output because all sensors give analog output. A 10K potentiometer is used to provide the reference voltage. Basic sensor unit diagram is given below. To operate the sensor we should send a message to the GSM modem. That modem will receive the message it will send the information to the micro controller through decoder.

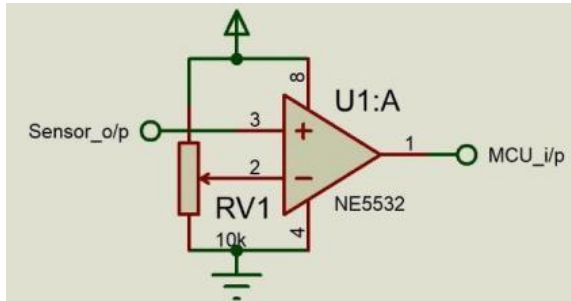


Fig. 5 Sensor Unit.

Water level sensor unit consist of two parts, one sensor is used in reverse tank and second is used inside water tank [4].

### d) Relay Unit

A relay is an electrical operated switch. Relay is used where it is necessary to control a circuit by a low power signal In this project 5v DC Relay is used to control 12V load from 5V command signal from controller. A BJT (2N2222) is used for electrical switching of relay coil current. The relay circuit is given below [5]

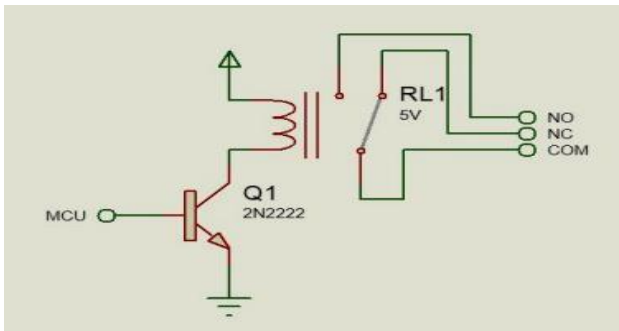


Fig. 6 Relay Unit.

## VII. ADVANTAGE OVER TRADITIONAL METHOD

Though there are only few smart products in market, those have some disadvantages. The main disadvantages of our smart water pump is high cost than other normal pump, some time it is difficult to maintain because if any time it does not work properly then it is difficult to find where is the main problem because for proper and efficient circuit diagram we used lots of element with lots of wire.

Advantages of proposed system over traditional methods are,

- Friendly user interface.
- Comparatively low cost than existing one.
- Built in power backup unit fully automatic service.
- No wastage of water and electricity.
- Low power consumption
- circuit. Easy to construct.
- Easily stop and start the motor at any time using GSM module by SMS.
- Reliability.
- Less chance of failure.

## VIII. OBJECTIVE OF THIS WORK

The main objective of this project is to design a user friendly as well as comparatively low cost smart Water Pump. The secondary objectives of this project are,

- Designing a device from practical
- perspective. Using the benefits of electronics.
- Integrating some existing ideas into
- one. Making our daily lifestyle easier.

## IX. DESIGNING THE SYSTEM

The block diagram of this project has been given in figure 7.

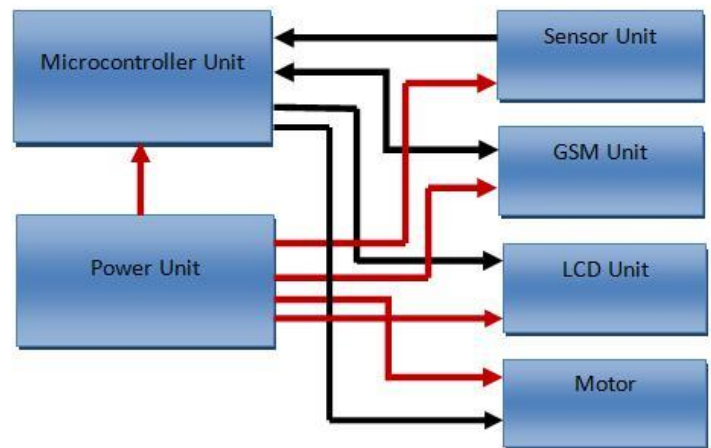


Fig. 7 Block Diagram.

Power Unit and Controller Unit are connected with all other units either directly or indirectly through Relay Unit. Sensor unit connected with Controller Unit where controller unit takes power from power unit and takes command. Motor connected with relay unit which also takes power from power unit and takes command from controller unit. LCD unit and sensors also take power from power unit and sensor gives input to controller unit. LCD display only receives command from controller unit and takes power from power unit. GSM module receives and sends command, controller give response to controller unit as well as takes power from power unit. Controller unit itself is also connected with power unit to take required power [5].

## X. SUGGESTION FOR FUTURE WORK

Many future works can be done in this topic. Any other kinds of water pump can be designed as smart water pump with different features related to that particular furniture.

This project can also be developed in many ways. Some ways has been listed below,

- Any new feature can be added in this project which can make this project more useful.
- The algorithmic platform of this project can be upgraded.
- We can be used a water filter in the water tank for the purpose of purifying the water.
- We will also use a heater for get hot water and will also use a cooler for get cold water.

- We will also set a battery here as a source for the purpose when in the absence of electricity we will turn on the pump by the battery.
- We will also set a smart meter with GSM that collect the bill & send it to the WASA.
- The circuit can also be designed in a new way which will make the whole device faster and more accurate. □  
The manufacturing cost can be optimized by choosing different components which will be lower in cost but it can be used to provide same feature.

#### XI. CONCLUSION

The aim of this project is to provide an efficient solution for automatic control of water supply in a building. Now a day's technology is running with time, it completely occupied the life style of human beings. Water is one of the most important basic needs for all living beings. But unfortunately a huge amount of water is being wasted by uncontrolled use. Some other automated water level monitoring system is also offered so far but most of the method has some shortness in practice. We tried to overcome these problems and implemented an efficient automated water level monitoring and controlling system, our intension of this research work was to establish a flexible,

economical and easy configurable system which can solve our water losing problem. The design of this system is very much sensitive and should be handled with utmost care because the microcontroller is a 5 volts device. So every small parameter should be given high importance while designing the interfacing circuit between the controller and the water motor.

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# Dual Mode Autonomous Unmanned Aerial Vehicle with Graphical User Interface & Flight Data Record

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**Abstract—** This paper proposed the development of an autonomous unmanned aerial vehicle (UAV) which is controlled wirelessly through graphical user interface. This proposed design capable to fly autonomously and also capable to track pre loaded mission automatically. Proposed mathematical model and artificial algorithm control technique by which quad rotor can capable to fly autonomously, trajectory tracking, graceful motion and accurate altitude hold performance. In this system author used IMU 9DOF (3-axis accelerometer, 3-axis gyroscope & 3-axis magnetometer) which ensure it smooth movement, graceful motion and trajectory tracing. GPS system and barometric sensor make it more efficient in autonomous mode. Several PID loops designed to get better stability and performance in different mode. All signals are processed by a powerful high speed controller board which makes it more efficient and effective. All data and result discussed at the end of paper.

**Keywords—** autonomous UAV system, inertial measurement unit, graphical user interface, PID control loops, stability and performance.

## I. INTRODUCTION

At present world drone technology is very familiar & versatile technology. Drones are remarkable devices. They can hover in midair, do back flips and spins; they can maneuver smoothly and precisely through small spaces or in concert with other drones; and they can do all this while carrying things like a stabilized video camera and a multitude of other technologies on board. The extent of their versatility is what makes them a viable option for a number of different tasks. Drones can be deployed as weapons in far-away wars, or can help reinvent the way humanitarian aid is provided. Drones can help advance scientific research, or can perform tracking and monitoring and surveillance work. Drones could revolutionize the way humans do certain work or even perform dangerous tasks, but they could also encroach on the core values of a free and democratic society. Drones have unique capabilities and are very flexible in terms of the tasks they can perform, which is what is making them a desirable alternative to manned flights.[1]

Drone technology raises important questions and concerns about privacy. There is a gap in regulation, which does not address issues related to purpose and the privacy implications of their use. Now government declared some rules and regulation to fly drone in different purposes. A mature quad

rotor system can be used for reconnaissance, rescue, photography and works that are dangerous or space limited for human beings [2], [6].

Drones are no longer exclusively for military use on the battlefield. They have been evolving into a more accessible tool that could eventually be put to various tasks domestically across North America. Drones do currently operate in limited circumstances in many countries, and their use is steadily on the rise. In addition to their projected proliferation in the public and private sectors here at home, they are also increasingly becoming available to Canadian citizens at large. At present not only in Canada but also in others countries drone technology increasing day by day. As for the public sector, in the near term law enforcement represents the greatest potential users of small drones domestically because they offer a simple and cost effective alternative to airborne law enforcement activities. UAV has variety of purposes, in areas such as national security intelligence gathering, critical infrastructure protection, public safety and crisis management, or in environmental research [10].

### A. Why an Autonomous UAV (Drone)

Drones are often referred to as a desirable alternative to manned flights, and it is largely due to their flexibility and unique capabilities. Drones can be a persistent, highly targeted and cheap form of surveillance. Drones can be deployed on demand and can generally stay in the air longer than manned aircraft. They are flexible in terms of the tasks they can perform, they can support high-resolution imagery and sensors, and the “plug and play” payload capability makes them easy to tailor to a specific flight purpose. Furthermore, they can cover vast and remote areas. The current and the speculated uses for drones range quite broadly across the public and private sectors. Government organizations, private sector entities and amateur enthusiasts are all seemingly eager to launch drones in domestic skies for a variety of purposes.

In the private sector, drones are for the moment fairly restricted, but may increasingly become a practical tool for commercial businesses. It has been speculated that they could be utilized for profitable commercial services such as infrastructure inspection, communications and broadcast services, wireless communication relay and satellite augmentation systems, natural resources monitoring,



media/entertainment, digital mapping, land and wildlife management, and air quality management/control.

### B. Related Works

Many researchers involve themselves into this area in recent years. As in [5], [7], [9], Samir Bouabdallah et al. carried out a series of researches on the control system of the quad-rotor UAV. Back stepping method was also used that is proposed [9]. To design stable and efficient control many researcher works with root locus analysis and PID control system [3]. In [1], a PD controller was presented by V. Kumar et al., and performs well in their robotic team [4]. Many researchers choose it as their experimental platform [1], [8].

## II. PROPOSED DESIGN

### A. System Overview

To desing a stable multicopter we need maintain some physics, mathmatics and aeirodynamic term. Aerodynamic help to define its movement and inertial motion. In the other hand mathematical calculation helps to manipulate required lift force, angular position, graceful motion and trajectory definition.

We designed drone’s body according with dynamics and also designed artificial algorithm to make it autonomous and well behaved. Hardwire system consists of different sensors, powerful controller unit and electronic equipments so on. For a desire movement controller takes data from different sensors. 3-axis accelerometer and 3-axis gyroscope provide data of its orientation, acceleration and angular rate. Then these data processed and compare with reference and desire value. This operation performs with the help of PID loop. Several PID loops used in these case like pitch control, roll control, yaw control, hover, altitude holding and orientation control. IMU (inertial measurement unit) provides real altitude, angular movement and orientation. After that required pulse sends to ESC (Electronic Speed Controller) for desire speed of rotation. Magnetometer provides real time direction with the global magnetic field reference. Barometric pressure sensor also provides real time altitude. GPS (global position system) module helps to make system autonomy. It helps find out any coordinate and reach to this coordinate. Telemetry kit helps to observe flight data wirelessly from ground station. It also send mission file and communicate with air part like USB serial mode (TTL mode).

In ground part consists of powerful ground station. PC/Laptop used for sending data through telemetry and coding or data logging from air part. Another radio transmitter used to switch different mode and operate in manual mode.

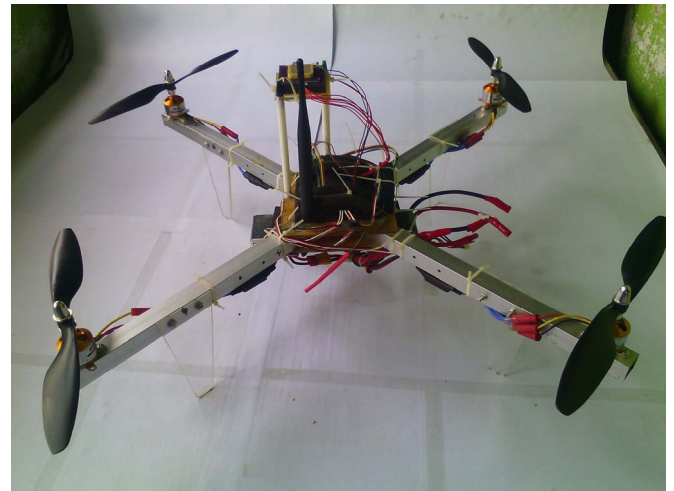


Figure 1. System Overview of Autonomous Unmanned Aerial Vehicle

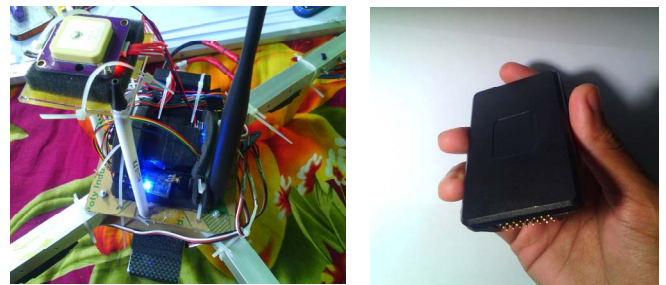


Figure 2. Air part hardware system in alive. Right figure shows Processing unit of an autonomous UAV.

### B. System Block Diagram

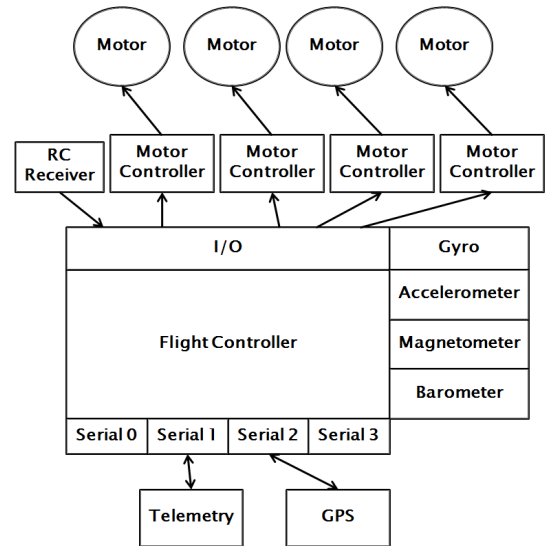


Figure 3. Proposed block diagram of UAV's air part.

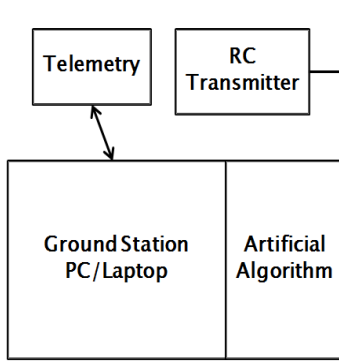


Figure 4. Proposed block diagram of UAV's ground station.

### III. SYSTEM MODELING

To design a stable multi-rotor copter we have to concentrate its structure and dynamics. We have to develop a firmware in which contains different control strategy, mode of operation, data evaluation and different PID loops for stability:

#### A. Body Dynamics

Body dynamic of multi-rotor copter governs the response of attitude control. Let consider a multi-rotor copter frame. We can derive expression in two coordinate system i.e. one is inertial coordinates and another one is body fixed coordinates.

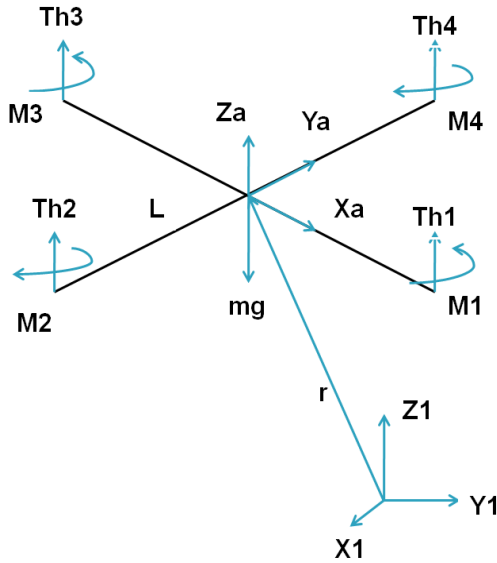


Figure 5. Force diagram of quad copter.

$U_1$  is sum of the thrust of each motor.  $Th_1$ ,  $Th_2$ ,  $Th_3$  and  $Th_4$  are thrust generated by front, rear, left and right motor respectively.  $m$  is Quad-copter mass,  $g$  is the gravity acceleration and  $L$  is the liver distance of Quad- copter.  $x$ ,  $y$  and  $z$  are the three axis position.  $\phi$ ,  $\theta$ ,  $\psi$  are three Euler angles representing pitch, roll and yaw.

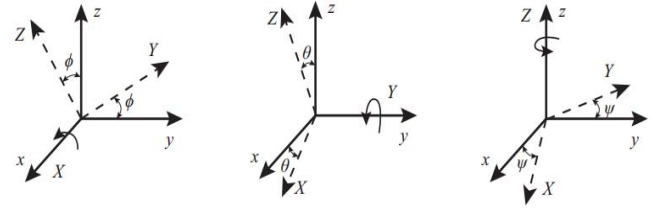


Figure 6. Attitude control definition.

With attitude angles defined as in Fig. 6, the transformation matrix from inertial coordinates to body fixed coordinates is:

$$R(\theta, \phi, \psi) = \begin{bmatrix} c\psi c\theta & c\psi s\theta\psi - s\psi c\theta & c\psi s\theta\phi + s\psi s\phi \\ s\psi c\theta & s\psi s\theta\psi + c\psi c\theta & s\psi s\theta\phi - s\psi s\phi \\ -s\theta & c\theta\phi & c\theta\psi \end{bmatrix} \quad (1)$$

Where  $s$  stands for sin,  $c$  stands for cosine, and  $\phi$ ,  $\theta$ ,  $\psi$  represent attitude angles of roll, pitch, and yaw respectively.

In the body fixed coordinates, the direct inputs are RPM (revolutions per minute) commands for the motors. The resultant outputs are  $Z$  directional thrusts in body fixed coordinates. However, the concerned outputs are attitude and position. To eliminate this gap, four control variables are defined as  $U_1$ ,  $U_2$ ,  $U_3$  and  $U_4$ . Each of the affects the attitude, rotation in roll angle, rotation in pitch angle and yaw angle respectively.

$$U = \begin{cases} U_1 = Th_1 + Th_2 + Th_3 + Th_4 \\ U_2 = (Th_3 - Th_1)L \\ U_3 = (Th_2 - Th_4)L \\ U_4 = M_1 + M_3 - M_2 - M_4 \end{cases} \quad (2)$$

Here  $Th_i$  is thrust generated by four motor,  $M_i$  are momentums, and  $L$  is lever length.

By applying the force and moment balance laws, motion formulations are given as

$$\begin{aligned} \ddot{x} &= \{U_1(\sin\psi\sin\phi + \cos\psi\sin\theta\cos\phi) - K_1\dot{x}\} / m \\ \ddot{y} &= \{U_1(\sin\psi\sin\theta\cos\phi - \cos\psi\sin\phi) - K_2\dot{y}\} / m \\ \ddot{z} &= (U_1\cos\phi\cos\theta - K_3\dot{z}) / m - g \end{aligned}$$

Where  $k_i$  is drag coefficient (assume zero since drag is negligible at low speed).

The angle  $\phi_d$  and  $\psi_d$  can determine as follows from Fig.7,

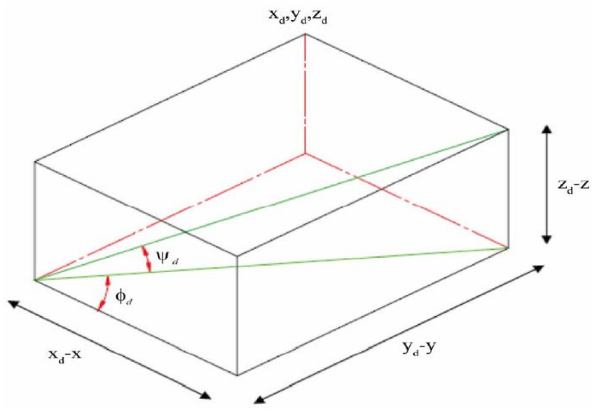


Figure 7. Angle movement of quad copter.

$$\phi_d = \tan^{-1} \frac{y_d - y}{x_d - x}$$

$$\psi_d = \tan^{-1} \frac{z_d - z}{\sqrt{(x_d - x)^2 + (y_d - y)^2}}$$

The second derivatives of each angle given as

$$\ddot{\phi} = U2 / I_{xx}$$

$$\ddot{\theta} = U3 / I_{yy}$$

$$\ddot{\psi} = U4 / I_{zz}$$

Where  $I_{xx}$ ,  $I_{yy}$ ,  $I_{zz}$  is rotary inertia around X, Y, Z axis respectively?

### B. Aerodynamics Effect

The thrust T produced by each motor is calculated as

$$T = \rho C_T A w_m^2 R^2$$

Where

$C_T$  : thrust coefficient

$\rho$  : air density

A: rotor disk area

R: blade radius

Propeller diameter & pitch-

$$D \sim \tau, p \sim \tau$$

$$\tau \sim E$$

Where, d: diameter of propeller,  $\tau$  : torque, E: energy

Frame parameters-

$$\text{Blade tip speed, } v \sim \sqrt{R}$$

$$\text{Lift, } F \sim R^3$$

$$\text{Inertia, } m \sim R^3, I \sim R^5$$

$$\text{Acceleration, linear } a \sim 1, \text{ angular } a \sim \frac{1}{R}$$

Where, R: frame center to motor distance

### C. Dynamics of Rotor

The dynamics of DC motor is generally described as

$$L_i \frac{di}{dt} + Ri + k_e w_m = u$$

$$J \frac{dw_m}{dt} = \tau - \tau_d$$

Where

$L_i$  : Coefficient of inductance

i: armature current

R: armature resistance

$k_e$  : back emf constant

$w_m$  : speed of motor

u: armature voltage

J: inertia of motor

$\tau$  : torque of motor

$\tau_d$  : load

### D. System PID Control

PID (proportional-integral-derivative) is a closed-loop control system that tries to get the actual result closer to the desired result by adjusting the input. Quad-copters or multi-copters use PID controller to achieve stability.

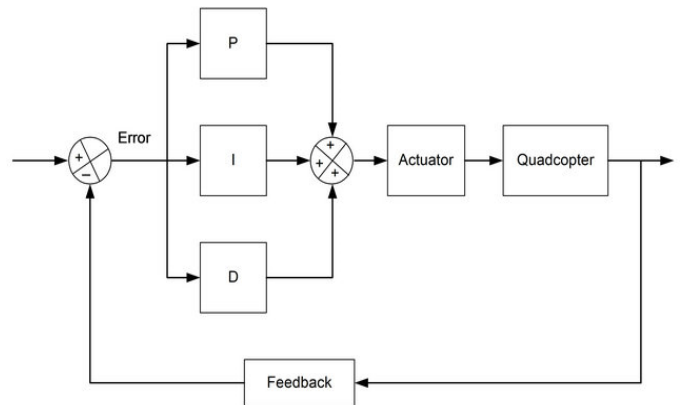


Figure 8. PID loop for system.

There are 3 algorithms in a PID controller; they are P, I, and D respectively. P depends on the present error, I on the accumulation of past errors, and D is a prediction of future errors, based on current rate of change. These controller algorithms are translated into software code lines.

Per axis PID structure shown in Fig.9. For any kind of control over the quad-copter or multi-copter, we need to be able to measure the quad-copter sensor output (for example the pitch angle), so we can estimate the error (how far we are from the desired pitch angle, e.g. horizontal, 0 degree). We can then apply the 3 control algorithms to the error, to get the next outputs for the motors aiming to correct the error.

Here we are going to look at what are the effects of these parameters to the stability of a quad-copter.

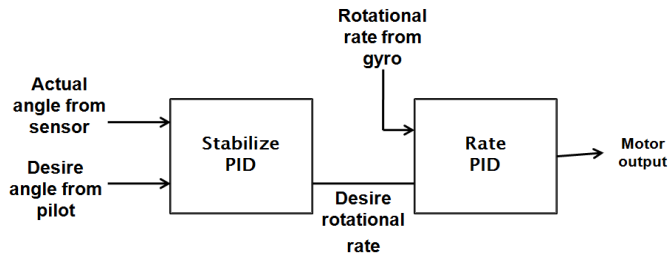


Figure 9. Per axis PID structure.

#### IV. RESULTS AND IMPLEMENTED DESIGN

##### A. On flight Simulation Data

Fig. 10, indicates the altitude hold performance. This is one of the important curves which indicate the stability and behavior of our drone. Here DAlt for desire altitude and Alt for altitude at which drone travels. This curve contains several mode of operations characteristics. When we shift from stabilize (manual) mode to hover mode or GPS lock mode then DAlt curve generate and then altitude calculated from IMU unit and also generate the barometer altitude curve shown in Fig. 11, as blue line. Alt and DAlt line lies close together that means altitude hold performance is good in different modes.

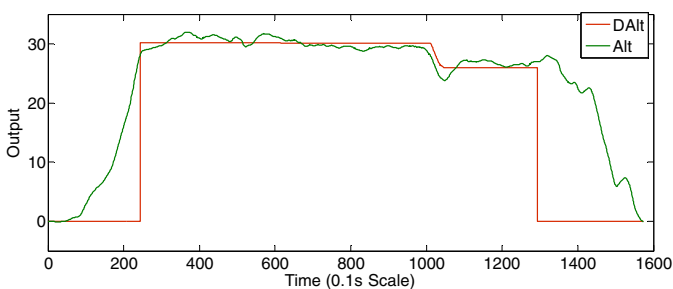


Figure 10. Altitude hold performance data in different mode.

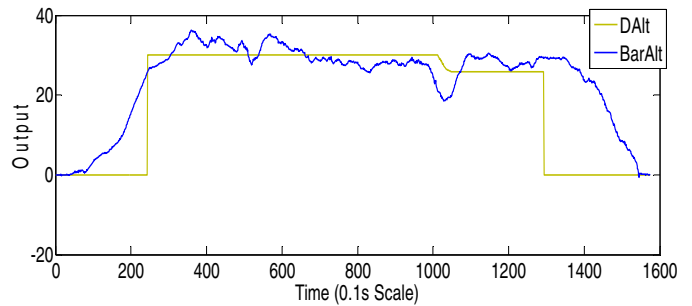


Figure 11. Altitude hold performance with barometer.

Fig. 12, shows the pitch response and Fig. 13, shows the roll response of UAV in different modes. Here, DesPitch and DesRoll for desire pitch and roll respectively. And only pitch and roll indicate the pitch roll response. If we observe the curves than we see that pitch and roll curve is similar to desire pitch and roll curve. We see in stabilize (manual) mode and altitude hold mode we get some spike which indicate pitch & roll action. Though stabilize mode is manual mode so we change pitch manually. In altitude hold mode- altitude maintain automatically but pitch & roll is also manual control. In loiter mode that means in GPS lock mode- all parameters controlled automatically without human interface. So in loiter mode spike is less which indicate it holds a constant coordinate with stability.

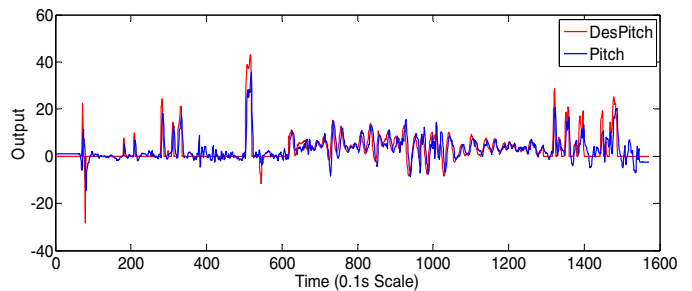


Figure 12. Response of pitch in different mode.

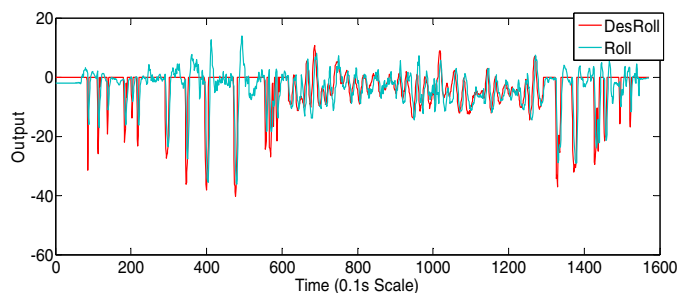


Figure 13. Response of roll in different mode.

Fig. 14, shows the throttle response in different modes. We see that throttle fluctuate in manual mode due to manual control of throttle fluctuation. In autonomous mode throttle automatically control by processor unit. So throttle response does not fluctuate significantly.

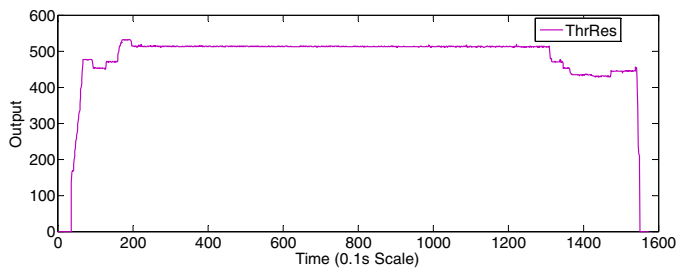


Figure 14. Throttle response of proposed design in different mode.

### B. Implemented Design

Total hardware design of proposed UAV is given below.

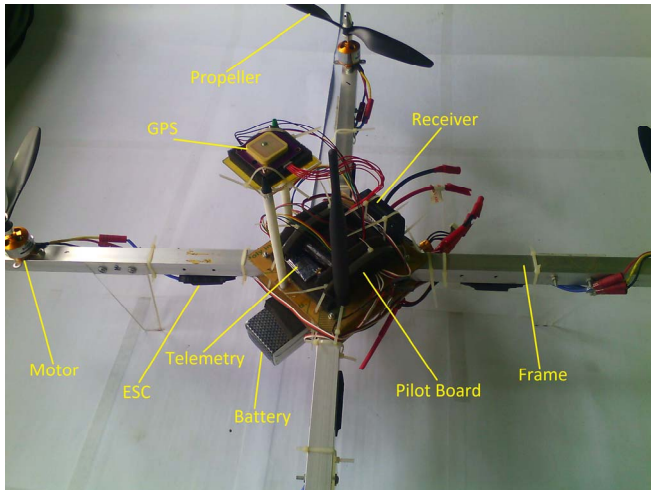


Figure 15. Real view of implemented design.

## V. CONCLUSION

From all of curve analysis we can conclude that overall performance of our system is stable. This system is capable to fly in different mode without complexity. It's performance, movement, orientation, motion, stability also good. This drone is capable to fly in several modes. The main modes are manual mode, hover mode, auto mode and return to lunch mode. In manual mode drone is controlled by remote device and in

others mode drone flies autonomously. This system have facility to see flight data by using powerful ground station and user can upload or override a mission in real time flight condition when a mission running. The distance between motor to motor is 0.61m. The overall total weight of implemented design is 1.46kg and its carrying capacity is 0.5kg.

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# A Novel Method of Remote Control of Power System Substations Based On Sensor Data Using GSM Networks

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**Abstract**— Remote monitoring of substation alarms and data from system assets enables the utility provider to operate the network at a greater efficiency, more safely, and with minimum power interruptions. Various monitoring systems have been developed for different architectures. Wireless communication has always been a prominent field of interest among researchers and system developers for power system monitoring and control. This paper presents a novel methodology of automatic monitoring and first level operation and maintenance of a substation using GSM based remote control. GSM network is widely known for its vast coverage area, cost effectiveness, two way data links and ready availability. The proposed system has been implemented in a simulation system using Proteus simulation software. The simulation results show simplicity and advantages of the proposed system over legacy monitoring systems.

**Keywords**—ARCS, SIM900, ATMEGA328, Arduino, virtual terminal

## I. INTRODUCTION

The electrical substation is an important part of an electrical system. The importance of substation automation has been further increased to become a necessity for the next generation modern power grid. The information about the existing condition of different components in a substation provides a clear picture of the state of its components so that 1<sup>st</sup> level necessary measures can be taken to maintain a healthy condition of substation [4]. Although it is possible to monitor the status of equipment in a substation manually, human error and system response speed become the crucial factor in building up a successful monitoring system [1]. To reduce these limitations and to make more handy monitoring systems utilizing the advancement of mobile application technology and communication, the condition based maintenance of substations is becoming possible through online measuring instruments. Thus, the measured information regarding voltage level, ambient temperature, equipment intake temperature, magnitude of current flow, supply frequency, power factor etc. are needed to be monitored through authorized mobile handsets. Furthermore, necessary steps could be taken through the same authorized mobile handsets if necessary.

## II. SYSTEM ARCHITECTURE

The basic system configuration of wireless Automated Remote Controlled Substations named ARCS is shown in Fig. 1. The networked system consists of sensors, microcontrollers, actuators, GSM modem, GSM networks, mobile handset.

- A. Sensors sense the voltage, temperature, current, frequency, power factor from different equipment of substation.
- B. The microcontroller takes the decision and enables the respective actuators to perform the first level corrective action if there is any abnormality. Also send information (alarm) as SMS via GSM modem to remote users. At the same time remote user can access the substation using mobile application and take corrective measure manually.
- C. Actuators are connected to the power equipment which will be activated automatically or manually by remote user if there is any abnormality.
- D. Communication medium or GSM network, which enables communication between controller and the user.

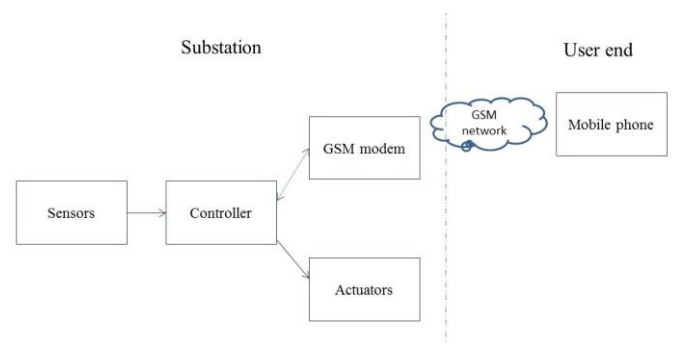


Fig. 1. Structure diagram of ARCS

The ARCS system has ensured two way communications among the substation and authorized users. Hardware architecture is shown Fig. 2. The system

facilitates remote access to the substation on real time basis. The sensors are connected to microcontroller that sense the voltage level, current, supply frequency, temperature, utilization of equipment, power factor. The corresponding relay responds according to the set point of threshold. The relay responds automatically or by manually. Automatic function will trigger as per preset command and the manual function will trigger from user input from authorized hand set remotely. Here GSM modem plays the role of communication medium between substations and mobile.

The program for the microcontroller is written in C and compiled using Arduino IDE to generate hex code. The generated hex code is burnt into the microcontroller using same IDE. The microcontroller contains 6 analogue pins (A0-A5) and 14 digital pin (0-13). As shown in Fig. 2.

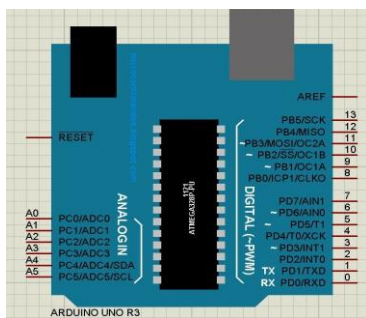


Fig. 2. ATMEGA328 microcontroller

In the program for simulation two analog pin (A0 & A1) has been defined as input. The analog input from sensors. 4 digital pins are assigned as output. Two Pins are dedicated to actuate the relays and the other two pins are used as alarm. Pin (0 and 1) is used for GSM modem. In simulator a virtual terminal is used in place of GSM modem and mobile. In figure 3, the source code shows the pin mode of microcontroller. Figure 4 shows the physical arrangement among microcontrollers, GSM modem and relays.

The GSM module is connected with the arduino board using the serial communication port. The TX pin of the Arduino is connected to the RX pin of GSM module through the max232 and the RX pin of the Arduino is connected to the TX pin of the GSM module using max232 itself.

```

void setup()
{
    lcd.begin(16,2);
    lcd.setCursor(0, 0);
    lcd.print("HELLOW WORLD");
    lcd.setCursor(0, 1);
    lcd.println("TEMP;VOLT");
    delay(1000); // wait 1000ms
    lcd.clear(); // clear LCD display
    pinMode(6, OUTPUT);
    pinMode(7, OUTPUT);
    pinMode(8, OUTPUT);
    pinMode(9, OUTPUT);
    pinMode(A0,INPUT);
    pinMode(A1,INPUT);
    Serial.begin(9600);
}

```

Fig. 3. Setup part of the source code

The code written in the arduino is able to communicate with the GSM module using AT command. The AT commands are send or received from the module using serial communication functions provided by the arduino library. The GSM module used in the circuit is a SIM900 based module which can communicate with other devices using RS232 serial communication port.

The GSM module respond “OK” when it receives the command “AT” and it is the best way of checking communication between the module and the microcontroller. By sending message one can activate or deactivate the relays.

GSM (Global System for Mobile) TTL- Modem is SIM900 Quad-band GSM device, works on frequencies 850MHz, 900MHz, 1800MHz and 1900MHz. it is very compact in size and easy to use as plug in GSM Modem. The Modem is designed with 3 V3 5V DC TTL interfacing circuitry, which allows User to directly interface with 5V Microcontrollers (PIC,AVR,Arduino,8085 etc ).the baud rate can be configurable from 9600-115200 bps through AT (Attention) commands. This GSM TTL Modem has internal TCP/IP stack to enable User to connect with internet through GPRS feature. It is suitable for SMS and data transfer application in mobile phone to mobile phone interface. The modem can be interfaced with a Microcontroller using USART (Universal Synchronous Asynchronous Receiver and Transmitter) feature (serial communication). Fig. 6 shows the details of GSM modem.

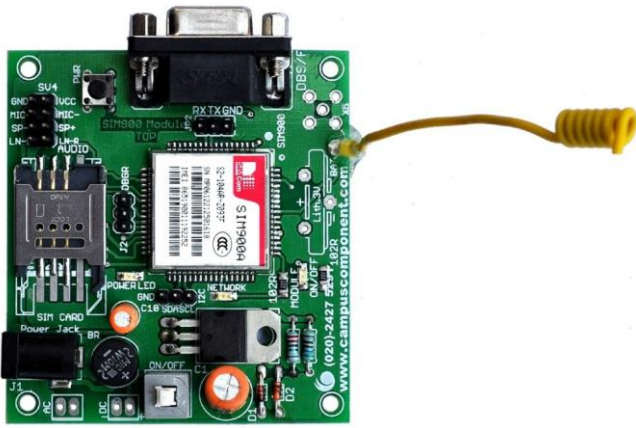


Fig. 5. A GSM modem (SIM900)

This is actual SIM900 GSM module which is manufactured by SIMCom. Designed for global market, SIM900 is a quad-band GSM/GPRS engine that works on frequencies GSM 850MHz, EGSM 900MHz, DCS 1800MHz and PCS 1900MHz. SIM900 features GPRS multislot class 10/ class 8 (optional) and supports the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4. With a tiny configuration of 24mm x 24mm x 3mm, SIM900 can meet almost all the space requirements in User's applications, such as M2M, smart phone, PDA and other mobile devices. The MAX232 is an integrated circuit that converts signals from an RS-232 serial port to signals suitable for use in TTL compatible digital logic circuits, so that devices works on TTL logic can share the data with devices connected through Serial port (DB9 Connector). This power supply socket which actually named as AC/DC Socket provides the functionality to user to connect external power supply from Transformer, Battery or Adapter through DC jack. User can provide maximum of 12V AC/DC power supply through AC/DC socket. This is power supply designed into maximum protection consideration so that it can even prevent reverse polarity DC power supply as well as DC conversion from AC power Supply. It also includes LM317 Voltage Regulator which provides an output voltage adjustable over a 1.2V to 37V.

The LM35 series are precision integrated-circuit temperature devices with an output voltage linearly-proportional to the Centigrade temperature. The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. As the • Power Supplies LM35 device draws only 60  $\mu$ A from the supply, it has • Battery Management very low self-heating of less than 0.1°C in still air. The LM35 device is rated to operate over a -55°C to • HVAC 150°C temperature range, while the LM35C device is • Appliances rated for a -40°C to 110°C range (-10° with improved accuracy).

A single phase step down (220V to 12 V) transformer is used for individual phase for voltage measurements of line voltage. A rectifier unit is used (bridge rectifier) to convert AC to DC. Here is the circuit for sensing the DC voltage for Controller input using an op-to coupler:

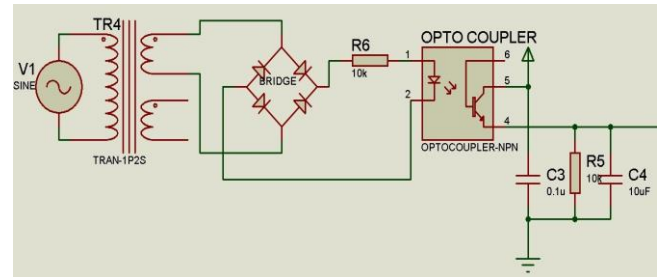


Fig. 6. Line Voltage measurement circuit

The Arduino can accept up to 5v on an analog input. Our DC voltage can range as high as 12vdc in certain cycles, so we designed a voltage divider that would provide 5v at 12v DC voltage, and less at various lower voltages. And the corresponding program would be

```
Supply = analogRead(A1);
// read the voltage on the divider
pinVoltage = Supply * 0.00488;
// calculate the voltage on the A/D pin
// A reading of 1 for the A/D = 0.0048mV
// if we multiply the A/D reading by 0.00488 the
// we get the voltage on the pin.
Output = pinVoltage * ratio;
// Use the ratio calculated for the voltage divider
// to calculate the supply voltage
```

ACS715 Current Sensor is used to sense the current. The Sensor is a simple carrier of Allegro's 30A ACS715 Hall effect-based linear current sensor, which offers a low-resistance (~1.2 m $\Omega$ ) current path and electrical isolation up to 2.1 kV RMS. This version accepts a unidirectional current input up to 30 A and outputs a proportional analog voltage (133 mV/A) that measures 500 mV when the input current is zero. The typical output error is  $\pm$ 1.5%. It operates from 4.5 V to 5.5 V and is intended for use in 5 V systems.

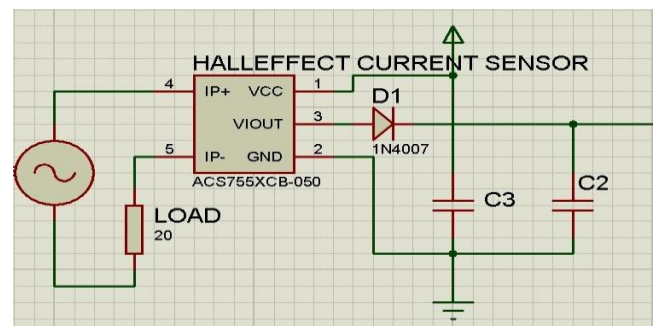


Fig. 7. Current measurement circuit

The next step is to track the current flowing, or produced by a source. We are using an ACS715 Hall Effect



sensor to track the current being passed. And the corresponding program would be

```
//read the analog in value:
sensorValue = analogRead(A2);
// convert to milli amps
outputValue = (((long)sensorValue * 5000 / 1024) - 500) *
1000 / 133;
amps = (float) outputValue / 1000;
```

5 V relays are used as Actuators. The following things are required to connect the relays with controllers. Diode (1N4007), NPN transistor (2N2222 or BC548), 5V relay.

### III. SIMULATION PROCEDURE

According to procedure, temperature, voltage, current could be measured remotely and also corrective actions can be taken automatically. The total work is done on the simulator Proteus and the changes of parameters are shown in Table I.

TABLE I. CHANGES IN PARAMETERS

Sensors	Allowable limit	values	Relay status	Alarm	Output
Temp	T < 30 degree	21	LOW	NO	fan off
		33	HIGH	YES	fan On
Volt	180 < V < 250	174	HIGH	YES	Gen On
		204	LOW	NO	Gen Off
		258	HIGH	YES	Gen On

TABLE II. SENSOR DATA BASED ACTUATION

Sensors	Allowable limit for generator	values	Relay status	Alarm	Output
Utilization	70%	60%	LOW	NO	Additional generator "off"
		75%	HIGH	YES	Additional generator starts
Frequency	49.5- 50.5 Hz	49 Hz	HIGH	YES	Standby generator starts

A. Temperature sensors calculation: Here LM35 temperature sensor has been used. The analog reading of the sensor is fed to A0 pin of the microcontroller and in the coding the analog values are divided into 0-500 equivalent points than digitalized this value to (0-1023) as shown in Fig. 9.

```
void loop()
{
  A=analogRead(A0);
  B=map(A, 0, 1023, 0, 500);
  lcd.setCursor(0, 0);
  lcd.print("ROOM TEMP:");
  lcd.setCursor(11, 0);
  lcd.print(B);
  lcd.print("'C ");
  if(B>30)
  {
    digitalWrite(6, HIGH);
    digitalWrite(8, HIGH);
  }
  else{
    digitalWrite(6, LOW);
    digitalWrite(8, LOW);
  }
}
```

Fig. 8. Part of the code related to temperature sensing

Similarly analog voltage reading is taken and map to (0-1023)

Utilization calculation of a generator will be calculated as follows:

$V(\text{voltage}), I(\text{current})$  will be found from sensors reading  
 $KVA = \sqrt{3} * V * I$ ; and  $X = KVA$ ; ( $X$  is an interger);  
 The utilization =  $(X/Y) * 100\%$  ( $Y = \text{generator capacity}$ );  
 If the generator runs above 70%, two conditions may be added

1. An additional standby generator will start and take the additional load
2. Non critical load will be disconnected.

Same output will be set in case of imbalance of frequency. The reading of frequency will be obtainable using the frequency sensor. Simulation results were obtained that enabled straightforward comparison of the control systems for each of the reference.

The system has many significant excellences, such as wireless, great quantity of data transmission, high-availability and low-expenses. The future tasks are going to be completed very shortly. Comprehensive work is ongoing.

### IV. HARDWARE SETUP

A portion of hardware simulated architecture of ARCS is as shown as figure 10. Proteus simulator version 7.8 has been used demonstrating two inputs (one sensor and another POT) and corresponding output. A virtual terminal has been introduced in place of mobile hand set.

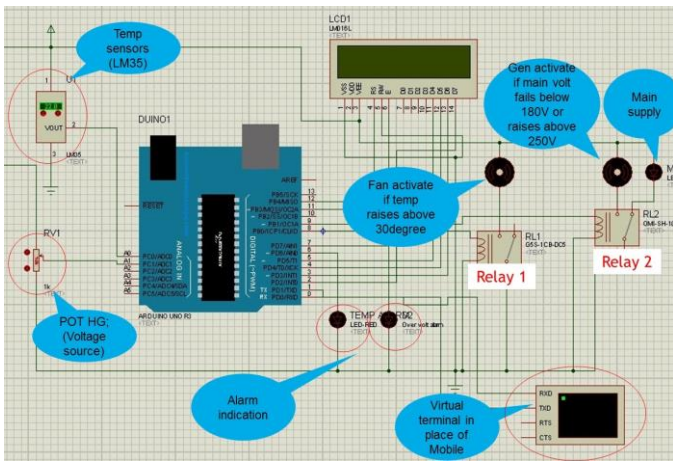


Fig. 9. Hardware diagram of Simulator

### V. RESULTS AND DISCUSSION

The results are described in terms of different sensor data.

A. *Temperature:* Here, the temperature threshold is set at 30 degree. if the ambient temperature crosses 30degree the corresponding additional exhaust fan and cooling fan of substation will be activated as in Fig. 10 and Fig. 11.

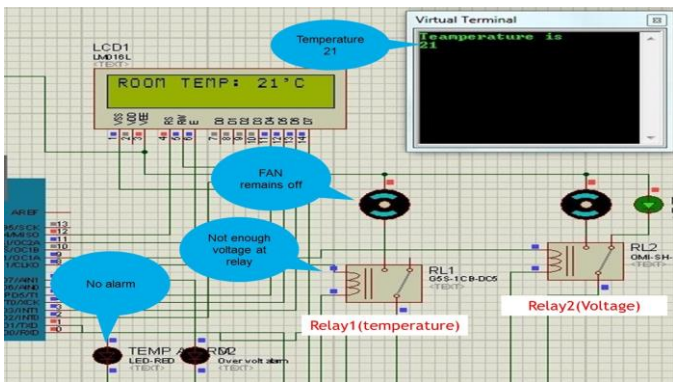


Fig. 10. At 21 degree C ambient temperature, the cooling fan remains in off state. Here the ambient temperature 21 degree is below than threshold. The corresponding cooling fan remains off. A text is send to Mobile hand set (virtual terminal) mentioning the value of temperature.

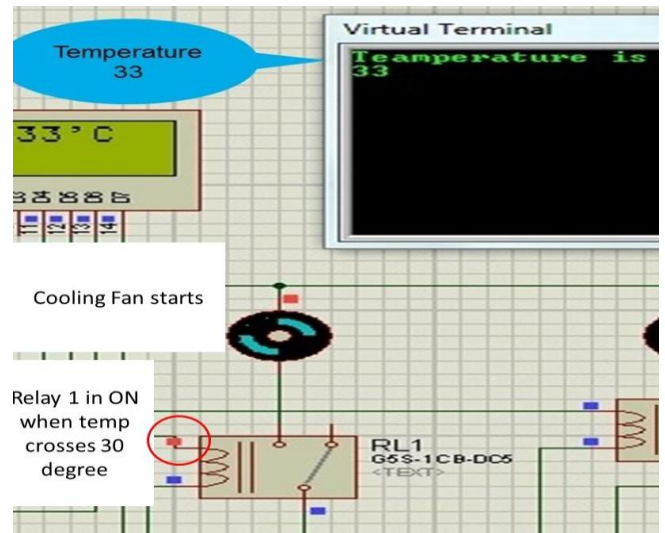


Fig. 11. At 33 degree C ambient temperature, the cooling fan is running. Here the ambient temperature 33 degree crosses the threshold. The corresponding cooling fan starts. Alarm is created and A text is send to Mobile hand set (virtual terminal) mentioning the value of temperature.

B. *Voltage:* Here , the POT is used to vary the incoming voltage. Here one phase is taken. The corresponding relay will be enabled when the voltage level falls below 180 or exceeds 250 volt. Within this safety limit, Main will be supplied. But out of the range the generator will be started after disconnecting the Main supply.

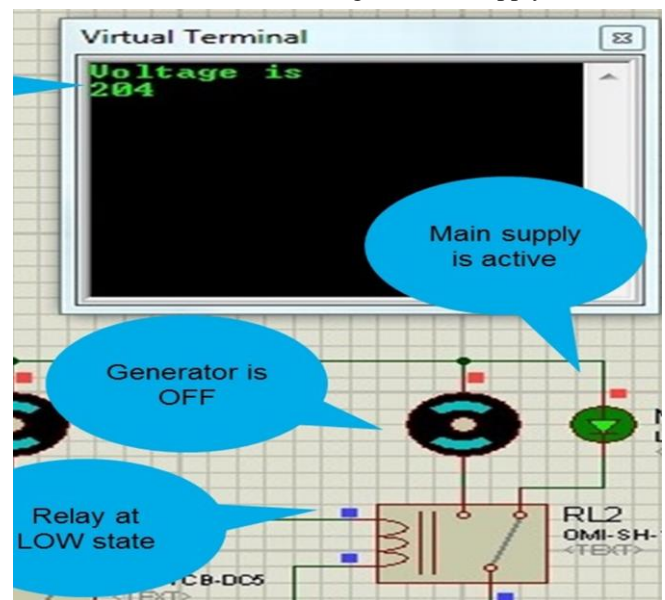


Fig. 12. The supply voltage is 204 volt which is within safety limit. There is no alarm, generator is in off state, and voltage measurements are available at virtual terminal.

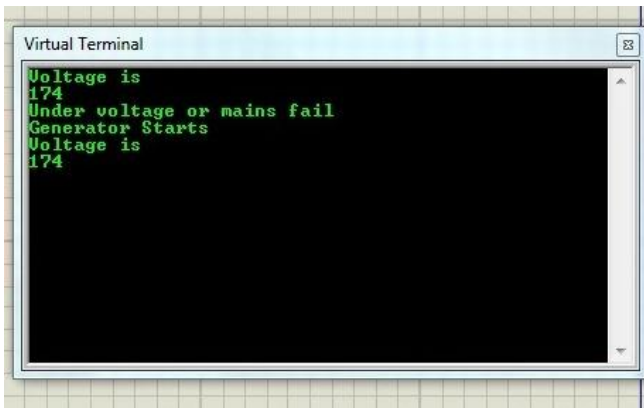


Fig. 13. The supply voltage is 174 volt which is out of safety limit. The alarm is ON, generator is running, Main supply is disconnected and voltage measurements are available at virtual terminal.

Our measurement procedure is inexpensive, simple, reliable, quick, responsive and effective over conventional monitoring system. We are working on integration of frequency and power factor measurement & correction procedure to improve the system and a mobile application is under construction.

## VI. CONCLUSION

Design and implementation of the automated remote controlled substation (ARCS) using the remote mobile phone has been discussed. The purpose of ARCS is to use mobile SMS facility and GSM modem for automation of substation. Different hardware and software unit of the ARCS is described. The complete software has been designed using C language. The ARCS program is tested in Proteus ISIS Professional 7.8 simulator and quite satisfactory results have been received. The ARCS furnishes a good paradigm for any automation system based on mobile phone and GSM.

Substation automation is a rapid increasing area of interest and benefit to utilities. Substation automation goes beyond traditional SCADA to provide added capabilities and information that can further improve operations and maintenance, increase system and staff efficiencies, and leverage and defer major capital investments.

Application and data of interest may include remote access to intelligent electronic devices (IED)/relay configuration ports, waveforms, event data, diagnostic information, and video for security or equipment status assessment, metering, volt/VAR management and others.

Here we have designed a microprocessor based relays and other intelligent devices provide unprecedented flexibility and rich functionality switch, in turn, provide low cost monitoring, analysis and diagnosis of electrical faults in the power network.

The main advantages of this ARCS model are to provide a remote and secured access to the individual authorized personnel via mobile hand set which is too much portable and handy. ARCS system is also easy to design and low cost

to implement. Besides this the main advantages are, one can access the substation through mobile hand set where GSM network is available.

## ACKNOWLEDGMENT

The project is carried out as a part of post-graduate level thesis work in the Department of Electrical and computer Engineering, North South University, Dhaka, Bangladesh. This work was supervised by Dr. Hasan Uz Zaman. We acknowledge with great gratitude his encouragement and constructive suggestions. We are also grateful to the Department of Electrical and Computer Engineering of North South University for providing us the opportunity and facilities to do this project.

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# Automated Student Performance Analysis Based on Student's Information Using Data Mining Techniques

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**Abstract**—Education is an essential medium of acquiring skills and knowledge which enhances the knowledge, skill, and intelligence of a person and enables him to lead a successful life, but there has some lacking in our education system. Therefore a lot of researches are occurring in the improvement of education as well as student performance. During the last decades, the development of education system in Bangladesh was remarkable. So as a part of development process we propose a system for improving the performance of student. First we collect data from the uci repository of school student containing their school information, previous exam result, family information, study information etc. Then we apply the basic data mining technique to find out the reasons which are falling great effect on the result of a student. Since many Bangladeshi students are doing fail in the mathematics, so we only used the mathematics dataset in our experiment. We were given two class levels (pass or fail) on the basis of the students higher secondary result for classification. We used two data mining technique in our experiment; those are naive Bayes and c4.5 decision tree. In our result, We were able to show that a good predictive accuracy can be achieved when providing previous grades (primary and secondary result). From the experiment we found some knowledge of the reason behind the unsuccessful student. This knowledge will help the Governing body of education system and school authority to improve their resource for the development of student performance.

## I. INTRODUCTION

Student performance is the evaluation of student result along a variety of dimensions that includes class participation, individual written work on papers and exams, and group activities like projects and thesis presentations. Over the last couple of years the educational level in Bangladesh has improved but decreasing the failure rate of Mathematics is still challenging. The guardians are deeply concerned on the performance of their children in mathematics. So they are keeping extra home tutors to increase the performance of their children in mathematics without identifying the actual reason behind this. There are many facts act behind the performance of a student such as family background, school environments, teacher quality, student skill and many other things. So keeping extra home tutor is not the only solution of this problem.

In our paper we tried to evaluate the student performance in the higher secondary examination result. Since the maximum

number of failure students are failed in mathematics so we have tried to find out the actual reasons behind the increasing rate of failure in mathematics. If the governing body of our education system and the guardians of the student take some necessary steps to remove those problems according to our research output then the failure rate of student in mathematics will be decreased.

Most of the Bangladeshi students are spending lots of valuable time by using social networking like Face book, Twitter, Whatsapp, Viber etc. Many of them are killing their most valuable time by playing video games, watching tv serial, pornography etc. Those bad habits are falling negative effects on their study which information was not collected in our dataset. So this is the main limitation in our research.

Our aim is to reduce the number of failure students on mathematics in the secondary exam in our country. And we tried to find out reason behind this problem. Sometimes student did fail in the exam because of their family problem then their personal problem (study, health etc.). In the dataset they collect the student family information, school information as well as their academic background. So we tried to find out all kinds of problem behind this. First we collect the dataset from [1], and then apply the two classification algorithm of data mining are applied for acquiring knowledge about the student higher secondary result on mathematics. The two algorithm are Naive Bayes and C4.5 decision tree.

The remainder of this paper is organized as follows: in the next section we provide a brief overview of the related work. In section III we discuss about our dataset. In section IV we discuss about methodology. Our experiment result are shown in section V. Finally we provide the conclusion and future work of this research in section VI.

## II. RELATED WORK

The students performance is depends on the school environment and school management was described the authors in [2]. On the other hand the authors in [3], was discovered that the teacher is playing the key role in student performance. In [4] the authors classify the students into five groups in order to

their performance by using Expectation-Maximization Algorithm (EM-clustering). It is rely on the maximum possibility estimates of parameters in Probabilistic models.

Ayesha et al. in [5] applied the k-means clustering algorithm to forecast students learning performances in a students database, which comprise class quizzes and exams. Before the transportation of final exam, the collected information will be transmitted to the class teacher. To reduce the failing ratio this study helps the teachers by taking adequate steps at right time and improve the performance of students.

By using ID3 and C4.5 Classification Algorithms Kalpesh et al. in [6] discussed about the predicting student performance to improve the academic performances and also have developed a model which can project the feat of students from their Preceding performances using the data mining techniques under Classification.

By using the Weka data mining tool Ahmad et.al in [7] assimilate the performance of different data mining techniques to categorize the student's learning genre. The author perform different data mining techniques and balance their performances to this paper. The author uses Bayes classifier, classification rule and a tree classifier to find the most momentous classifier for detecting student learning style for comparison. The classification tree algorithm has a considerable percentage of accuracy compared to Bayes and classification rule which conclude to this paper.

Garcia et al. in [8] applied the Naive Bayes classification algorithm to predict student academic performance. The authors divided the data into 3 groups for applying Naive Bayes classification algorithms by using Rapid Miner software of data mining. The paper terminated that the model is 60% accurate and was applied to predict the academic performance after checking of the result of the prediction 50% were considered as correct.

To evaluate the student performance AI-Radaideh et.al. in [9] applied the data mining classification techniques in various courses to improve the quality of higher education. In this paper the authors used three different classification method, i.e. ID3, C4.5 and Naive Bayes classification and also uses the CRISP framework to mine the student data.

N. S. Shah [10] has used different decisions tree algorithms (C45 Random Forest, BF Tree, Rep Tree), Functions ( logistic RBF Network) ,Rule (3 Rip) and Bayes Net, Naive Bayes to classify students of BBA program of University of Karanchi. In this paper Random Forest vindicated to most accurate classifier J48 decision tree, BF Tree ,Rep Tree and JRip rule. To predict the grades of students Bidgoli, Koshy, Kortemeyer and Punch [11] applied tree classifier as well as non-tree classifiers. Kabra and Bichkar [12] applied J48 algorithm to predict student performance to take with 346 346 first year students of an engineering college collecting their demographic data and past performance data (SSC or 10th marks, HSC or 10 + 2 exam marks etc.).

### III. STUDENT PERFORMANCE DATASET

TABLE I  
DESCRIPTION OF ATTRIBUTES

Attribute	Description
Sex	Students sex (binary: female or male)
Age	Age of student (numeric: from 15 to 22)
School	school name (binary: Gabriel Pereira or Mousinho da Silveira)
Address	home address type (binary: urban or rural)
Pstatus	parents cohabitation status (binary: living together or apart)
Medu	Education information of mother (numeric: 0- none, 1- primary (4th grade), 2- 5th to 9th grade, 3- secondary or 4- higher)
Mjob	job description of student mother (nominal: 'teacher', 'health' care related, civil 'services' (e.g. administrative or police), 'at home' or 'other')
Fedu	Education information of father (numeric: 0- none, 1- primary (4th grade), 2- 5th to 9th grade, 3- secondary or 4- higher)
Fjob	job description of student father (nominal: 'teacher', 'health' care related, civil 'services' (e.g. administrative or police), 'at home' or 'other'))
Guardian	students guardian information (nominal: mother, father or other )
famsize	student family size (binary: $\leq 3$ or $3$ )
famrel	family relationships quality (numeric: from 1- very bad to 5- excellent)
Reason	cause to choose this school (nominal: close to home, school reputation, course preference or other)
Traveltime	travel time from home to school (numeric: 1- $> 15$ min., 2- 15 to 30 min., 3- 30 min. to 1 hour- 4- $> 1$ hour).
Studytime	study time weekly(numeric: 1- $< 2$ hours, 2- 2 to 5 hours, 3- 5 to 10 hours or 4- $> 10$ hours)
Sex	Students sex (binary: female or male)
Sex	Students sex (binary: female or male)
Failures	past class failures number (numeric: n if $1 \leq n < 3$ , else 4)
Schoolsup	extra school support (binary: yes or no)
Famsup	family support for education (binary: yes or no)
Activities	extra-curricular activities (binary: yes or no)
Paidclass	extra paid classes for mathematics (binary: yes or no)
Internet	Internet uses at home (binary: yes or no)
Nursery	attend in nursery school (binary: yes or no)
Higher	higher education possibility (binary: yes or no)
Romantic	romantic relationship (binary: yes or no)
Freetime	free time (numeric: from 1- very low to 5- very high)
Gout	going out with friends (numeric: from 1- very low to 5- very high)
Walc	alcohol consumption in weekend (numeric: from 1- very low to 5- very high)
Walc	alcohol consumption in weekend (numeric: from 1- very low to 5- very high)
Dalc	alcohol consumption in workday (numeric: from 1- very low to 5- very high)
Health	health status (numeric: from 1- very bad to 5- very good)
Absences	school absences number (numeric: from 0 to 93)
G1	first period grade (numeric: from 0 to 20)
G2	second period grade (numeric: from 0 to 20)
G3	final grade (numeric: from 0 to 20)

Dataset were collected from UCI repository. There were two types of dataset for two subjects (Portuguese Language and Mathematics). In [13] they used both dataset for measuring the student performance on Portuguese Language and Mathematics. Since most of the Bangladeshi students are failed in mathematics in higher secondary exam. And our aim is to find the problem behind this failure student. So we used the dataset of mathematics only. In this dataset they collect some data from student with Questionnaire process and some from their primary school and secondary school result transcript. They collect student family information (like father education, mother education, father occupation, mother occupation etc.), personal information (like age, sex, study hour etc.), school information (like school location, school support etc.) from question answer of the student. Other attribute (like absences, G1- first period grade, G2 -second period grade, G3 -final grade) were collected from school. They collect the 395 student information and 33 attributes for mathematics subject in the dataset . The attributes descriptions are given in the Table 1.Last three attributes(G1,G2,G3) in the Table 1 are depended on the student result in examination.

#### IV. METHODOLOGY

##### A. Naive Bayes

Naive Bayes is a simple probabilistic classifier algorithm using Bayes theorem [14] [15]. It is a conditional probability. A training set of tuples  $n$  and attribute vector  $X=(x_1, x_2, x_3, \dots, x_n)$  are given. We need to classify it into  $m$  classes ( $c_1, c_2, c_3, \dots, c_m$ ). The classifier will predict that  $x$  belongs to the class having the highest posterior probability conditioned on  $x$ .

For  $i \leq j \leq m$ , and  $i \neq j$

$$P(c_i|x) > P(c_j|x) \quad (1)$$

Then we need to maximize  $P(c_i|x)$ . The maximum posterior hypothesis is

$$P(c_i|x) = P(x|c_i) * P(c_i) * \left(\frac{1}{P(x)}\right) \quad (2)$$

Where  $p(x)$  is constant

$$P(x|c_i) = P(x_1|c_i) * P(x_2|c_i) * \dots * P(x_n|c_i) \quad (3)$$

##### B. C4.5 Decision tree

Decision tree is a tree in which each internal node represent test (attribute), each edge represent outcome of test and leaf node represent class level. C4.5 generates classifiers which are expressed in decision trees. It is developed by Ross Quinlan [16]. C4.5 builds decision trees from a set of training data. Given a dataset  $S=s_1, s_2$  of already classified samples consisting of a  $p$ -dimensional vector  $(x_{1,i}, x_{2,i}, \dots, x_{p,i})$ , where  $x_j$  represent attribute values, as well as the class level. C4.5 chooses the attribute of the data for each node of the tree which most effectively splits its set of samples into subsets enriched in one class or the other. The splitting criterion

is the normalized information gain. The highest normalized information gain attribute is chosen to make the decision. The algorithm then recurs on the smaller sub lists. Some base cases of the algorithm:

- I. If all the samples belong to the same class, then simply creates a leaf node for the decision tree saying to choose that class
- II . If all the features do not provide any information gain, C4.5 creates a decision node higher up the tree using the expected value of the class
- III. If the Instance of previously-unseen class encountered, then C4.5 creates a decision node higher up the tree using the expected value

The general algorithm for building decision trees is[3]:

- I. Check the base cases
- II. For each attribute  $x$
- III. Find the normalized information gain ratio from splitting on  $x$
- IV. Let  $x_{high}$  be the attribute with the maximum normalized information gain
- V. Then make a decision node that splits on  $x_{high}$
- VI. Recur on the sublists acquired by splitting on  $x_{high}$ , and add those nodes as children of node

#### V. EXPERIMENT AND RESULT

Using both classification (Naive Bayes, c4.5 Decision tree) algorithms we have generated our result. We measure our result using the accuracy rate thats mean number of correctly classified instances. We used weka to implement this. Weka (Waikato Environment for Knowledge Analysis) is free and popular software written in java [17], developed at University of Waikatoof Waikato, New Zealand. We used the Naive Bayes and j48 (for c4.5 Decision tree) tool for classifications. We evaluate the result using two tools given in weka. There are:

- I. Cross Validation: Divided all the data set in a given number and use one portion as a test data set and rest others as a training dataset
- II. Percentage Split: The given percentage is training data and rest others are testing data

In Figure 1 we have showed the accuracy (number of correctly classified instances) for three cases. In Figure 1 we can see that student previous great is falling great effect on the new result. Without previous grade the classifier accuracy result is not good as well as with the previous grade. The Knowledge gain from the c4.5 decision tree is given in Table 2.

**Case A:** with previous grade (primary and secondary school result).

Classifier	Cross Validation					Percentage Split				
	10	20	30	40	50	50	60	70	80	90
Naïve Bayes	88	87	86.8	87.84	87.08	81	84.8	86.4	84.8	82
C 4.5	92.6	93.4	92.4	93.4	92.9	90.4	91.7	95	91	94.8

**Case B:** with previous grade (only primary school result).

Classifier	Cross Validation					Percentage Split				
	10	20	30	40	50	50	60	70	80	90
Naïve Bayes	80	79.7	78.7	80.25	78.9	74.6	76.58	78.8	78.4	77
C 4.5	85.5	85.5	86.8	85.5	87	83.7	87.97	88	86	79.5

**Case C:** No previous grade.

Classifier	Cross Validation					Percentage Split				
	10	20	30	40	50	50	60	70	80	90
Naïve Bayes	60	59	59	58.4	59	51.7	53	55	57	56.4
C 4.5	55.7	57.7	55	52.6	58	60.4	54.4	50.8	67	66.7

Fig. 1. Results of the Naive Bayes and C4.5 classifier for three cases

TABLE II  
KNOWLEDGE GAIN

Serial No	Knowledge
1	If $G2 \leq 11$ , then student fail.
2	If $G2 \leq 12$ , pstatus=A then student fail
3	If $G2 \leq 12$ , pstatus=T and internet=no then student pass
4	If $G2 \geq 12$ , then student pass.
5	If $G2 \leq 12$ , pstatus=T and internet=no then student pass
6	If $G2 \leq 12$ , pstatus=T ,internet=yes, famrel $\geq 4$ then student pass
7	If $G2 \leq 12$ , pstatus=T , internet=yes,famrel $\leq 4$ and higher=no then student pass
8	If $G2 \leq 12$ , pstatus=T , internet=yes,famrel $\leq 4$ , higher=yes, school=MS then student fail
9	If $G2 \leq 12$ ,pstatus=T,internet=yes,famrel $\leq 4$ ,higher=yes,school=GP, traveltime $\geq$ then student pass
10	If $G2 \leq 12$ , pstatus=T , internet=yes,famrel $\leq 4$ , higher=yes,school=GP,traveltime $\leq 1$ ,nursery=no then student pass
11	If $G2 \leq 12$ , pstatus=T , internet=yes,famrel $\leq 4$ , higher=yes,school=GP,traveltime $\leq 1$ ,nursery=yes, $\geq 1$ then student fail
12	If $G2 \leq 12$ , pstatus=T , internet=yes,famrel $\leq 4$ , higher=yes,school=GP,traveltime $\leq 1$ ,nursery=yes,walc $\leq 1$ ,absences $\geq 4$ then student pass
13	If $G2 \leq 12$ , pstatus=T , internet=yes,famrel $\leq 4$ , higher=yes,school=GP,traveltime $\leq 1$ ,nursery=yes,walc $\leq 1$ ,absences $\leq 4$ then student fail.

## VI. CONCLUSION AND FUTURE WORK

Education is the utmost importance for eradicating the unemployment problem of any nation. It is also importance to improve the trade and commerce, and to bring prosperity to any country. However, for improvement of our education system, there is a great need for the improvement of student performance. So as a part of development process we propose a system for improving the performance of student. In our experiment we used the basic data mining technique (Nave Bayes and c4.5 Decision Tree) to predict the student performance. We evaluate the result on the basis of accuracy rate for the three cases. Therefore we were able to show that student result mostly depends on the previous grade of a student. Using previous grade we have showed 95% accuracy result. We also gain some knowledge about the reason behind the unsuccessful student. By using this knowledge governing body of education system will be able to improve their resource for reducing the failure rate of student. In our paper we mainly focused on mathematics but many of Bangladeshi students also weak in English, Physics, Economics etc. So In future we will try to analysis the student performance on those subjects. We will also collect the Bangladeshi school student information including social networking using time, video game playing, watching tv serial etc. which are the most probable reason behind the student failure. In this paper

we evaluate the performance of a student in higher secondary exam. In future we will try to evaluate the performance of the university student.

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# A Video Transcoding Time Prediction Model using Gradient Boosting Machine

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**Abstract**—Predictive analytics techniques can tremendously improve the performance of computing systems by optimizing energy, waiting time and throughput via predicting the execution time of scheduled jobs beforehand. As a consequence of the correlation between video transcoding parameters and video transcoding time, the transcoding time is predictable from input video properties and transcoding parameters. This paper applies gradient boosting machine to predict the transcoding time of videos using video metadata and conversion features with no detailed information about the applied codec. The evaluation results of the experiments conducted on benchmark Youtube video characteristics dataset show that our model reduces transcoding time prediction error by as much as 4.03% over previously applied methods. This model also indicates that features about coding standard and codec allocated memory used for transcoding, size, duration, bitrate and framerate of videos are crucial for prediction.

**Keywords**—Video Properties, Video Transcoding Time Prediction, Gradient Boosting Machine, Quality of Services

## I. INTRODUCTION

Video transcoding is generally known as video conversion that is the process of converting a video file from one format to another to make video files viable across different configurable platforms and devices. There are several major video conversion types such as resolution conversion, bitrate conversion, temporal conversion, container conversion, codec conversion, error reliance conversion, and any combination of these [1]. Recently, transcoding of video content is becoming an increasing requirement for the digital media industry since the increasing number of various devices and platforms, and the availability of numerous video formats with various platforms. As we know, users want to play a video in various formats on various devices and platforms with a bunch of properties. For instance, some users want high definition videos, while others want low resolution videos, but it is almost impossible in realistic setting to store a single video in all possible formats to fulfill the end users needs. Fortunately, video transcoding or conversion mechanism can lead us to get rid of these kinds of problems.

Although the major methods of video transcoding were originally employed to reduce video file size, and to make distribution on mobile networks easier, it is increasingly used in recent time to make online media contents viewable across platforms and enable HTTP live streaming and adaptive bitrate delivery. However, video transcoding is still a delicate and time-consuming process, while extremely useful in evolving

streaming of nowadays multi-media marketplace. Moreover, almost every transcoding results in some degree of loss, and subtle encoding nuances that can directly affect the video quality. As a consequence, it is crucial to start with each and every transcode with a high quality mezzanine file and carefully consider the requirements of specific target formats and content types.

Note that the estimation of probable time of video conversion has tremendous impact in many domains. For instance, distributed and multicore systems can conquer the problem of over provisioning by estimating the resource requirement of each job as the unavailability of resource requirement in advance makes the run time scheduling of conversion job in multicore and cloud environment much more challenging. Moreover, someone needs to depends on the worst case values for video conversion job since the resource requirement of video conversion job is mainly rely on video data and transcoding parameters that lead to over provisioning of resources to maintain satisfactory quality of services (QoS).

Most importantly, every computing systems such as smartphones, tablets, laptops, servers, data centers, and clouds have resource management components which determine how to schedule the execution of different jobs over time [2] to make sure optimal system usages, efficient energy utilization, or program resources allocation e.g. memory, storage, bandwidth. In order to get optimal performance from management components, they need to assess how to perform a assigned task depending on its properties, and therefore, to learn to project for the best for the future. For instance, consider a cloud conversion service with a set of two kinds of conversion requests, fast conversion job in set S1, and slow conversion job in set S2. S1 scheduler is often dealt with the decision of whether to run each set of different CPU resources, possibly taking longer for execution, or to interleave between the two sets and assign the jobs fairly, and possibly executing the job much more faster. Scheduler can make wise decision i.e. it can return results faster, possibly minimize energy and maximize throughput, *when it can efficiently estimate the duration of each job for execution on a given platform*. Again, the proper job scheduling is really essential unless skewed distribution of conversion time can have a tremendous impact on the performance of the system [3]. Fortunately, low overhead, data preprocessing techniques, and highly accurate machine learning algorithms can be applied to leverage such things.

In this paper, we apply a novel ensemble learning algorithm, namely gradient boosting machine [4] to predict the transcoding time of videos using heterogeneous set of video metadata features such as duration, bitrate, height and width of videos and transcoding features such as coding standard, output codec, and total allocated memory for transcoding. As a result of the prediction of the transcoding time of videos before scheduling for conversion, scheduling decision can be made in advance based on the predicted transcoding time to obtain optimal usages of resources such as memory, bandwidth.

Hence, gradient boosting machine is the ensemble of multiple weak classifiers or decision trees in which each successive decision trees are built from the prediction residual of the preceding decision trees to form a final highly accurate prediction model. The final prediction model guarantees that it performs much better than the individual performance of each decision tree. Note that the applied gradient boosting machine comprises of several good qualities including high accuracy, competitive computational performance both in training and prediction steps, and capability to handle large training dataset. In our experiments, we found that gradient boosting machine predicted the conversion time of videos with around **4.75%** MAPE error rate on publicly available Youtube video characteristics dataset that was as much as **4.03%** reduction over previous methods. In addition, gradient boosting machine measured that information about output width and output codec and total codec allocated memory used for conversion, bitrate, width, size, duration, and framerate of videos, number of frames in a video were crucial for predicting the transcoding time of videos. To the best of our knowledge, this is the first time that gradient boosting machine with linear regression objective function is applied to the task of predicting the conversion time of videos.

## II. RELATED WORK

Over the last couple of years, several researchers proposed numerous cloud based distributed transcoding and resource allocation systems. For instance, Zhenhua Li et al. [5] proposed and implemented a cloud transcoder system focusing on providing video transcoding service rather than transcoding job scheduling. In their system, video request contains a video link and the user-customized transcoding parameters by users who upload a video request rather than the video content parameters including format, resolution. Jokhio et al. [6] designed a scalable distributed message passing interface based on transcoder in which video was statically segmented at group of pictures in three different ways. They focused on the parallelization and data distribution among computing units. Their key contribution was video segmentation for transcoding in distributed environment, and evaluation of the video startup time in such environment. Later Jokhio et al. [7] demonstrated a prediction-based dynamic resource allocation and deallocation algorithms to scale video transcoding service in cloud environment. Based on a regression model, they proposed an algorithm providing a mechanism to allocate and deallocate virtual machines that tracked and predicted

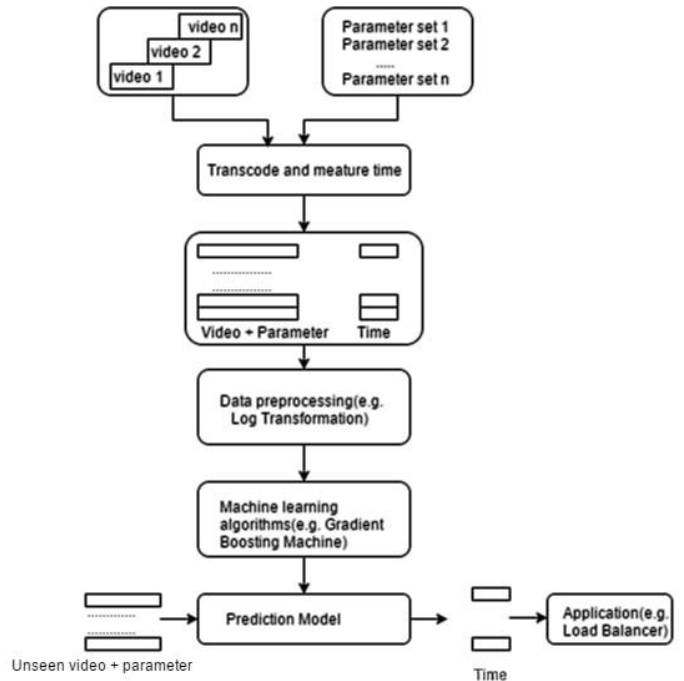


Fig. 1. A generic video transcoding framework

the aggregate target transcoding rate required by the service. Note that avoiding overflow and underflow of the output videos buffer are the major challenges. They avoided overflow and underflow challenges of output video buffer minimizing oscillations in the number of servers. Huang et al. [8] presented multilevel parallelized transcoding framework for cloud-based video proxy to deliver transcoded videos for streaming. They applied hallsh based, and lateness-first mapping to optimize transcoding speed and reducing transcoding jitters.

As per our knowledge based on literature review, there are only two similar studies available in literature that also attempted to predict the transcoding time to boost the performance of the scheduling tasks and to ensure QoS. Roitzsch et. al. [9] developed a prediction model to estimate per-frame decoding times of modern decoding algorithms using expert selected metric to train and to predict decoding times of video encoded in MPEG-1, MPEG-2, and MPEG-4 part 2 algorithms. Their major limitation is that their method did not support a set of codecs from multiple codec families. Deneke et. al. [1] proposed support vector regressor (SVR) and multilayer neural network (MNN) based prediction model for predicting the transcoding time of videos using video metadata and transcoding parameters with no specific information about the used codec to design loading balancing scheme to aid throughput and QoS.

## III. VIDEO TRANSCODING FRAMEWORK

The main focus of this work is to develop automated system that can estimates the conversion time of videos using input video and conversion parameters. The conversion time prediction results can then be utilized by the service provider

for many purposes such as scheduling decision making, load balancing, and QoS predictions. Therefore, using this system, conversion service providers can predict the conversion time of videos, and can manage their conversion server more efficiently. The key components of this system are fundamental, relevant and highly predictive video metadata and conversion features e.g. codec, bitrate and framerate, data preprocessing techniques e.g. logarithmic transformation, and machine learning algorithms e.g. gradient boosting machine that can learn to measure the probable conversion time of videos using the video metadata and conversion features. Figure 1 portrays the big picture of the transcoding system. Usually transcoding service providers possess a log regarding transcoding parameters and actual video. Hence, we can create training dataset in supervised learning format based on the traces by including conversion parameters, actual video or its primary properties e.g. width, height, framerate and bitrate, and calculated conversion time. The collected dataset is then preprocessed using various data preprocessing techniques e.g. logarithmic transformation. Several type conversion techniques are also applied to create final suitable and predictive training dataset. After that we can apply machine learning method e.g. gradient boosting machine to train on the preprocessed dataset to predict the transcoding time of the seen and unseen videos. Finally, the predicted results is used for many purposes including load distribution across the nodes, and QoS.

#### IV. GRADIENT BOOSTING MACHINE FOR TRANSCODING TIME PREDICTION

The goal of this work is to predict the transcoding time of videos using gradient boosting machine (GBM) algorithm in regression setting. In training step of this approach, heterogeneous set of video metadata and transcoding features are fed to GBM to build the desired prediction model. The trained GBM model is then used in prediction step to carry out transcoding time prediction task of the unseen videos. The rest of this section covers brief description of key idea, algorithmic description, and regularization strategies of GBM for regression.

##### A. Key Idea

GBM [10] is an ensemble learning algorithm that is the combination of gradient-based optimization and boosting. GBM produces strong prediction model by combining multiple weak prediction models in which weak models are created by sequentially applying to the incrementally changed dataset. Optimization based on gradient in GBM utilize the gradient computations to minimize the cost function of a model with respect to training dataset, while boosting additively gathers an ensemble of weak models to build prediction model for video transcoding time prediction challenge. In short, the main idea beneath GBM is to build a series of simple and probably inaccurate decision trees or weak models successively from the prediction residuals of the preceding decision trees and combine them to construct a final highly accurate prediction model.

##### B. Algorithmic Description

The technical description of the predictive GBM [4] [11] is given below:

- **Input:** GBM takes  $(x_1, y_1), \dots, (x_n, y_n)$  as training dataset in which  $x_i \in X$  are the set of features extracted from video contents and transcoding properties and  $y_i$  is the required transcoding time that is the prediction label. GBM also takes a differentiable loss function  $L(y, F(x))$  and the number of gradient boosting iteration  $M$  as input.
- **Algorithm:**
  - I. Initialization of the model with a constant value

$$F_0(x) = \underset{\gamma}{\operatorname{argmin}} \sum_{i=1}^n L(y_i, \gamma) \quad (1)$$

II. For each gradient boosting iteration  $m = 1, \dots, M$

1. For  $i = 1, \dots, n$ , compute pseudo-residuals

$$r_{im} = - \left[ \frac{\delta L(y_i, F(x_i))}{\delta F(x_i)} \right]_{F(x)=F_{m-1}(x)} \quad (2)$$

2. For  $j = 1, \dots, J_m$ , GBM fits a regression tree to the labels  $y_i$  providing terminal region  $R_{jm}$ .  $J$  is the size of the tree that controls the level of feature interaction in the model.
3. For  $j = 1, \dots, J_m$ , GBM then computes the multiplier  $\gamma_m$

$$\gamma_{jm} = \underset{\gamma}{\operatorname{argmin}} \sum_{x_i \in R_{jm}} L(y_i, F_{m-1}(x_i) + \gamma) \quad (3)$$

4. Finally, update the model

$$F_m(x) = F_{m-1}(x) + v \sum_{j=1}^{J_m} \gamma_{jm} I(x \in R_{jm}) \quad (4)$$

where  $v$  ( $0 < v \leq 1$ ) is the shrinkage constant that regulates the learning rate of GBM by reducing the size of the incremental steps.

- **Output:**  $F_M(x)$

##### C. Regularization

Generalization capabilities of GBM is one of the essential concern. A number of parameters can contribute towards reducing the effects of overfitting by controlling learning rate and/or by introducing randomness into GBM. For instance, the smaller values of learning rate  $v$  such as  $v \leq 0.1$  can generally ensure better generalization and performance on unseen dataset. Overfitting can also be eliminated by fitting weak model on a subsample or constant fraction e.g.  $0.5 \leq \text{fraction} \leq 0.8$  of the training dataset at random with no replacement. Furthermore, to reflect generalization, we can use a large number of trees or boosting iteration  $M$ , and control  $J$ , by picking the value of  $J$  in between 4 and 8.

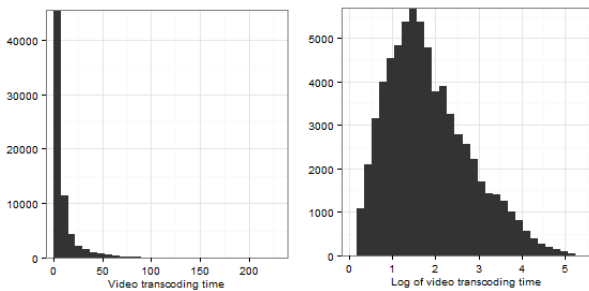


Fig. 2. From left to right, distribution of original transcoding times, and logarithms of original transcoding times of videos of Youtube video characteristics dataset

## V. YOUTUBE VIDEO CHARACTERISTICS DATASET

Online video characteristics and transcoding time (**Youtube video characteristics**) [1] dataset is publicly available at UCI Machine Learning Repository that comprises of 68784 Youtube video instances including 10 fundamental video characteristics with video ID. Deneke et. al. developed crawler using random prefix sampling method [12] to sample over videos as crucial statistics regarding fundamental video characteristics which are not publicly available by Youtube. They then probed, analyzed, and collected elementary properties of each of the sampled video using Ffprobe to generate video transcoding parameters. They achieved actual transcoding time of videos for each of the simulated transcoding request through the measurement on a cloud instance from Amazon EC2. Youtube video characteristics dataset composed of total 20 features including input and output video characteristics, and their conversion time and memory resource requirements during the conversion of videos to different formats. These 20 features cover information about duration and bitrate of video, height and width of video in pixels, actual and estimated video frame rate, coding standard used for the video, YouTube video category, direct link to video with expiration date, number of i, p, and b frames in the video, number of frames in video, total size of i, p, and b videos in byte, total size of video, output codec, bitrate, framerate, width and height used for video conversion, and total codec allocated memory for conversion.

## VI. EXPERIMENTS AND RESULTS

The proposed GBM prediction model was evaluated on Youtube video characteristics dataset in which we randomly split entire dataset into training dataset (80%), and test dataset (20%). We performed 6-fold cross validation on the training dataset, and the final cross-validated model was test on the test dataset. We benchmarked the proposed method against previous applied methods [1] such as SVR and MNN using Youtube video transcoding dataset. We displays the comparison in Table I. Each of the experiments were run for 20 times with different random seeds, and the results were obtained by averaging over 20 different experimental runs.

We preprocessed 10 skewed features e.g. duration, bitrate, framerate, i, p and b frames, total number of frames, size

of i and p frames, and total size of videos using logarithmic transformation that are shown in Figure 4. Note that we modeled the video conversion time prediction problem as regression problem as we aims to estimate the transcoding time of videos in real time. Hence, we built two different GBM models in which one of them (M1) was used original transcoding times as the prediction label, and other one (M2) was used the logarithm of the original transcoding time as the prediction label. During the performance evaluation of the regression models, we evaluated the models by measuring the mean absolute percentage error (MAPE) between the predicted times and the original transcoding time (**GBM\_MAPE**) for M1, between the predicted times and logarithm of the original transcoding time (**GBM\_MAPE\_LOG**) for M2, and between the exponents of predicted transcoding time and the original transcoding time (**GBM\_MAPE\_EXP**) for M2.

TABLE I  
VIDEO TRANSCODING TIME PREDICTION BENCHMARK. THIS TABLE DISPLAYS THE MAPE AND STANDARD DEVIATION OF MAPE (**MAPE-SD**) GENERATED FROM TWO DIFFERENT MODELS

Setting	MAPE	MAPE-SD
GBM_MAPE	23.6657%	0.0317
GBM_MAPE_LOG	2.5959%	0.0086
GBM_MAPE_EXP	4.7490%	0.0131

For training and validating the proposed GBM, we set *linear regression* as objective function, the value of the learning rate  $v = 0.1$  to reflect better generalization, the size of the tree  $J = 3$ , and subsample size *fraction* = 0.8. Finally, the number of boosting iteration  $M$  was selected using 6-fold validation approach. Table I shows the performance of GBM during the prediction of video conversion time. From Table I, it can be outlined that GBM was better than SVR and MNN since MAPE generated from GBM was **4.75%** that was rela-

TABLE II  
TOP 14 FEATURES BASED ON THE IMPORTANCE SCORES OF FEATURES, MEASURED VIA GBM, FOR VIDEO TRANSCODING TIME PREDICTION

Feature	Gain * 100
Output width in pixel	43.4686
Output codec	31.47
Total codec allocated memory	9.55
Video bit rate	7.7755
Width of video in pixel	2.95
Output bit rate	1.8163
Output frame rate	1.5384
Total size in bytes of p videos	0.527
Actual video frame rate	0.5267
Output height used in pixel	0.3413
Number of i frames in video	0.0095
Duration of video	0.0093
Total size of video	0.0088
Number of frames in video	0.0086

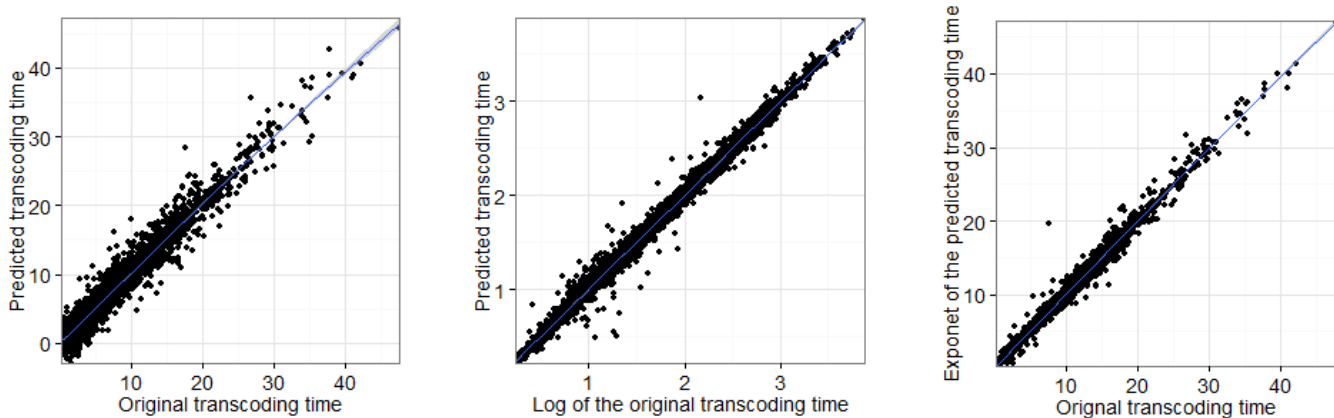


Fig. 3. From left to right, for GBM, scatter plots of original transcoding time against predicted transcoding time based on model M1, logarithm of the original transcoding time against predicted transcoding time based on model M2, and the original transcoding time against the exponent of the predicted transcoding time based on model M2 on the test subset of the Youtube video characteristics dataset

tively smaller than the MAPE generated from SVR (18.64%) and MNN (8.78%). Another important point to note from Table I and Figure 3 is that training over the logarithm of the original conversion time is extremely useful to fit the GBM model better as we can observe MAPE generated from GBM trained on the original conversion time was 23.67%, while MAPE generated from GBM trained on the logarithm of the conversion time, and further transformation of the predicted conversion time by taking the exponent of the predicted conversion time was 4.75%. Finally, these prediction results can be utilized for the performance optimization of the job scheduler, load balancing and QoS expectation of the users by the transcoding service providers via estimating the video transcoding cost of requests, and managing the transcoding servers more effectively.

GBM uses *gain* [13] to estimate the contribution of each feature to the prediction model. GBM takes each gain of each feature of each tree, and computes mean per feature to provide a vision of the entire prediction model. We measured the relative importance scores of features using GBM for predicting the transcoding time of videos for which we trained GBM using entire Youtube video characteristics dataset. Table II highlights the relative importance scores or  $Gain * 100$  of the top 14 features. It can be observed from Table II that features related to the information about output width and height in pixels, output codec, bitrate, and framerate, total codec allocated memory, total size and duration of videos, and number of frames in videos had strong significance towards the prediction of the conversion or transcoding time of videos.

## VII. CONCLUSION AND FUTURE WORK

This paper introduced and implemented GBM to tackle the challenge of predicting transcoding time of videos to boost the performance of transcoding services using several metadata and transcoding features e.g. bitrate, framerate, output codec. Our findings suggest that GBM is able to measure the video conversion time with a minimal error rate using these metadata and conversion features. More interestingly, we found that the

strategy of training the GBM model on the logarithm of the conversion time is extremely useful for better model fitting. GBM also outlined relevant and influential metadata and conversion features e.g. output width and height in pixels, output codec, bitrate, and framerate, total codec allocated memory, total size and duration of videos, and number of frames in videos computing their relative importance scores. Future work will include, first, the evaluation of the GBM model on more complex and different video streaming datasets. Second, the comparison of the GBM based video conversion time prediction model with many other state-of-the-art models.

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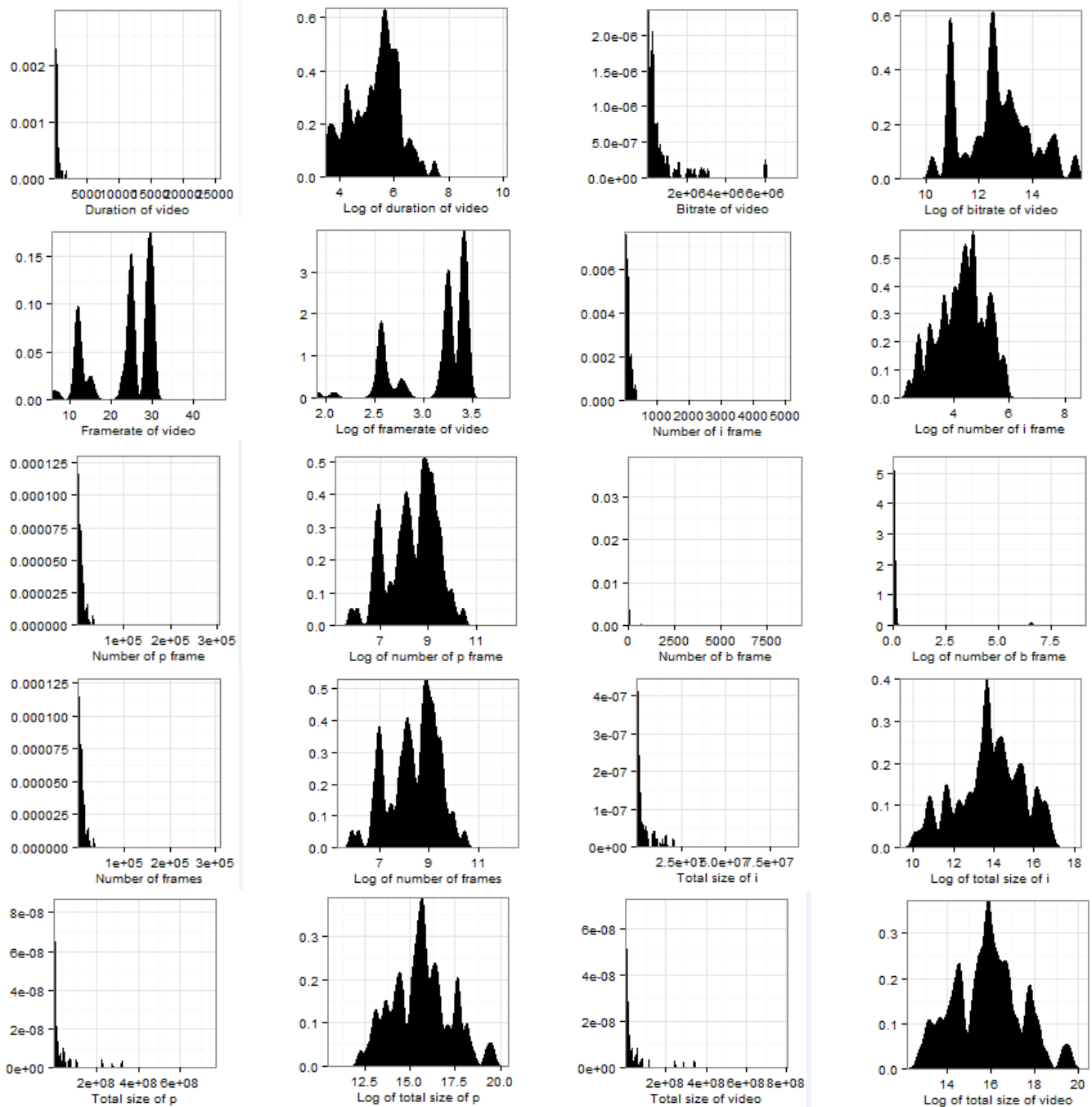


Fig. 4. Feature distribution of several original, and logarithm of original features of Youtube video characteristics dataset

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# Improving different classification algorithm using bagging,boosting and blending ensemble methods on Portuguese banking dataset using WEKA

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**Abstract—** Economic depression is a sustained economic recession in which a nation GDP and GNF show a negative growth along with greater business failure and unemployment. Recently, Economic depression affects business organization and banking sectors. For the economic depression, customer attention becomes impossible. Marketing is very useful tool for banking sector for attracting customer for a term deposit. Data mining technique is completely helping in the performance in the campaign. The purpose of this paper is to propose various classification methods to predict whether a new customer will have a term deposit or not. To predict bank marketing deposit, we analyzed performance of two data mining classification algorithms named as J48 and naive Bayes. This paper investigates the ability of ensemble methods to improve the efficiency of basic J48 and naive Bayes machine learning algorithm.

**Keywords-** Bank Direct Marketing; Deposit prediction; Data Mining; J48; Nave Bayes; ensemble methods; Bagging ;Boosting and Stacking;

## I. INTRODUCTION

The banking sector is one of the most important sectors of any country. In current scenario marketing is very useful tool for banking sector for attracting customer for a term deposit. Generally, there are two types of marketing: 1) Mass marketing and 2) Direct marketing.

Mass marketing, [1] which uses mass media for advertisement and promotion of a product, good or service such as radio, television, print and newspaper to the public without discrimination. While direct marketing, target in a specific set of the customer by studying the customer information and characteristics. Usually, the selected customers are contacted

via a telephone, mail post to the customer. Data mining can provide an effective tool for direct marketing that interact with their customer.

Data mining is the process of extracting hidden and innovative information from a large volume of datasets. Now a dayes, Data mining is used in the different sectors such as banking and financial. Generally, data mining technique is used to develop a high efficient classification model. In bank marketing, different data mining algorithm can be used for classifying. In this paper, Our main purpose is presenting the best model for deposit prediction.

The structure of this paper organized as follows: In the next section, we present the related work. In section III, We introduce our methodology and focusing on describing our datasets. In section IV, we present our experimental environment. Finally In section V, we provide the conclusion of this research and investigate direction for future work.

## II. RELATED WORK

Different types of algorithm are proposed for deposit prediction and classification.

In [1] comparative study has been conducted on MLPNN (Multilayer perception neural network) with different classification like as TAN (Naïve Bayes), LR (Logistic regression) and C5.0 is used for analyzing the result of accuracy, sensitivity, and specificity. MLPNN show the best for accuracy that is 90.49, LR shows the best percentage for sensitivity that is 65.53 and C5.0 show the best for specificity that is 93.23 for bank term deposit prediction.

This paper [2] has been measuring and comparing the classification performance of four different classification algorithm J48, LADT, RBFN and SVM on the bank direct marketing dataset to classify for bank deposit prediction. SVM provide the best prediction perform in terms of accuracy, sensitivity, and Specificity.

The future study is to predict the software models based on some other data mining algorithm.

### III. METHODOLOGY

Data mining has two essential approaches. One is supervised learning and other is unsupervised learning. Supervised learning is the most popular approach. The class label of each training tuple is known is referred as supervised learning. Otherwise, the class label of each training tuple not known in advance.

In this paper, we used the supervised learning approach. This paper has analyzed the effectiveness of four data mining techniques for the purpose of deposit prediction on the bank direct marketing. Now, we discussed below:

**J48:** The decision tree approach is a most used data mining technique that can classify both categorical and numerical data, but the output attribute must be categorical. J48 algorithm [3] is a most popular classifier algorithm developed by Ross Quinlan that used to create a decision tree. Decision tree J48 is the open source Java implementation of algorithm C4.5 developed by the weka project team. In fact, it used the concept of discovering to classify data. By applying a decision tree like J48 on the data set would allow predicting the target variable of a new data set.

**Naïve Bayes:** Naïve Bayes is one of the most popular classifiers that is used in the banking sector for classification. Naive Bayes classifier is a probabilistic classifier that performs probabilistic prediction and predicts class membership probabilities. Naive Bayes classifier also is known as a statistical classifier. The Naïve classifier is a classification technique based on Bayes Theorem with independent assumptions between the predictors.

The Bayes Theorem is:

$$P(h|x) = \frac{P(x|h) * P(h)}{p(x)}$$

Where,

$P(x) = \text{Prior probability of } x.$

$P(h) = \text{Prior probability of } h.$

$P(h|x) =$

*Posterior probability of h condition on x.*

$P(x|h) = \text{Posterior probability of x condition on h}$

#### A. ENSEMBLE METHODS:

Ensemble methods refer to the powerful learning model that combine the multiple algorithms to produce better classification performance. There are three types of Ensemble method:

**Bagging:** Bagging stands for Bootstrap Aggregation. It is one of the simplest and most intuitive ensemble based

algorithms [6] that creates separate samples of the training dataset and each training dataset is used to train a different classification.

Path - weka.classifiers.meta.Bagging

STEPS:

- 1) Click “Classify...” in the “Algorithms” section.
- 2) Click the “Choose” button.
- 3) Click “Bagging” under the “meta” selection.
- 4) Click the “Choose” button for the “classifier” and select “J48” under the “tree” section (all parameter must be default).
- 5) Click the “OK” button on the “Bagging” configuration.
- 6.) Click the “Start” button.

**Boosting:** Boosting [5] is an interactive technique which calculates the output using many different models that were created by the different algorithm and find the final result using the weighted sum of the weak classifier.

Path - weka.classifiers.meta.AdaBoostM1

STEPS:

- 1) Click “Classify in the “Algorithms” section.
- 2) Click the “Choose” button.
- 3) Click “AdaBoostM1” under the “meta” selection.
- 4) Click the “Choose” button for the “classifier” and select “J48” under the “tree” section (change the numIteration=1).
- 5) Click the “OK” button on the “AdaBoostM1” configuration
- 6) Click the “Start” button for run.

**Blending:** Blending [7] is the Similar to boosting. Blending is a very interesting way of combining different model where multiple different algorithms are applied on the training dataset to create a model and Meta classifier is used to make an accurate prediction on unseen data.

Path - weka.classifiers.meta.Stacking.

STEPS:

- 1) Click “Classify” in the “Algorithms” section.
- 2) Click the “Choose” button.
- 3) Click “Stacking” under the “meta” selection.
- 4) Click the “Choose” button for the “metaClassifier and select “J48” under the “function” section and click the “choose” button.
- 5) Click the value (algorithm name, it’s actually a button) for the “classifiers”.
- 6) Click “ZeroR” and click the “Delete” button.
- 7) Click the “Choose” button for the “classifier” and select “Naïve Bayes” under the “tree” section and click the “Close” button.



- 8) Click the “X” to close the algorithm chooser.
- 9) Click the “OK” button on the “Bagging” configuration.
- 10) Click the “Start” button for a run.

#### B. Dataset description:

In this paper, we used a bank marketing dataset [8] that was gathered from a Portuguese retail bank from May 2008 to November 2010. This data set was gathered up by S. Moro, P. Cortez and P. Rita from Portuguese banking institution. The data is related to direct marketing campaigns of a Portuguese banking institution. This dataset contains 45211 phone contacts. Each contact has 16 inputs attribute and one decision attribute. It has two results; the client will subscribe to a term deposit or not.

There are two datasets:

1) bank-full.csv that contains with all examples corresponding to 45211, ordered by date (from May 2008 to November 2010). This dataset used for training datasets for build the model.

2) bank.csv that contains 10% of the examples (4521), randomly selected from bank-full.csv. This datasets was used for test dataset.

### IV. EXPERIMENT RESULT

WEKA is the data mining tool that was developed at University of Waikato New Zealand. We used three data mining classification algorithm in Weka tool (WEKA version 3.7.13) [9] for bank term deposit prediction. All experiment was performed on CORE i3 with 2GB RAM and operating system windows 7.

#### A. Performance measurement

A confusion matrix is a visualization tool or contingency table that describe the performance of classification algorithm. Confusion matrix consist of True positive (TP), False positive (FP), True negative (TN) and False negative (FN). True positive simply the number of correct prediction that an instance is true, false positive simply the number of incorrect prediction that an instance is true. True negative simply the number of correct prediction that an instance is false and True positive simply the number of incorrect prediction that an instance is false. Sensitivity, specificity, and accuracy have been used to appraise the result.

Sensitivity: Sensitivity defined as the percentage of correct classified positive. It is also known as a True positive rate (TPR) and recall.

$$Sensitivity = \frac{TP}{TP+FN} \quad (1)$$

Specificity: Specificity was defined as the percentage of correct classified negative. Specificity also known as a True negative rate (TNR). Specificity equivalent to 1 minus False Positive Rate.

$$Specificity = \frac{TN}{TN+FP} \quad (2)$$

Accuracy: Accuracy refers to the total number of prediction that was correct.

$$Accuracy = \frac{TP+TN}{TP+FN+TN+FP} \quad (3)$$

TABLE I. RESULT FOR NAÏVE BAYES PREDICTION PERFORMANCE.

Algorithm	Comparison results of Naïve bayes classification		
	Accuracy	Sensitivity	Speci city
Nave bayes	87.724	92.6	50.7
AdaBoostM1 (Naive bayes)	88.8299	94.7	43.6
Bagging(Naive bayes)	87.6355	92.6	49.9

TABLE II. RESULT FOR J48 PREDICTION PERFORMANCE.

Algorithm	Comparison results of J48 classification		
	Accuracy	Sensitivity	Speci city
J48	93.9615	97.8	64.5
AdaBoostM1(J48)	93.9615	97.8	64.5
Bagging(J48)	96.1292	99.0	74.5

TABLE III. RESULT FOR STACKING(J48 AND NAÏVE BAYES) PREDICTION PERFORMANCE

Algorithm	Comparison results of Stacking classification		
	Accuracy	Sensitivity	Speci city
Stacking	92.192	96.6	58.7

In this table, we show the comparison result with J48 and naïve Bayes using Ensemble Method. It is obviously that Bagging (J48) show the best Accuracy, Sensitivity, and Specicity compare with other classification.

#### B. ROC curve

A receiver operating characteristic (ROC) curve are similar to gain charts that can be represented false positive rate and true positive rate. X axis shows percentage of false positive rate and Y axis shows percentage of true positive rate.

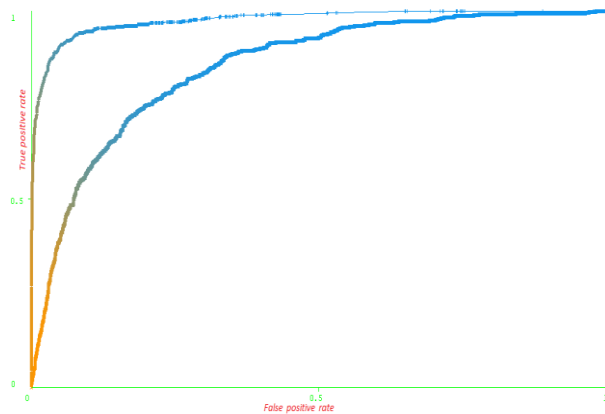


Fig1: ROC curve for Bagged J48 and Bagged Naïve bayes Classifiers.

## V. CONCLUSION

We also discuss Data mining and its various methodology in brief that is used to develop the bank term deposit prediction model. After discussing the different data mining methodology, We have predicted the bank term deposit. In this paper, we try to increase the efficiency of J48 and Naive

Bayes algorithm on Bank dataset using different ensembles and we come to the conclusion that the ensemble methods are always more efficient than the individual algorithm in this case. For this dataset, bagging ensemble method works best. The other ensembles are better than individual J48 and Naïve Bayes. In future, we may extend this work by using other algorithm on the same dataset.

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# Designing & Implimentation of Floating Solar System in Bangladesh

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**Abstract**—Bangladesh is mainly a land of rivers. There are many ways to utilize these rivers as resources. Now-a-days, renewable energy has become essential for generation of electricity. As solar panels have increased efficiency in low temperature and evaporation control so that a floating based solar system is really a novel idea to utilize water surface. In this paper, a design for pilot implementation of floating solar system to fulfill the increasing demand of electric power has been proposed which may give a better solution for power scarcity in developing countries like Bangladesh.

**Keywords**—floating solar system, substation designing, power generation, data estimation.

## I. Introduction

Solar system is a growing power generation sector all over the world. But in Bangladesh, the improper designing, unutilizing causes bad impact as predicts high expectation from developing country. Though Bangladesh has high availability water surface, these area remain useless. The floating PV system is a new method in solar energy genetarion. This system has a positive aspects such as it never spoils water, keeps environment natural and also maintain efficiency.

## II. Description

### A. Block diagram of floating solar system

Here is shown the basic block diagram of floating solar system. The main equipment has been connected according to the figure respectively. Floating solar panels, solar controller, battery storage, AC/DC inverter have been used for the system in fig.1

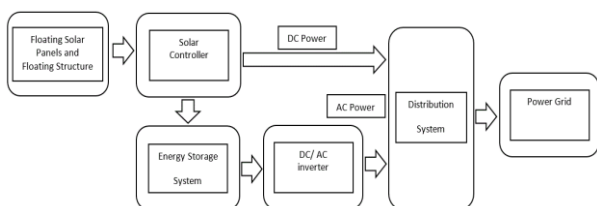


Fig.1 Basic block diagram of a floating solar system.

### A. Concept of design floating solar system

Floating solar system is a combination of solar power plant system and floating system technology. Here, floating system is a structure contain the solar plant and it is constructed using floater system. Mooring system maintain the positions of floating solar system according to the water wave. PV system contains PV generation equipment and is installed on the top of the floating system. Underwater cables generated power is transferred from floating solar system to substation. Hence floating solar system design has been showing in Fig.2 [1]

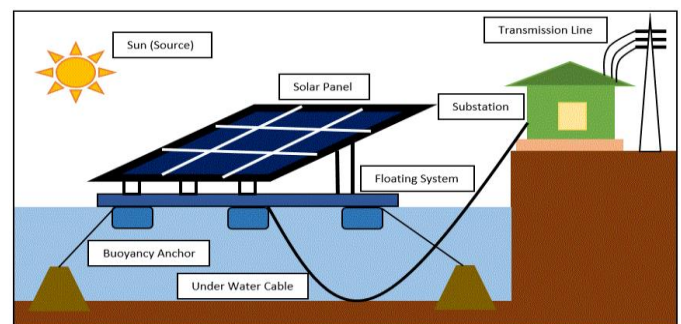


Fig.2 Floating solar system design

## III. Growing Power Generation

To reduce demand on electrical power grid, it's necessary to use renewable energy which is not only better for consumers but also for keeping sound environment. People from different parts of the world have been trying to use this renewable energy for their daily purposes. Day by day more modification is updating and floating solar system is one of them.

First floating system was installed by Niente, on a pond for power generation in 2007. Some of projects have been taken in different countries which will be find successful and generated power has been shown in Fig2

Country	Project Location	Generated power
Japan	Constructing world's largest floating solar power-plant in Chiba	Will generate 16,170 MWh/year.[2]
India	* installed at Rajarhat, West Bengele new town in December 2014.  * will be taken at southern state of Kerala by National Hydro-power corporation(NHPC).	* Generates about 10KW solar power each day.[7]  * will generate 50MW.[4]
China	Establishing on east china over 40,000Km	would produce 3.6 million GWh/year. [3]

Fig.3 Country based project location and power generation.

For any country, 1square kilometer of water allows 75 MW of floating solar as well as will generate 82 GWh/year electricity each year. [3]

#### iv. Implementation of floating system in Bangladesh

##### A. Purposes to use

It can be used as two purposes. It is not only use for power based mills and industries but also used for household purposes.

##### B. Data for establishing floating solar system

To establish floating solar system, some of the variables like solar isolation, diffuse radiation, sunshine hours and temperature is of great importance. Most of them solar insolation and solar sunshine has been analysis on different cities of Bangladesh from 1988 to 1998 in Fig.4 and graphical representation in Fig.5 and average sunshine on Dhaka city in 1961 to 1980 in Fig.6 and it's graphical representation in Fig.7

Monthly Global Solar Insolation at Different Cities of Bangladesh (in kWh/m<sup>2</sup>/day)

Month	Dhaka	Rajshahi	Sylhet	Bogra	Barishal	Jessor
January	4.03	3.96	4.00	4.01	4.17	4.25
February	4.78	4.47	4.63	4.69	4.81	4.85
March	5.33	5.88	5.20	5.68	5.30	4.50
April	5.71	6.24	5.24	5.87	5.94	6.23
May	5.71	6.17	5.37	6.02	5.75	6.09
June	4.80	5.25	4.53	5.26	4.39	5.12
July	4.41	4.79	4.14	4.34	4.20	4.81
August	4.82	5.16	4.56	4.84	4.42	4.93
September	4.41	4.96	4.07	4.67	4.48	4.57
October	4.61	4.88	4.61	4.65	4.71	4.68
November	4.27	4.42	4.32	4.35	4.35	4.24
December	3.92	3.82	3.85	3.87	3.95	3.97
Average	4.73	5.00	4.54	4.85	4.71	4.85

Fig.4 Solar isolation in different cities in Bangladesh. [6]

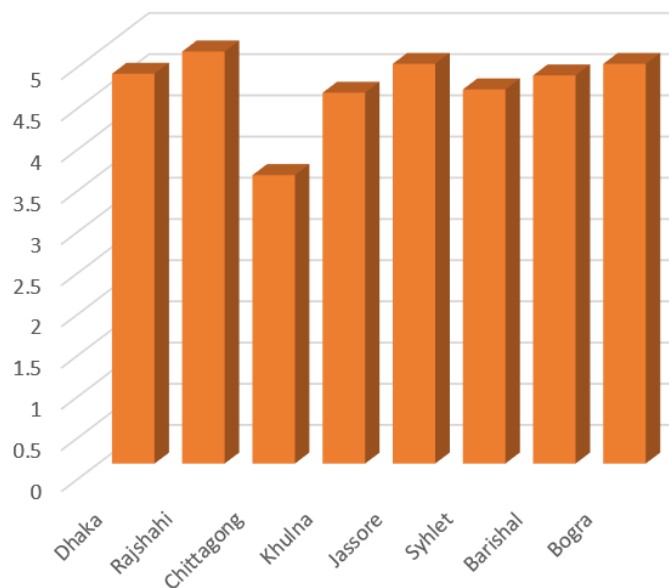


Fig.5 Graphical representation of solar isolation based on data

Daily Average of Bright Sunshine Hours at Dhaka (Average period: 1961 to 1980)

Month	Daily Mean	Maximum	Minimum
January	8.7	9.9	7.5
February	9.1	10.7	7.7
March	8.8	10.1	7.5
April	8.9	10.2	7.8
May	8.2	9.7	5.7
June	4.9	7.3	3.8
July	5.1	6.7	2.6
August	5.8	7.1	4.1
September	6.0	8.5	4.8
October	7.6	9.2	6.5
November	8.6	9.9	7.0
December	8.9	10.2	7.4
Average	7.55	9.13	6.03

Fig.6 Daily average bright sunshine at Dhaka. [6]

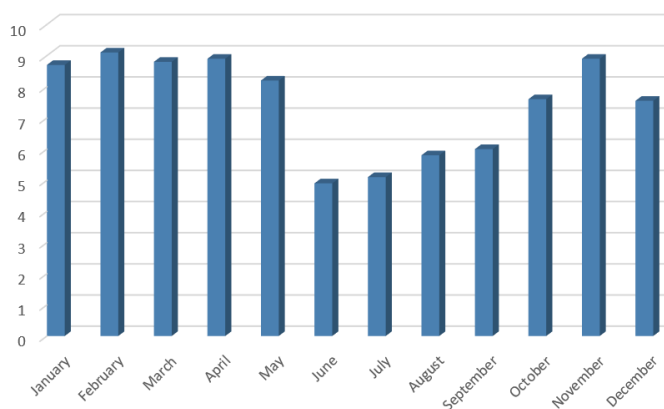


Fig.7 Graphical representation of bright sunshine hour at Dhaka (1961-1980). [6]

### C. Scope for establishing floating solar system in Bangladesh

Future of floating solar system can be a great achievement in Bangladesh to meet the power crisis. Bangladesh has also many rivers and wetland. There are 47 major Haors, 6300 Beels of varying size of which 3500 are permanent and 2800 are seasonal. Here major Haors(Hakaluki & Tanguar Haor) and permanent beels(Chalan beel) can be used a floating solar system which will continuously generate power efficiently.[5]

## v. Model of Floating solar system in Bangladesh & it's benefits

Here it is showing the future model of floating solar system in Fig.8 which has many benefits and some of them are analyzed below



Fig.8 Future model of floating solar system in Bangladesh

### A. Environmental benefits

Natural evaporative cooling of the system keep the water temperature lower and hence the efficiency is increased. By installing solar panels floating on lakes, lagoons or ponds resulting in improved power production. In turn, the solar panels shade the water, limiting algae growth and helping reduce evaporation. As clean energy, it has no CO<sub>2</sub> emission. It is an alternative idea for solar energy using water surface instead of land which is also positive aspects.

### B. Power supply for irrigation

The power generated in a floating solar system is easily supplied to water pump for irrigation for cultivation.

## vi. Conclusion

Establishing floating solar system is according to the spirits of age technology to meet the growing power demand in a developing country like Bangladesh. Due to lower temperature of water surface, the floating solar system is more efficient than conventional land based solar energy plant. It is not only generate power but also helps to reduce the land area and environmental pollution.

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# A Total Automation in Water Management, Distribution and Billing

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**Abstract—** In this paper, we proposed a fully automated system for supply-water management, distribution and billing. Water level sensors were used to determine the level of the water in the master tank. Based on the water level, the switching of the pump was controlled automatically using a PIC microcontroller based system. For distribution, a DTMF based gating system was used to control the supply by mobile calls from remote location using a GSM module. All the updates were made available to the concerned operator by sms for remote monitoring. Flow meters were used to measure the total amount of water consumed per month. Using existing mobile network these data could be sent to the remote server for billing. The design of the overall system is described in a step by step manner. The system was implemented practically to a laboratory extent and also in computer simulations. The performance is evaluated and typical results are summarized which proves the efficiency and feasibility of the proposed system.

**Keywords—**Water Management; Mobile controlled distribution ; Flow meter; Automatic billing.

## I. INTRODUCTION

Water is an invaluable resource. Though the most of the earth's surface is covered with water, very little of it is usable and drinkable. Consequently, in most of the cities, water from an unpolluted source is collected, purified and distributed over large residential area. Proper management and distribution of water has been an important issue worldwide. It has been one of the most critical crises for many densely populated countries like Bangladesh where it is done manually in a conventional way. City dwellers often accuse the authorities of mismanagement of water and they get unsatisfied. Moreover, sometimes it is seen that some areas remain totally deprived of water while the others are wasting it. Sometimes, the inhabitants of this deprived area are even seen to get down to the road with a procession demanding water or uniform water distribution and proper management. Present manpower fails to fulfil their demand even after putting their best effort. In fact, it requires a huge skilled and unskilled sincere manpower. It is also true that increasing manpower may not solve the problem totally because of their inherent negligence as long as human being is concerned. Realizing these issues many developed countries have already started automation in these types of works [1]. There have been proposed few methods for automatic water management and billing separately in current

literature [2-6], but overall integration of these three modules has yet to be implemented. In Bangladesh these are still being done manually and no satisfactory automation in water management, distribution and billing are designed and practically implemented yet.

In this work, we designed a system offering total automation in water management, distribution and billing. Water level of the master tank is automatically sensed and adjusted as demand and can be monitored remotely by a simple GSM mobile. For controlled distribution in different remote areas, we designed a gate system on the distribution route which can be controlled remotely as desired by using simple mobile call or sms. In addition, we proposed an automatic billing system of the respective consumers. For this, we used flowmeter based water measurement system to measure the total amount of water consumed per month and a GSM module to send the result to the remote server for billing. The server after computing bill by automatic billing software will in turn send the bill statement to the respective users by email. The consumers can then pay their bill on line by their credit card from home. In the overall system only a little manpower is required for monitoring purposes. Hence, there is a little possibility of negligence or mismanagement.

The remainder of the paper is organized as follows: in Section II, the design and implementation procedure is discussed. Typical results and performance evaluation of the system designed is given in Section III. Finally, in Section IV, we conclude the paper by discussing the usefulness, applications and limitations of the work with the directions for further extension of our work.

## II. SYSTEM STRUCTURE AND DESIGN

In this section, we discuss the overall design procedure under three main sub sections step by step. These are automatic pump control, mobile controlled distribution and automatic billing sections.

### A. Automatic Motor Control According to Tank Water Level

There are various cheap and efficient water level sensors available in the local market [7]. We used four such sensors at different heights of the master tank to determine the level of water in the tank. The outputs of the sensors were

continuously fed to a PIC microcontroller of model 16F877A [8]. We programmed it to automatically switch the pump based on the output of the sensor array. For example, when the tank was fully empty, output of the all the sensors was low (0) and the motor was turned on. The level of the water increased gradually and the sensors output started to change. The motor remains switched on until all the sensor output became high which indicated that the tank was full and the motor was turned on. This process continued as long as power was given to the system. A 16x2 LCD display was used for reading the status of the motor and the tank water level on the spot. A microcontroller based GSM module could be used to send these statuses to the remote operator for monitoring using existing mobile network [9-10]. A flowchart of the complete operation of this module is shown in Fig. 1. A schematic implementation is shown in Fig. 2.

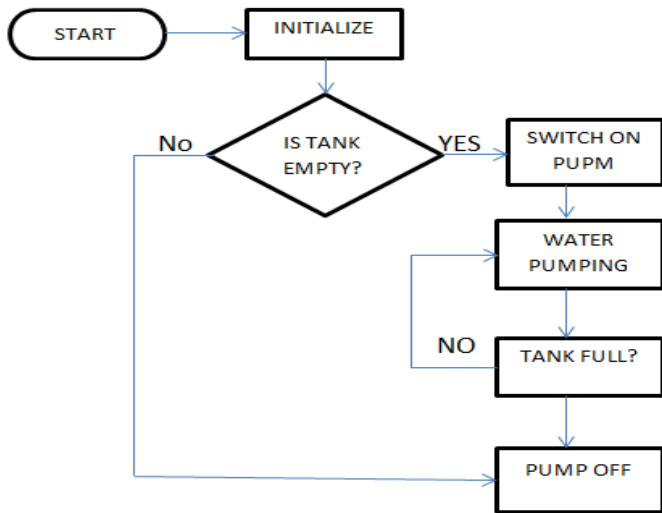


Figure 1. Flowchart for motor control

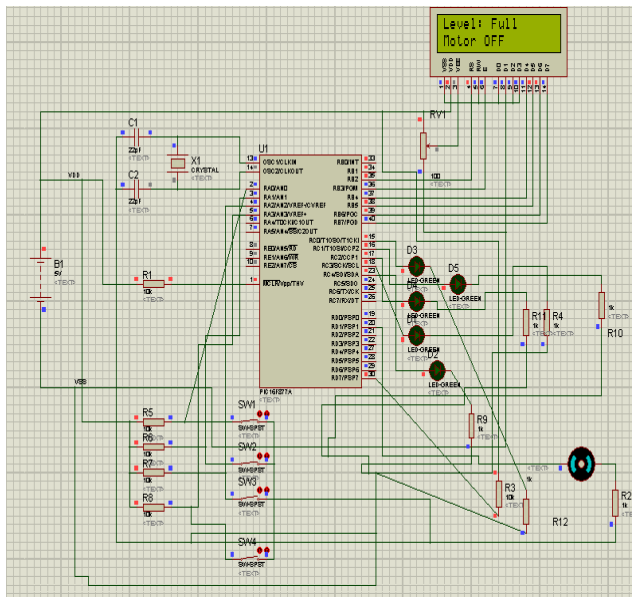


Figure 2. Schematic diagram of motor control

### B. Mobile Controlled Water Distribution

This module consists of a GSM module, dual tone multi-frequency (DTMF) decoder and microcontroller based gate control system. The functional work flow is illustrated in Fig. 3.

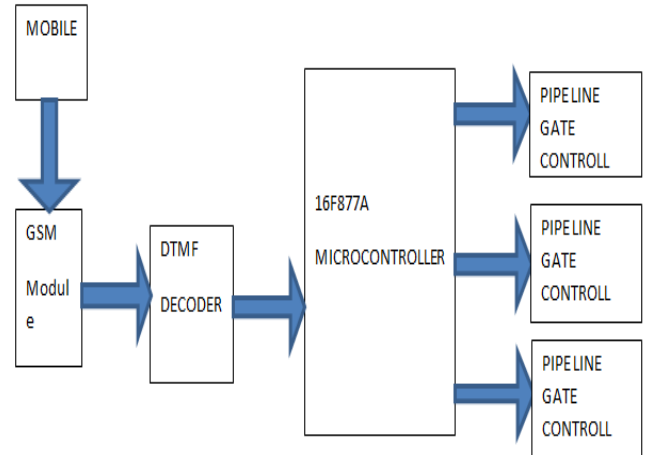


Figure 3. Flowchart of mobile controlled water distribution

The GSM module received the digit sent by the distant operator and the DTMF decoder was used to identify the dual tone associated with the key pressed and decode it to four specific digital digits which were then fed to the microcontroller for controlling the gate. The standard DTMF scheme [11] is given in TABLE I.

TABLE I. STANDARD DTMF SCHEME

Key	Low Frequency (Hz)	High Frequency (Hz)	Binary Output			
			D0	D1	D2	D3
1	697	1209	0	0	0	1
2	697	1336	0	0	1	0
3	697	1477	0	0	1	1
4	770	1209	0	1	0	0
5	770	1336	0	1	0	1
6	770	1477	0	1	1	0
7	852	1209	0	1	1	1
8	852	1336	0	0	0	0
9	852	1477	1	0	0	1
0	941	1336	1	0	1	0
*	941	1209	1	0	1	1
#	941	1477	1	1	0	0

For key 1, two signal of frequency, 697 Hz and 1209 Hz respectively were generated and decoded to binary output 0001. According to the program instructions, the microcontroller translated this signal into command to switch the motor on for required time to control the gates to the pipes. The gates were closed if another specific key, for example, 2, was pressed after initiating a call to the GSM module. A schematic of the typical implementation of this module is illustrated in Fig. 4.

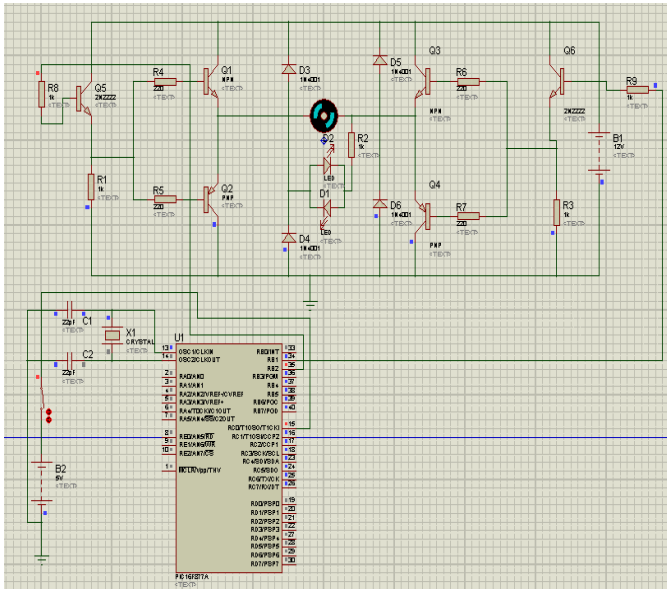


Figure 4. Schematic diagram of mobile controlled water distribution.

### C. Automatic Billing System

The rate of water flow through can be sensed by different flow sensors, like JT-121 [12]. A flowmeter can then be used to record the total amount of water [13]. Fig. 5 depicts the flowchart of the automatic billing system. The output of flow sensor is proportional to flow of water which is in the form of square wave [14]. The number of square wave will be stored in the microcontroller. The wave controller counter will be set till the wave ends. Counter value will be incremented according to the duration of the wave. Finally, the value of the timer will be converted into decimal digits. The input of the flow sensor is fed to the microcontroller. The value then transmitted to the bill calculating unit through SMS using GSM modem. Another GSM modem received the value and sent the value to a PC for bill calculation with bill calculation software. The amount of bill is then sent to the consumer through SMS. The consumer can then pay their bill online.

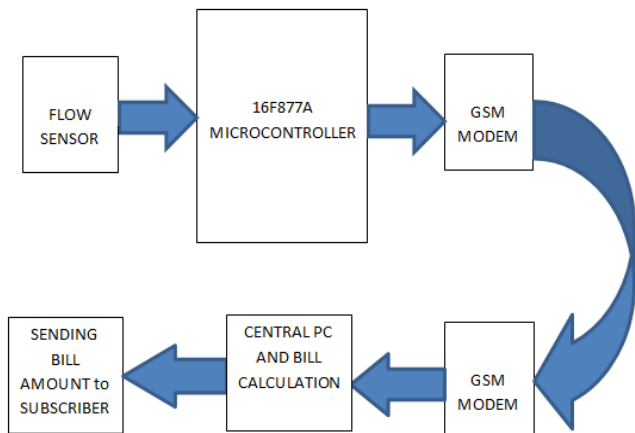


Figure 5. Flowchart of billing system

### III. RESULT SAND DISCUSSION

For the purpose of motor control, when the water level became very low, all the sensor output got High (1) and motor

was turned ON. When the water tank was full, all the sensor outputs became Low (0) and as a result, the motor was automatically turned OFF. These observations are summarized in TABLE II.

TABLE II. MOTOR AND TANK STATUS

Sensor Output				Tank status	Motor
Sensor1	Sensor2	Sensor3	Sensor4		
0	0	0	0	Empty	ON
0	0	0	1	Full up to Level 1	ON
0	0	1	1	Full up to Level 2	ON
0	1	1	1	Full up to Level 3	ON
1	1	1	1	Full	OFF
1	0	0	0	Decreased to Level 3	OFF
1	1	0	0	Decreased to Level 2	OFF
1	1	1	0	Decreased to Level 1	OFF
1	1	1	1	Empty	ON

The motor statuses were sent to the remote operator for monitoring. Typical message from the GSM module employed is shown in Fig. 5. For the mobile controlled supply, when 1 key was pressed from the remote mobile, the gate was opened and closed when 2 was pressed. These are summarized in TABLE 3. These statuses were available to the remote operator as displayed in Fig. 6.

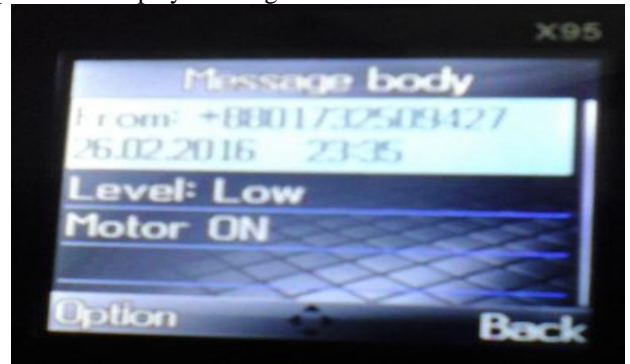


Figure 6. Showing motor status ON

For billing unit, the flow meter output was available that could be sent to the remote server for billing. However, we could not employ any server for billing.

TABLE III. TYPICAL CONTROL OF REMOTE SUPPLY

Key Pressed	Low Frequency (Hz)	High Frequency (Hz)	DTMF Decoder Output				Supply Status
			D0	D1	D2	D3	
1	697	1209	0	0	0	1	Gate ON
2	697	1336	0	0	1	0	Gate OFF



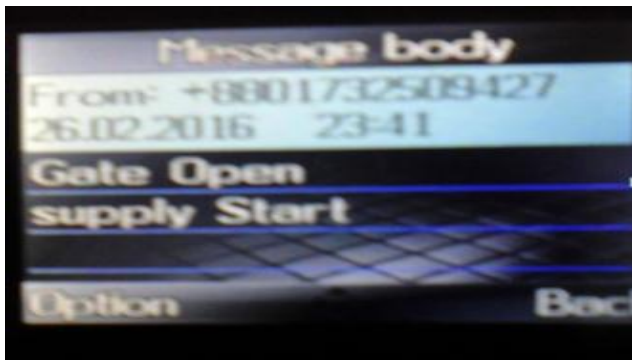


Figure 6. Showing motor status OFF

#### IV. CONCLUSION

In this paper we described a totally automated system for water supply, bill calculation and overall management of water for any region using GSM technology and microcontroller. This would overcome limitations of the existing systems and significantly reduce the manpower and associated cost. This system can be practically implemented in any region including cities or town. In addition, the water distribution, we proposed, can be combined with the irrigation system, and then the system would add an extra benefit because of mobile controlled water distribution. We can simply control water supply by using mobile to resident area and supply extra water for irrigation. It can also be important for fire control. If an area is affected by fire, then we can remotely stop water supply to other areas and can supply much water to that area to control fire. Furthermore, in future, this work can be extended to detect water leakage in different areas. Water supply can be controlled based on the consumer's demand and bill payment. The system can be interfaced with the internet for controlling and monitoring from any area.

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# Faster Image Segmentation Using Parallel Mean Shift Algorithm

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**Abstract**—Many of the existing segmentation algorithms have high computational cost, specially for high resolution images. The availability of multicore processors is drawing the attention of many researchers towards the development of various tools and techniques for parallel programming. The key objective of parallel processing is to reduce the computational time of a program involving very large input data. Our idea is to explore current multi-core commercial processors in order to speed up image segmentation process. In this paper, a multi-core parallel implementation of the Mean Shift algorithm is presented that aims at providing better execution time, while delivering a similar outcome produced by a sequential implementation. The presented framework is able to work with any number of cores to take full advantage of the upcoming processors having unseen number of cores. Our implementation is tested using different images on multiple systems with different number of cores.

## I. INTRODUCTION

In automatic image interpretation, the process of extracting different objects that composes an image is one of the primary steps. This process is known as image segmentation and consists of sub dividing an image into meaningful regions. Image segmentation is a fundamental active research area in computer vision. The motivation behind such importance lies in its practical implications in content based image retrieval, object recognition, optical character recognition etc. The availability of image acquisition devices are very common now a days, even it is not rare for one to have multiple low cost camera devices at a time. Additionally, the popularity of social networking sites are encouraging people to capture and share “moments”. Billions of high resolution images are being captured every day making information extraction from images a lucrative research topic. The main objective of image segmentation is to represent the image in a much meaningful manner to be understandable by a computer/machine. One of the major obstacles towards efficient real-time image segmentation is the required computational time. High resolution images are large in size, taking considerable amount of time for processing. In this article we present a low cost solution to this problem using existing tools and techniques i.e., mean shift algorithm and Parallel Pattern Library (PPL).

Mean shift algorithm, introduced by Fukunaga and Hostetler (in 1976), has been successfully used for image segmentation. Mean shift is often used as a nonparametric clustering method that aids finding modes, and many recent applications of computer vision use it for image segmentation or object tracking.

Other applications of mean shift algorithm include clustering, kernel density estimation, image processing, filtering, space analysis etc., [1]–[4]. Parallel programming has gained significant attention in recent years due to the evaluation of low cost computing resources (such as multicore processors, clusters, cloud computing platforms etc.) and huge amount of data at hand to process. Researchers are looking for techniques to exploit this parallel platforms for faster data processing. PPL is a programming model that provides a set of easy to use programming constructs and containers for developing applications for a parallel computing platform. Mean shift inherits an interesting property, that is the angle between two consecutive mean shift vectors is always less than 90 degrees which provides a smooth result in image segmentation [5]. However, it is observed that a complete application of mean shift algorithm is time consuming. To decrease the run time of the algorithm we have used PPL to exploit the multicore programming system. Our implementation of the system dynamically scales the degree of parallelism using all the available processing cores. Moreover, PPL provides cancellation support, state management, and other services required for parallel programming.

In this paper, we present a faster image segmentation process for computer vision applications. In Section 2, we introduce some existing research on image segmentation, parallel processing, mean shift algorithm and some approaches to parallel mean shift algorithms. Section 3 presents our high performance mean shift algorithm using PPL. Section 4 describes the comparative experimental results obtained using our system. Section 5 concludes the paper and outlines some areas for future research.

## II. LITERATURE REVIEW

This section discusses some preliminary concepts related to our research. We provide an overview, along with some related work, on image segmentation, application of mean shift algorithm in image segmentation and parallel processing.

### A. Image segmentation

Dividing images into multiple parts is the sole objective of image segmentation, and it is basically used to detect objects or other pertinent information in digital images. Image segmentation refers to the automatic process of partitioning an image into regions corresponding to semantically meaningful

objects. A large variety of image segmentation techniques are available in the literature, some of them are considered general purpose and some are specially designed for specific domains. Some previous work on image segmentation are briefly discussed below.

Until now, major portion of research in image segmentation involves detecting the homogeneity (or discontinuity) of low-level features such as color and texture in the feature space. The procedures, detecting homogeneity, assume that adjacent pixels whose value (gray level, color value, texture, etc.) lies within a certain range belong to the same object class [6], [7]. Wisely chosen threshold values are used to differentiate classes. These approaches perform well on images including only two opposite components. Another school of thoughts assume that pixel values change rapidly at the boundary between two regions [8], [9] i.e., at the edges of objects. Edge detectors such as Sobel operators [10], Roberts cross operators [11], or more complex Canny operators [12] use this approach. Most of the edge detectors obtain discontinuous color edges. To acquire the actual region boundaries, some post-procedures such as edge tracking, gap filling, smoothing, and thinning operations are required. The time-consuming post-procedures can be avoided using another approach, known as region based approach. Region-based techniques count on the fact that pixels in the same region have similar visual features e.g., gray level, color value, or texture. A popular technique of this approach is the split and merge algorithm [13], [14]. Some other techniques use combination of edge detection and region growing techniques. For example, Pavlidis et al. [15] describe a method to detect edges based on features such as contrast, gradient and shape and then find the segments using a region-growing approach. In [16], Haddon and Boyce generate regions from the image co-occurrence matrix and refine them using edge information.

### B. Image segmentation using mean shift clustering

Clustering techniques classify pixels of an image into several groups which have been applied successfully to image segmentation. The classical k-means algorithm is one of the widely used techniques for clustering. Another well adapted algorithm is mean shift clustering, we use this algorithm in our system. One of the main advantages of this algorithm over other techniques is that it does not rely upon a priori knowledge of the number of clusters. Furthermore, it does not implicitly assume any particular shape of the clusters allowing the analysis of object having arbitrary shapes. However, the selection of scale parameters still remains a challenging problem affecting its performance. Mean shift considers the feature space as sampled from an empirical Probability Density Function (PDF). It assigns the closest peak to the data set's underlying probability density function. We can state the mean shift algorithm using the follows steps: (i) define a window around each data point, (ii) compute the mean of data within the window, and (iii) shift the center to the mean and repeat till convergence, i.e., the center of the window no longer shifts. In image segmentation process, each pixel is considered as

a data point. The co-ordinate of the pixel is primarily set as the geometric center of the window. Then a center of pixel intensity is calculated using the pixels within the window [2]–[4]. The segmentation techniques described in the previous section uses various assumptions such as - objects of interest have uniform shading; or a considerable gray-level change occurs between the objects and the background. However, these assumptions have proven inaccurate in many vision applications; as a result, often time they require controlled conditions or human supervision [1], [2], [5]. In mean shift image segmentation, a kernel is defined for each pixel which articulates measure of intuitive distance between pixels. The size and shape of the kernel is automatically determined with the aid of Parzen windows [5]. After a suitable kernel value is determined, mean shift procedure iterates over each pixel and assign a mean shift point to each pixel. Mean shift points are iteratively moved upwards along the gradient of the density function defined by the sum of all the kernels as long as they reach a stagnant point (a mode or a hilltop on the virtual terrain dened by the kernels). Once the iteration stops, the pixels associated with the set of mean shift points that transfer to the (approximately) same stationary point are considered to be members of a single segment. Despite the advantages of the mean shift image segmentation, kernel density estimation does not always scale with the dimension. Another short coming of the approach is that sometimes it fails to detect edges correctly, specifically if feature space contains more than six dimensions [3], [17], [18]. In some situations mean shift algorithms take long computation time [19].

### C. Parallel processing

Parallel computation is the accompanying use of more than one CPU or processor cores to complete a task. In general, parallel processing makes programs run faster using multiple processing units [20], [21]. *Task parallelism* and *data parallelism* are two programming models for parallel programming. The task parallelism focuses on distributing threads beyond different parallel computation nodes in which different processor executes the same or different programs on same or different data. Different processors communicate with each other during execution. On the other hand, data parallelism is a programming technique for splitting a large data set into smaller chunks that can be operated in parallel. In this model, multiple CPUs execute same program with a part of the input data set. We adapted data parallelism in our proposed system.

PPL is designed by native C++ developers and bundled with Microsoft Visual Studio providing features for multicore programming. PPL builds on the scheduling and resource management components of the Concurrency Runtime. The features of PPL include: a mechanism to execute several work items (tasks) in parallel, generic algorithms that act on collections of data in parallel, generic containers providing safe concurrent access to their elements, and procedures to exploit data parallelism. PPL provides a convenient and readily-usable toolkit that combines the simplicity of managed-language

equivalents with the elegance and expressiveness of C++. PPL uses more abstract concepts than threads and fibers as the base unit of scheduling [22].

#### D. Parallel mean shift algorithms

A number of parallel mean shift approaches can be found in literature. Moreover, several mean shift based segmentation algorithms are well-known for their superior performance against the traditional approaches. We briefly discuss some of the approaches below.

An approach to parallel mean shift for interactive data volume segmentation can be found in [2]. The presented system implements a mean shift clustering algorithm on a parallel environment using an NVIDIA GeForce 8800 GTX card for interactive processing. This GPU implementation of the algorithm segments  $256 \times 256 \times 256$  volume in 6 seconds which is hundreds time faster than its single CPU version. Parallel mean shift has been successfully applied to image segmentation too. A high-resolution image segmentation technique using parallel mean shift is available in [1]. Here, the proposed algorithm works concurrently on multiple feature space kernels on a many-core GPGPU platform. Their experiment shows that the parallel version performs better than the traditional implementations. Yet another image processing system using GPU based mean shift algorithm can be found in [23]. The authors map the mean shift vector calculation using six kernels on a GPU. Their experiment is available on publicly available CAVIAR video revealing the speedup gained using the parallel tracking algorithm. Among the recent initiatives, Craciun et al. [24] achieve parallelism in mean shift clustering using a FPGA based hardware architecture.

### III. HIGH PERFORMANCE IMAGE SEGMENTATION USING MEAN SHIFT ALGORITHM

This section discusses our approach to high performance mean shift algorithm. Our system reduces the running time of traditional image segmentation procedures by applying parallel programming techniques. We present a parallel high performance mean shift algorithm using PPL. This dynamic mean shift algorithm updates both the sample space and the “mean”, which is a subspace of the sample space. In general, mean shift uses a window and repeat it until it finds the last input point. We followed the Single Program Multiple Data (SPMD) model for parallel implementation which divides the input data (i.e., image) into multiple parts according to the number of available cores. For example, if a CPU has 4 cores, it will partition the input image into 4 parts and each part will be processed by a single processing unit. Finally the segmented partitions are merged together to get the output image. This process is illustrated in Figure 1.

In our proposed system, all the cores run the same program with a part of the input data. A specially designated master process manages whole segmentation task by taking care of image partitioning, result accumulation, and other management tasks. The other processes, known as slaves, receive data from the master and performs operations locally. The

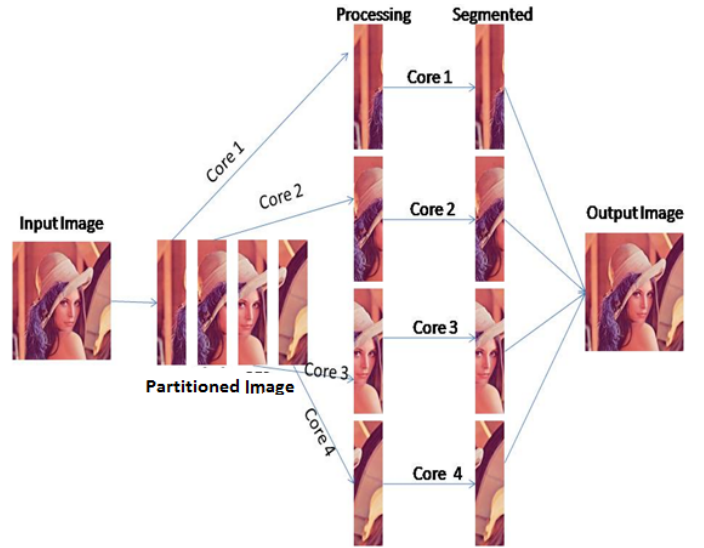


Fig. 1. Image segmentation using parallel mean shift algorithm.

master process first checks for available cores in the system from the attribute value of `dwNumberOfProcessors` which is a member of `SYSTEM_INFO` structure. It also gets the image size using appropriate OpenCV function (`cvLoadImage(inputImage)`). After getting the image size and core numbers, master process divides the image into smaller blocks of size  $\frac{N \times M}{n}$ , where  $N$  is the height of the input image,  $M$  is the width and  $n$  is the number of available cores. Hence, each core get a smaller piece of the input image for processing. The cores are given integer ids from 0 to  $n-1$  by the system and master process sends the first partition ( $PImg_1$ ) containing columns 0 to  $\frac{M}{n-1}$  to core 0, the second partition ( $PImg_2$ ) containing columns  $\frac{M}{n}$  to  $\frac{2 \times M}{n-1}$  to core 1, and so on. For example, for an  $512 \times 512$  image and 4 cores, core 0 gets to process columns 0 to 127, core 1 gets columns 128 to 255, core 2 gets columns 256 to 383, and core 3 gets columns 385 to 511. Each slave processor applies the mean shift based segmentation algorithm on its local sub block of the input image independently and sends their local output to the master process. Finally, the master process aggregates the output of each slave to generate the output image. The steps of the system is illustrated in Figure 2. Given that all the cores run efficiently and completes their job at the same time, the overall system will be faster than running the system on a single core.

### IV. EXPERIMENTAL RESULTS

We summarize our findings in this section. The overall performance of the system depends on the number of available computational cores. We used OpenCV provided by itseez and PPL provided by Microsoft Visual Studio 2010. Five  $512 \times 512$  standard images, namely *Cameraman*, *Lake*, *Mandrill*, *Pepper* and *Leena* are used in our experiment. We use the same set of images on various machine architectures of see the scalability of our implementation. The running time of the segmentation

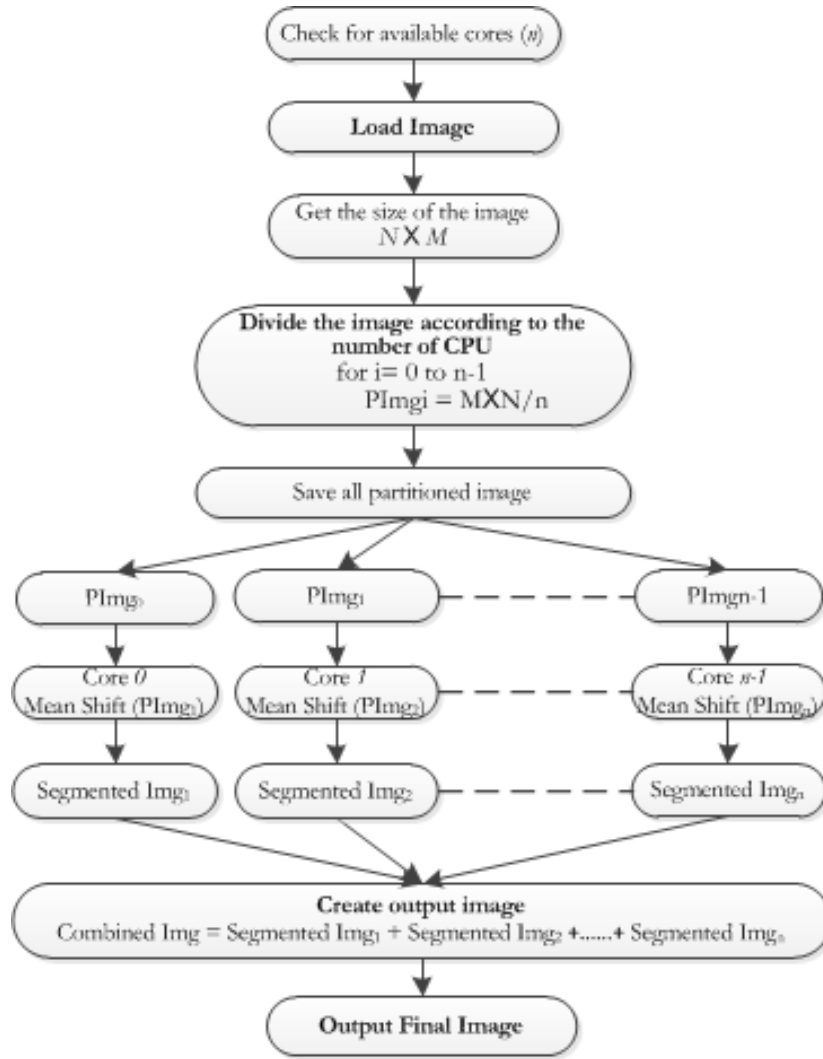


Fig. 2. Steps of the parallel image segmentation system.

algorithm on various machines are shown in Table 4. Our experiment shows that in every cases the parallel version outperforms the sequential version (as expected). We also get several other interesting observations. For example, the running time also depends on the number of connected regions in the images [25]. Among our test images, Cameraman contains 7220, Lake contains 18961, Lenna 13452, Mandrill 107507, and Pepper contains 30887 connected regions which is why Mandrill takes most time on any CPU. Modern operating systems utilize the threads efficiently which reduces the execution time too. Note also that execution time reduces with the increasing number of the cores which supports the scalability of the system. Moreover, we observed that even though our system is faster than the existing one it does not hamper the segmentation quality in the output. Figure 4, shows the execution time of our system on the test images.

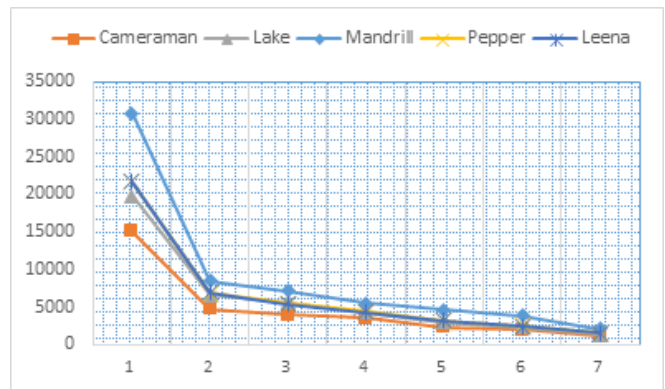


Fig. 3. Execution time of the test images on machines with various number of cores.

## V. CONCLUSION

Computer applications, exploiting the parallel platforms, are increasingly needed to meet the demand of efficient high

Image	Processor	Clock Speed	# of Cores	# of Threads	Time (in ms)
Cameraman	Pentium 4	2.8	1	N/A	15035.26
	Dual Core	2.6	2	N/A	4746.59
	Core 2 Duo	2.93	2	N/A	4011.78
	Core 2 Quad	2.3	4	N/A	3545.73
	Core i3	3.1	2	4	2316.07
	Core i5	2.9	4	4	1951.84
	Core i7	3.4	4	8	1224.02
Lake	Pentium 4	2.8	1	N/A	19750.96
	Dual Core	2.6	2	N/A	6617.28
	Core 2 Duo	2.93	2	N/A	5584.85
	Core 2 Quad	2.3	4	N/A	4321.54
	Core i3	3.1	2	4	2942.36
	Core i5	2.9	4	4	2342.05
	Core i7	3.4	4	8	1307.71
Mandrill	Pentium 4	2.8	1	N/A	30749.13
	Dual Core	2.6	2	N/A	8439.29
	Core 2 Duo	2.93	2	N/A	7144.87
	Core 2 Quad	2.3	4	N/A	5480.34
	Core i3	3.1	2	4	4665.66
	Core i5	2.9	4	4	3824.01
	Core i7	3.4	4	8	2048.41
Pepper	Pentium 4	2.8	1	N/A	21623.67
	Dual Core	2.6	2	N/A	6878.19
	Core 2 Duo	2.93	2	N/A	5455.41
	Core 2 Quad	2.3	4	N/A	4367.73
	Core i3	3.1	2	4	3144.13
	Core i5	2.9	4	4	2557.12
	Core i7	3.4	4	8	1502.32
Leena	Pentium 4	2.8	1	N/A	21657.37
	Dual Core	2.6	2	N/A	6902.16
	Core 2 Duo	2.93	2	N/A	5436.07
	Core 2 Quad	2.3	4	N/A	4323.73
	Core i3	3.1	2	4	3141.15
	Core i5	2.9	4	4	2464.33
	Core i7	3.4	4	8	1532.69

Fig. 4. Execution time of the proposed system on the test images.

volume of data processing. The existing literature survey depicts that most of the parallel algorithms require special hardware which is costly. Due to the revolution in computer architecture, multicore devices are very common today inside nearly all desktops and laptops, most gaming consoles, and the newest smart phones. This circumstance demands user applications to scale accordingly and perform sophisticated operation speedily. In this paper, we introduced a low cost high performance mean shift algorithm to meet this demand. Our system uses the available CPU architecture and a library of functions providing parallel programming constructs. Learning PPL is also fairly easy for anyone having a little experience with C or C++ languages. Our experimental analysis confirmed that our system runs faster without sacrificing the quality of the output. In terms of performance, the parallel implementation is about two and a half times faster than the sequential one.

Although the developed system successfully exploited the available parallel computing platform, it has some limitation. Our approach requires additional computation for partitioning the image, without proper partitioning the output will be distorted. Sometimes parallel computing takes longer time due to inter process communication. Another demerit of our system is that for a single processing unit it is not very effective. While generating the output image our system leaves a linear pixel difference which could be removed using carefully chosen adaptive partitioning mechanism. In the future, our intention is to use the same principle of division of work to develop systems capable of dealing with every kind of data, not only images. Thus, it is expected that our image segmentation procedure can handle extremely large images efficiently and without requiring special hardware.

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# Analysis of PV Module Efficiency for Different Types of Si Based Technology Considering the Effects of Environmental Parameters

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**Abstract**—Photovoltaic (PV) modules are one of the most effective, sustainable, and eco-friendly systems. In our paper we have discussed about the overall performance of Si based Photovoltaic module based on parameters of solar cell. A proper comparison is developed among the mono-crystalline, polycrystalline and amorphous material using the model parameters. This work also illustrates the variation of fill factor and efficiency of a specific photovoltaic module under real operating conditions. In this paper, MATLAB is used to investigate the P-V characteristics to evaluate the maximum power point of solar photovoltaic cell considering the effect of temperature and solar radiation.

**Keywords**-Solar cell; solar radiation; PV array; temperature; MATLAB; mathematical model; maximum power point; crystalline; fill factor; efficiency

## I. INTRODUCTION

Now a day's energy shortage is worldwide concern issue. In order to overcome the obstacles of energy crisis, the sources of renewable energy have become a major issue in the recent years [1]. Renewable energy is used to generate electrical power from the solar energy using the concept of Photovoltaic (PV). It has come into view for its great advantages and less maintenance [2-3]. Among the solar technology, the photovoltaic array (PV) has been making a positive attention due to its capability of energy conversion without intermediate thermal process [4]-[6].

At present, the trend of utilizing solar energy has started all over the world and it is expected to be increased in near future. If the solar energy is used in right track, it can meet the need of having sufficient energy of the world ([1],[7-9]). Photovoltaic solar cell systems always shows non-linear voltage current relationship which varies with different types of environmental and electrical parameters [1].

The main semiconductor material for the solar cells is the pure silicon technology. Most of the efficient Photovoltaic cells are made of pure silicon. However, its degree of purity is very much important for the efficient design of PV cell.

The most commonly used types of these semiconductor materials for Photovoltaic energy conversion are thin Film, mono-crystalline, poly-crystalline silicon and amorphous material. However, performances of these modules depend on various types of electrical and environmental parameters. In

this paper, our study mainly focuses on analysing the three-type PV materials [5-7].

To this aim, three different PV systems consisting of mono-crystalline, poly-crystalline and amorphous silicon materials were considered to make a comparison in terms of the efficiency [5].

## II. PHYSICS OF SOLAR CELL

Photovoltaic systems (PV) are made from semi conducting materials and convert photon energy into electricity. When sufficient amount of sunlight reaches these materials, photons with a specific wavelength trigger electrons to flow through the materials to produce direct current (DC) electricity ([5],[8-12]). Most importantly, semiconductor materials are used to make the solar panels and among these materials, silicon is generally used. In order to achieve higher output voltage, solar cells are connected in series along with the parallel connection for producing higher output current ([1-4],[9-15]). Photovoltaic cells are generally connected in series configuration to form a PV module. The modules can be arranged to form large PV panel. Panels can be grouped to form large photovoltaic arrays [16-20].

The operating principle of solar cell may be described from a PN junction where there are drift and diffusion currents for forward and reverse polarization. The influence of electric fields separates these carriers within the junction. As a result, a current is produced which is proportional to solar irradiation incidence [7-9].

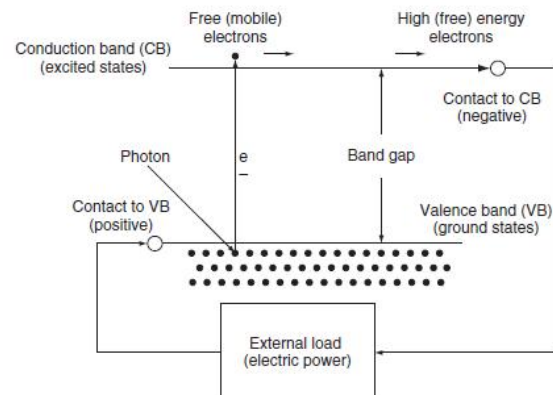


Figure 1. Physics of solar cell in terms of band theory.



### III. MODELING OF PHOTOVOLTAIC ARRAY

Solar cell is one kind of device that is fabricated in a thin layer of semiconductor. A typical solar cell device converts light energy into electrical energy ([12]-[16]).

#### A. Equivalent circuit of solar cell

To analysis the characteristics of different types solar cell materials we have considered a single diode modequivalent circuit (Figure 2) to implement a solar cell model. We have derive the equations of output voltage, outputcurrent, Fill factor (FF) and Efficiency (Ef) in terms of various parameters ([1],[10],[15]-[18]).

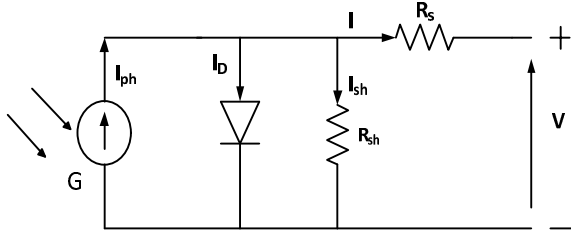


Figure 2. Equivalent circuit of solar cell

#### B. Fundamental Mathematical equations of Solar Cell

The basic equations that represent the operating principle of solar cell is based on the equivalent circuit are given below ([1],[9]-[15], [21-22]).

Applying the KCL on the equivalent circuit, we can write the equation of photocurrent which is given in equation (1).

$$I_{ph} = I_D + I_{sh} + I \quad (1)$$

In this equation,  $I_{ph}$  is Photo current generated in PV cell which depends on the solar radiation (G).  $I_D$  and  $I_{sh}$  are Diode current and Shunt current respectively.  $I$  represent the Load current of the solar cell ([1],[9]-[15], [21-22]).

Semiconductor diode is a nonlinear device and the basic fundamental characteristic of semiconductor diode is defined by the following exponential equation ([1], [22]).

$$I_D = I_S \left[ \exp\left(\frac{V_D}{V_T}\right) - 1 \right] \quad (2)$$

Here,  $I_D$  and  $V_D$  represent the diode current and voltage across the semiconductor diode.  $I_S$  signifies Temperature dependent reverse saturation current and  $V_T$  is Thermal voltage which depends on reference temperature ( $T_C$ ) and ideality factor of diode (n).

$$V_T = \frac{nkT_C}{q} \quad (3)$$

Here, n= Diode ideality factor,  
 $k$  = Boltzmann constant ( $1.3806503 \times 10^{-23}$  J/K)  
 $q$  = charge on electron ( $1.602 \times 10^{-19}$  C)

If we operate the semiconductor diode in reverse bias region then reverse saturation current will be  $I_{SO}$ .

$$I_{SO} = \frac{I_{SC}}{\left[ \exp\left(\frac{V_{OC}}{N_S V_T}\right) - 1 \right]} \quad (4)$$

Where,  $V_{oc}$  is Open circuit voltage per cell in Volt,  $I_{SO}$  is Diode reverse saturation current,  $I_{SC}$  means Short circuit current per cell at reference temperature and solar radiation.

$N_S$  and  $N_P$  represent the Number of solar cell connected in series and Number of solar cell connected in parallel respectively.

The following equation represents temperature dependence of diode the saturation current ([1],[9]-[15], [21-22]).

$$I_S = I_{SO} \left(\frac{T_O}{T_C}\right)^3 * \exp\left[\frac{qE_g}{kn} \left(\frac{1}{T_O} - \frac{1}{T_C}\right)\right] \quad (5)$$

Photo current generated in PV cell mainly depends on solar radiation and temperature. The value of Photocurrent is linearly proportional to the amount of solar radiation. The equation of photo current based on temperature and solar radiation is represented by the equation (6) ([1],[9]-[15], [21-22]).

$$I_{ph} = [I_{SC} + K_{SC}(T_C - T_O)] * \left(\frac{G}{G_S}\right) \quad (6)$$

We can write the equation of load current from basic equation as follows:

$$I = I_{ph} - I_S \left[ \exp\left(\frac{V + IR_S}{V_T}\right) - 1 \right] - \frac{V + IR_S}{R_{sh}} \quad (7)$$

$$I = N_P I_{ph} - I_S \left( \exp\left[\left(\frac{q}{nkT_O}\right) \left(\frac{V}{N_S}\right)\right] - 1 \right) - \frac{V}{R_{sh}} \quad (8)$$

Where,  $K_{sc}$  is Short circuit current temperature coefficient and  $E_g$  represent the Band gap energy of crystalline material in eV.

$R_s$  = series resistance of the cell that represents the internal losses of solar cell and  $R_{sh}$  is Shunt resistance of the cell which is parallel with the diode that takes the leakage current to the ground.

$G_S$  and  $G$  is solar radiation at standard test condition and operating Radiation condition respectively.

$T_C$  is standard test condition temperature and  $T_0$  is operating cell temperature.

Efficiency in photovoltaic solar panels is measured by the ability of a panel to convert sunlight energy into DC energy output. Basic equation of Fill Factor (FF) and Efficiency (Ef) is given below ([1],[9]-[15], [21-22]).

$$FF = \frac{V_m I_m}{V_{oc} I_{oc}} \quad (9)$$

$$Ef = \frac{P_{max}}{P_{in}} \quad (10)$$

Where, maximum Power,  $P_{max} = V_m I_m$  (11)

In this paper we used MATLAB software to investigate the maximum power point, fill factor and efficiency in different types of condition temperature and solar radiation. To perform this analysis we have use the data list of table 1. These data are based on 180W ZED fabric mono-crystalline PV solar panel [23].

TABLE I  
PARAMETERS OF ZED FABRIC PHOTOVOLTAIC SOLAR

Parameters	Type/Value
Cell Technology	Si crystalline
Number of cells in series	72
Open circuit voltage (Total)	45 Volt
Short circuit current (Total)	5.25 Ampere
Voltage at maximum power	36.31 volt
Current at maximum power	4.98 ampere
Maximum system voltage	1000 volt
Maximum power	180 watt
Temperature coefficient	.0023 V/ <sup>o</sup> Celsius
Saturation current	1.6595 nA
Temperature range	-40 <sup>o</sup> C to 80 <sup>o</sup> C
Cell efficiency	15.2%
Module efficiency	15%
Standard test temperature	25 <sup>o</sup> C
Standard test radiation	1000 w/m <sup>2</sup>

IV. COMPARISON OF EFFICIENCY BETWEEN DIFFERENT TYPES OF CRYSTALLINE MATERIAL

Efficiency of a solar cell depends on the spectrum and intensity of the incident sunlight and the temperature of the solar cell.

Table (II-VII) provides the relevant statistics based on maximum power, fill factor and efficiency of Mono-crystalline, Polycrystalline and Amorphous based solar cells respectively.

A. Variation of Efficiency of Different Types of Materials due to change of Solar Radiation

Table (II-IV) presents the variation of efficiency due to change of solar radiation.

1) Variation of Efficiency of Monocrystalline due to change of Solar Radiation

TABLE II. SIMULATION RESULT FOR MONOCRYSTALLINE DUE TO CHANGE OF SOLAR RADIATION

G	Pm	Vm	FF	Efficiency
200	35.5	36	0.150265	13.87772
400	73.84	38	0.31255	14.43282
600	113.7	38	0.48127	14.81593
800	154.3	39	0.653122	15.0798
1000	195.3	39	0.826667	15.2694

2) Variation of Efficiency of Polycrystalline due to change of Solar Radiation

TABLE III. SIMULATION RESULT FOR POLYCRYSTALLINE DUE TO CHANGE OF SOLAR RADIATION

G	Pm	V	FF	Efficiency
200	28.57	31	0.120931	11.16863
400	62.53	33	0.264677	12.22216
600	98.37	35	0.416381	12.81832
800	135.3	36	0.572698	13.22292
1000	173.1	37	0.732698	13.5337

3) Variation of Efficiency of Amorphous due to change of Solar Radiation

TABLE IV. SIMULATION RESULT FOR AMORPHOUS DUE TO CHANGE OF SOLAR RADIATION

G	Pm	V	FF	Efficiency
200	30.57	33	0.129397	11.95047
400	66	35	0.279365	12.90041
600	103	36	0.435979	13.42164
800	141	36	0.596825	13.77998
1000	179.9	37	0.761481	14.06536

Figure 3 demonstrate the variation of solar efficiency by increasing the solar radiation. It can be said that, Mono-crystalline materials shows maximum efficiency in standard test condition of the solar model.

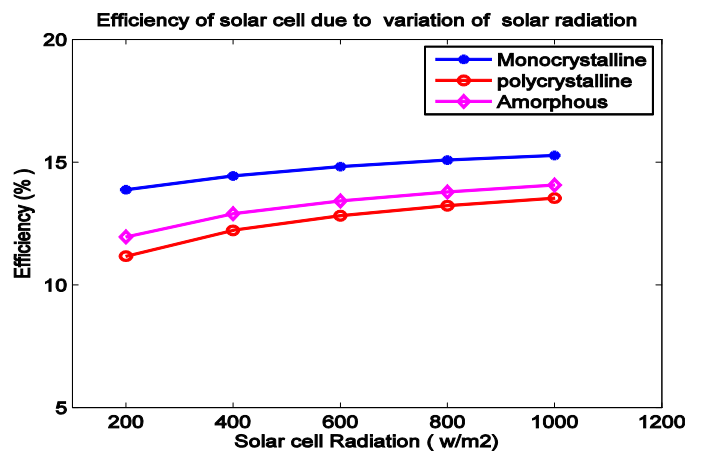


Figure 3. Efficiency of solar cell due to variation of Solar Radiation

B. Variation of Efficiency of Different types of Materials due to change of Temperature

Performance of different solar materials in terms of efficiency due to the variation of temperature presents in table (V-VII).

1) Variation of Efficiency of Monocrystalline due to change of Temperature

TABLE V. SIMULATION RESULT FOR MONOCRYSTALLINE DUE TO CHANGE OF TEMPERATURE

T	Pm	V	FF	Efficiency
0	170.7	43	0.72254	13.34606
20	157.4	40	0.666243	12.30621
40	144.2	37	0.61037	11.27418
60	131.2	33	0.555344	10.25778
80	118.4	30	0.501164	9.257022

2) Variation of Efficiency of Polycrystalline due to change of Temperature

TABLE VI. SIMULATION RESULT FOR POLYCRYSTALLINE DUE TO CHANGE OF TEMPERATURE

T	Pm	V	FF	Ef
0	223.2	46	0.944762	17.45074
20	183.1	38	0.775026	14.31555
40	143.8	31	0.608677	11.2429
60	105.6	24	0.446984	8.256263
80	69.81	17	0.295492	5.458047

3) Variation of Efficiency of Amorphous due to change of Temperature

TABLE VII. SIMULATION RESULT FOR AMORPHOUS DUE TO CHANGE OF TEMPERATURE

T	Pm	V	FF	Efficiency
0	219	45	0.926984	17.12236
20	187.7	39	0.794497	14.6752
40	156.6	33	0.662857	12.24366
60	126.1	27	0.533757	9.859042
80	96.3	22	0.407619	7.529149

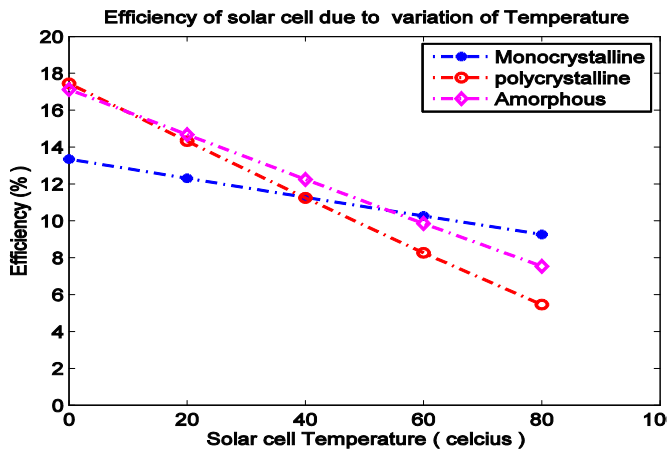


Figure 4. Efficiency of solar cell due to variation of Temperature

As can be seen from the tables (II-VII) and figures (III-IV), it can be clearly said that the maximum power (Pm) as well as efficiency are decreased when temperature of the amorphous cell is increased. However, not only the maximum power but also the efficiency is climbed up with the rise of radiation of the amorphous cell. Similarly, for Monocrystalline solar cell, the maximum power (Pm) is decreased with the increasing of temperature and simultaneously, the efficiency is reduced too. On the other hand, both the maximum power (Pm) and efficiency are hiked with the rise of the radiation. Furthermore, for Polycrystalline solar cell, the increasing growth of the maximum power (Pm) and efficiency can be observed with the gradual improvement of radiation. But with the gradual boom of the temperature, the maximum power (Pm) and efficiency are both declined.

V. P-V CHARACTERISTICS OF MATERIALS DUE TO VARIATION OF SOLAR RADIATION

A. P-V characteristics for monocrystalline

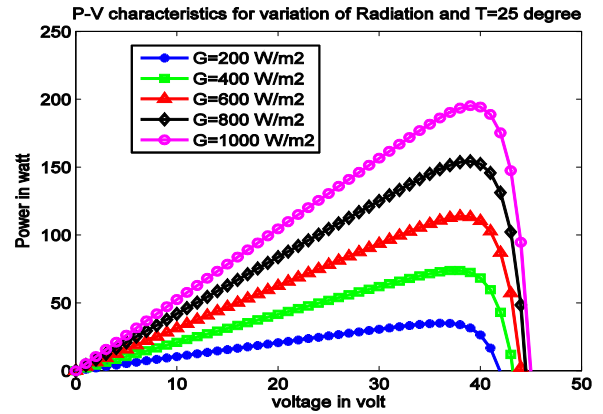


Figure 5. P-V Characteristics for mono-crystalline material due to variation of solar radiation

B. P-V characteristics for Polycrystalline

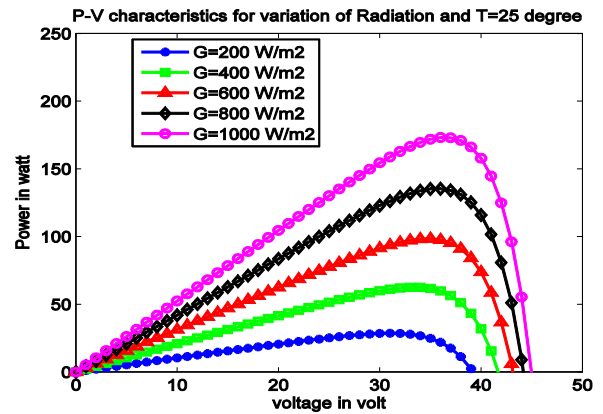


Figure 6. P-V Characteristics for Poly-crystalline material due to variation of solar radiation

C. P-V characteristics for Amorphous

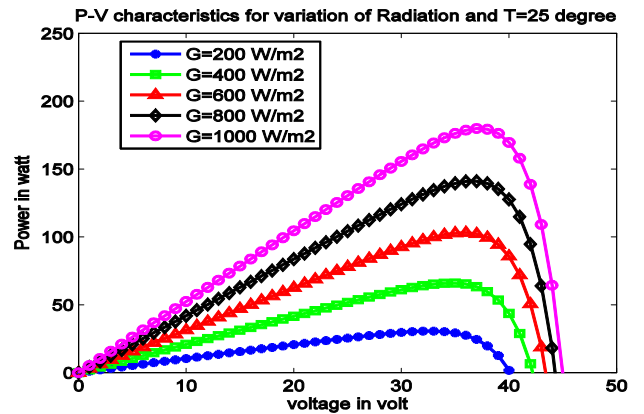


Figure 7. P-V Characteristics for amorphous material due to variation of solar radiation

## VI. P-V CHARACTERISTICS OF MATERIALS DUE TO VARIATION OF TEMPERATURE

### A. P-V characteristics for monocrystalline

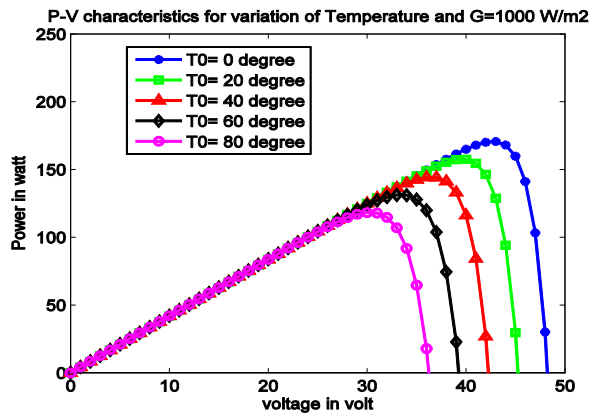


Figure 8. P-V Characteristics for mono-crystalline material due to variation of Temperature

### B. P-V characteristics for Polycrystalline

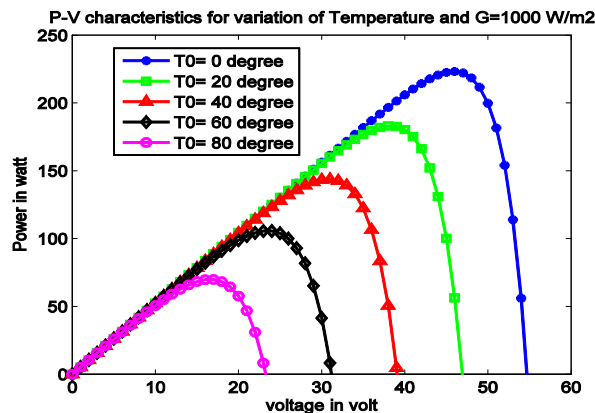


Figure 9. P-V Characteristics for poly-crystalline material due to variation of Temperature

### C. P-V characteristics for Amorphous

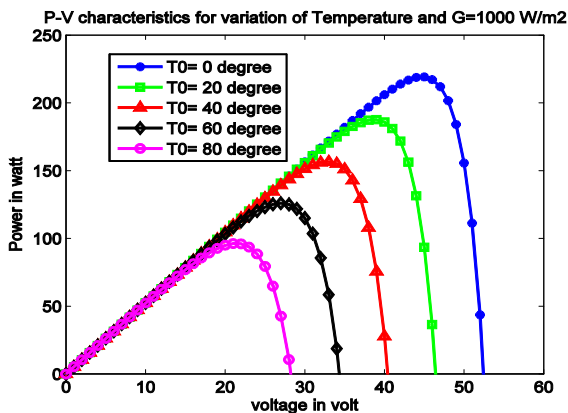


Figure 10. P-V Characteristics for amorphous material due to variation of Temperature

## VII. CONCLUSIONS

The next century will witness a productive insight in terms of renewable energy sources, particularly solar energy and its derivatives. This renewable and enormous energy source offers a solution to the energy problem all over the world. Smart Grid technology can be a proper solution for overcome the power crisis problem. Renewable energy like solar energy is an added advantage to the Smart Grid ([1],[5-6],[10-13],[24-25]).

This paper investigated a specific PV model to observe the performance the Photovoltaic solar cell under different varying parameters such as solar radiation, ambient temperature. In this paper, A MATLAB model for the solar PV cell, modules and array was presented and analyzed through simulations using MATLAB. This model used the fundamental circuit equations of a solar PV cell taking into account the effects of electrical and environmental parameters. In our paper, we refer the temperature and solar radiation as environmental parameters. Ideality factor, series and shunt resistance, reverse saturation current considered as electrical parameters. In this paper, we emphasized on the evaluation of the effects ambient temperature and solar radiation on the efficiency of the solar panels. We have considered the mono-crystalline, Poly-crystalline and amorphous material for our evaluation.

From the analysis throughout the paper, we can say that performance of solar cell for any types of material depend on the standard conditions of solar cell. But Monocrystalline solar cell shows better performance than other type of material. As from discussion, Si solar cells demonstrate high conversion efficiency, but In order to produce cheap and efficient PV devices, research on a large number of different thin film technologies is in progress.

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# Anime Face Detection Using Combination of Cascade Classifiers

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**Abstract** — In this paper, we propose a method for anime face detection by training a combination of cascade classifiers. A number of different anime face features corresponding to different facial zones are extracted which are experimentally shown to be useful for detecting anime faces. Human face detection systems are not always suitable for anime face detection because facial features on anime or cartoon faces can differ greatly from human faces. Not much work has been done specifically on anime face detection which presents considerable challenges because of the variability originating from the distinct drawing styles and representation of emotional states by various artists. The proposed method uses a combined classifier which is constructed from several classifiers, each of which has been trained to detect a single feature. The experiments performed on an image database of 102 anime faces validate that a combination of detected features is useful and the implemented anime face detection system has a high accuracy of about 90%.

**Keywords**—*cascade classifier; haar-like features; haartraining; anime; detection; machine learning*

## 1. INTRODUCTION

Face detection system is a computer application which is capable of discovering faces from a given image dataset. It has a wide range of applications, for instances it is used in the focusing capability of digital camera, or in the detection of pedestrians in the video surveillance. One of the most notable applications of face detection is that it is the primary step of any version of computer visions, such as face recognition. Face recognition has been being widely used in security system and can be compared to other biometrics such as fingerprint or eye iris recognition systems. The other applications for face recognition include surveillance, access control, image retrieval, and automatic log-on for personal computers or mobile devices.

Human face detection and its various applications are very popular topics in the field of computer science nowadays, and many research works have been conducted. On the other hand, few researches have been done on anime face detection, though this field has quite a big potential. For our study, an anime face is considered to be the face of a character drawn by

an anime artist used in an anime show. The character is a human character and cannot be an anthropomorphized non-human. Like human face detection, anime face detection can be used as the primary step of anime face recognition. Anime face recognition has many applications as well, like identifying the emotional states of the characters or detecting the plot of an anime show etc. As the anime industry has been growing rapidly worldwide, the scopes of anime face based works are also on the rise. For example, anime industry is accounted for more than 7% of the Japanese film market [1]. The popularity and success of anime is seen through the profitability of the DVD market, contributing nearly 70% of total sales. The anime market for the United States was worth approximately \$2.74 billion in 2009 [2]. In this regard, anime face detection and its further implementations can help us to easily categorize the hundreds of anime shows airing every year by nature or genre.

The main challenges or constraints that make anime face detection different from human face detection are that the features of the anime faces that we would like to use for a supervised machine learning approach are mostly inconsistent in nature, i.e. the features are varied by several factors, such as the drawing style of the artist, the emotional states of the characters, the pose of the characters, the nature of the anime show, or illumination and occlusion. To overcome this problem, we use a combination of cascade classifiers that are capable of handling several features at a time. In this way, if one feature is hard to detect, we move on and try to discover another feature that implies the region of the facial region in an image. By applying this method, we acquired an accuracy rate of 89.77% for a dataset of 102 images, with a false alarm rate of only 5.68%.

## 2. RELATED WORKS

Numerous research works have been done on human face detection, which can be classified roughly into two groups [3]: (i) feature-based approaches and (ii) image-based approaches. In the first category, algorithms search for faces by finding and extracting common features of faces predefined exclusively. On the other hand, in image-based approaches,

algorithms search for faces according to the face definitions generated by processing a big set of image data earlier.

Among various applications of the face detection, there have been tremendous researches done in one particular field, which is face recognition. In a face recognition system, the algorithm searches among a lot of image sets to identify or verify if any face has occurred more than once. Face recognition error rates have decreased over the last twenty years by three orders of magnitude when the images have been taken under constrained environment [4]. Performances of many of the of the face recognition systems are dependent on some variant factors, such as lighting, pose, expression, aging and occlusion. Despite these challenges, some well-known algorithms such as DeepFace [5] and GaussianFace [6] showed result on par or better than the human-level performance when it comes to achieving accuracy.

In the field of anime face detection, there has not been much researches conducted. A system proposed by Takayama et al. [7] considers face detection and face recognition of cartoon characters by using feature extraction along with hair and skin color, and retrieves similar faces from a database. The proposed method has an accuracy of 74.2% on the experimental data which is better than most of the existing cartoon face detections.

### 3. OUR APPROACH

Our approach was motivated from the work of Viola and Jones' [8] cascade classifier training. Viola-Jones' approach was to find face features efficiently and train cascade according to those features for efficient detection. Though single cascade classifier was sufficient for finding human faces efficiently, it is not the case for anime face detection because of the variance in anime faces and other constraints stated above.

#### 3.1. Haar-like features:

Haar-like features [16][18] introduced by Viola and Jones [8] based on the work of Papageorgiou et al. [9] on Haar wavelets, are digital image features which consider rectangular regions around a point. The sum of pixel values around each rectangle is computed and finally the differences between these sums are calculated. This value is considered as the feature and a threshold value is used to check if this feature exists in an image. The main advantage of using this feature is that these features are computationally inexpensive and from an integral image [8] this two rectangle features can be extracted by only 4 array references. In figure 1, the example images of haar-like features are shown. These feature set is collected from Viola and Jones' paper. Two rectangle, three rectangle and four rectangle features are shown in this figure. From Integral images all of these features can be calculated efficiently in constant time. So, with haar-like features, detection process can be very fast and efficient [17]. Rapid object detection is the primary reason for us to choose a haar-like feature-based method for the task of anime face detection. In Figure 2, how haar-like features overlays on a face is shown. These

rectangular boxes match the eye area towards lower portion of eye (in second image) and middle area between eyes (in third image).

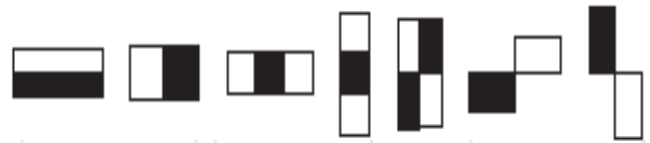


Figure 1: Example [8] of Haar-like feature sets.



Figure 2: The use of Haar-like features to overlay on a typical training face.

#### 3.2. Image database and feature extraction:

Training cascade requires two sets of images. First set contains a set of anime face images that is called positives. In positive set each image contains anime faces. Another set of images that does not contain faces are called negatives. These positive and negative sets are fed to training process. Our training database contains 205 positives and 600 negatives in total. For negative images, we consider those images that do not have any anime faces in it. These images mostly consist of pictures of random objects. These databases are created from images found in different anime sites and Google's image search. From positives usually a sub-window containing faces is our main consideration. Because anime faces varies differently from character to character, each face becomes somewhat different from one another. So, overall face sub-window might vary a lot. For this reason instead of whole face we extracted features that remain mostly common in anime faces. We used eye, lower face, left face, right face and central face as those features, and trained cascades differently on them. Grayscale vectors were created separately which was then fed to training process.

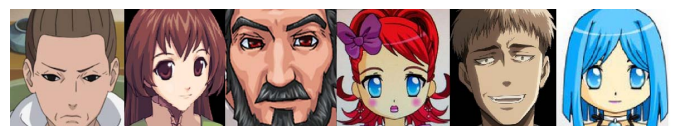


Figure 3: Features occur differently in different Anime faces. Eyes vary significantly, same goes to nose and mouth area. Face shapes and sizes also vary a lot.



Figure 4: Examples of vector files made from extracted features in order to start the procedure of supervised training. (top: eye, bottom: lower face)

### 3.3. Haartraining:

Haar-like features are extracted in a machine learning based approach from the sets of positives and negative images. For this, boosting algorithm AdaBoost [10] is used. The general AdaBoost is modified to train a classifier with only single haar-like feature. In each stage of the boosting algorithm a single weak learner classifier is trained on that feature. Performance varies with the stage considered and some other parameters. Each new stage is more complex than the previous one and combined with more haar-features than before. So, detection accuracy rate increases and false positive rate decreases with each additional stage. But the time taken in training process increases in exponential rate with each additional stage. In addition, two parameters, namely minHitRate and maxFalseAlarmRate, are significant in determining the efficiency and training time. MinHitRate defines expected hit rate or detection rate we want. MaxFalseAlarmRate indicates the false positive we are going to tolerate. A higher minHitRate and lower maxFalseAlarmRate are desirable for better performance. In our experiments, we have found the following values of the parameters to provide good performance by parameter tuning process: 8 stage training, 0.99 minHitRate and 0.1 maxFalseAlarmRate.

### 3.4. Combination of cascade classifiers:

From each feature vector of eye, lower face, central face, left face and right face, haartraining is used to train a cascade [14][15]. This trained classifier is capable of detecting a certain face feature (eye, lower face, central face, left face and right face) only. These cascades are then combined based on weighted sum. The weights are experimentally determined by first running the system on the constructed image database and then finding the best combination of the weights that maximizes the accuracy of the face detection. This combination of cascade classifiers is capable of detecting a complete face by detecting different facial features.

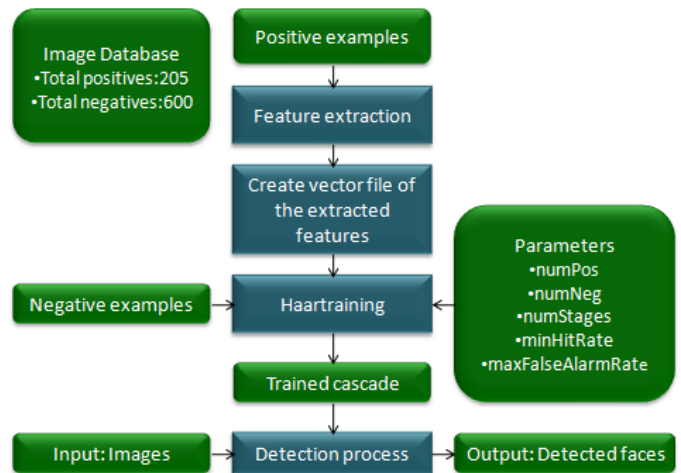


Figure 5: The complete working procedure. After training cascade classifiers and combining them image database of 102 images are ran through these classifiers. The output detects portion of the images.

## 4. EXPERIMENTAL RESULTS

After the training process is done, the trained combined cascade classifier is applied to our database. This database contains 102 frontal face images of different anime characters. Each image in the database is fed into our trained cascade and run through each single classifier of single face feature. These images are then run through the combination of those single feature classifiers. The output is detected portion of each image by those classifiers. Some of these outputs are shown in Figure 6. Each rectangular box shows detection for that particular feature by the cascade classifier trained on those features. Red rectangle box shows detection of left face, blue rectangle box shows detection of right face, green rectangle box shows detection of lower face, yellow rectangle shows detection of central face and cyan rectangle shows detection of eyes. As stated before anime faces vary differently in features, detection rate for each cascade classifier trained onto single feature varies from one another. In Figure 7, some face images where two or three features are detected, others remains undetected. These also lead to detection of face. If single cascade classifier was used instead there would be a possibility that these images might remain undetected. False alarm rate, also known as false positive rate defines the rate of false detections done by trained cascade classifiers. For the same reason, false positive rates also vary a lot. Some classifiers are low error prone but some tend to increase false alarm rate. In our case in particular, right face classifier gives a false detection rate of 22.5%, others on average 8%, lower face cascade gives best false alarm rate of 3.92% in our database of 102 frontal face images.

Term accuracy defines the true positive rate where face features are detected accurately by trained cascade classifiers. Accuracy given by each cascade classifier is somewhat 60-65% in average, where some of them give accuracy over 70%. In our case right side cascade gives an accuracy of 79.41%, central face classifier is 73.5% accurate. Some classifiers are



less accurate, with a rate of around 50%, but these are less error prone, which is actually helpful in some cases. For example, lower face cascade gives accuracy of 52.94% with a false alarm rate of only 3.92%.

These single classifier outputs are somewhat similar to other anime face detection researches out today. Anime face detection done by Takayama et al. [7] gives an accuracy or true positive rate of 74.2%. Takayama stated in his paper that other successful methods have accuracy of up to 71.0. Our efficiency is boosted by a large margin when we combined those single feature detection cascade classifiers. Our combined cascade classifier gives an accuracy rate of 89.77%. This is a significant improvement in detection accuracy over previous single cascade approach. This also shows improvement over results found by Takayama et al. [7], though, we have used a different (but similar) database for detection process. We also measured performance of another successful face detection api, FaceRect [11] over our database which gives true positive rate of only 21.57%. Another face detection classifier trained using OpenCV [12] by Nagadomi [13] gives success rate of about 73% over our database.

When more cascades detect regions concentrated in similar region, false detection from other classifiers can be easily detected and eliminated. So, false detection rate decreases too and we found a false detection rate of 5.68% using combined classifiers. The reason behind this improvement in detection is brought about by the power of combination of classifiers, because one classifier can succeed even when others may fail. For example, for a particular image, the lower face and left face can be easily detected but eye might not be easy to detect for the classifier and it may fail to detect a certain single feature. If we used only a single

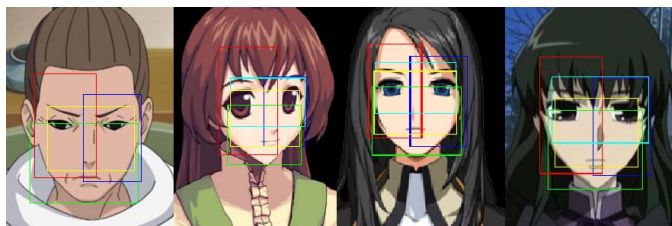


Figure 6: Detected features by the combined cascade classifiers.

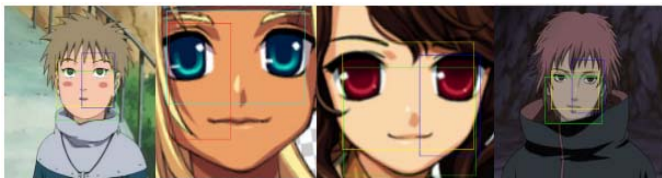


Figure 7: Some face images where only two or three features are detected. They are examples of hard cases where not all of the five features are detected.

TABLE I. COMPARISON OF THE OUTPUTS OF SINGLE CLASSIFIERS AND COMBINED CLASSIFIERS (PART-BASED AND COMBINED COMPARISON)

	Central face	Lower face	Left face	Right face	Eye	Combined
Accuracy/True positive rate	73.5%	52.94%	51.96 %	79.41%	47.05 %	89.77%
False positive rate	7.8%	3.92%	10.78 %	22.5%	7.8%	5.68%

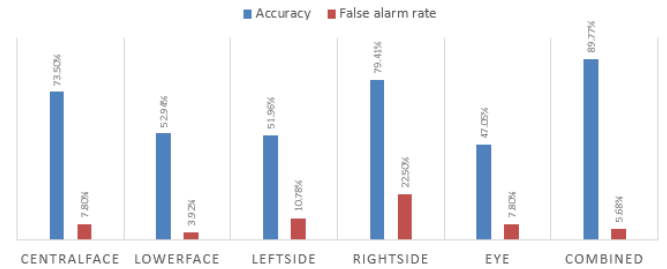


Figure 8: Output graph of accuracy and false alarm rate. Accuracy is shown in blue bar and red bar indicates false alarm rate.

cascade, this image may not be detected at all, but when a combined classifier is used, it is detected as face image as more than one feature are detected by the classifier. This overall improvement lead to fast, accurate and efficient anime faces detection.

## 5. CONCLUSION AND FUTURE WORKS

While the proposed system shows a good accuracy in detecting anime faces, the accuracy can be further incremented by using a more systematic way of training and by using a larger dataset of positives and negatives images. The method we propose here for face detection can be used for detecting faces in cartoon/animation shows as well, with little modifications.

Anime face detection can be used for various purposes, such as it can be used as a preliminary step for the process of anime face recognition, which also can be used to discover the emotional states of character from the show. This can be furthermore extended to identify the type of the show. The emotion recognition step can be useful to identify different phases of an anime show, which can be used to implement a machine learning based training system for automatic plot detection system. Anime face detection and recognition module can serve as a component of a parental control and guidance system providing advice and recommendation.

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# Break the Traffic: Traffic Condition Prediction to Find Best Suited Path Using Real Time Vehicle Information for Mobile Phone Application

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**Abstract**—Since traffic jam is a big problematic issue in today's world, it is needed to reduce this problem. The main reason behind the traffic jam is lack of actual information about the traffic. To protect the citizens from the traffic jam monster, here we propose 'Break the Traffic' which provides the traffic information to the user. The users can get the information in two ways, one is SMS-based and another is Internet-based application. Both of the systems make traffic forecast through vehicle detection in the routes and store in a traffic forecasting server. In SMS-based system, traffic information is sent to the users who subscribe the SMS-based solution. In Internet-based application, a traffic map has been developed by which pedestrians select a desired path. If the selected path addresses any change, the user is notified with that information. Based on this, users can change his/her travel routes.

**Keywords**—Traffic jam, Vehicle detection, SMS-based application, Internet-based application, Traffic map

## I. INTRODUCTION

Traveling more than 300 miles in an hour is not a dream. However, in most of the working days reaching destination right on time becomes a dream for the citizens of some cities like Dhaka. 15 years back, it was not as horrible as it is now and also it is true, 15 years from now on, only God knows how the roads and streets of the city will look like. Traffic Jam is that monster [1]. Unfortunately, for a largely populated city, it is impossible to remove in a overnight. But it may be possible to avoid traffic jam. When people move one place to another in a jammed city, there exists more than one route between the source and destination and people chooses anyone of these. Unfortunately, it is really important to choose the right path on right time, because it may help you to avoid the traffic jam. However, most of the cases people cannot get proper information about the condition of the routes. So, a system is needed by which the proper information about the traffic can be found within a few seconds in a minimum cost.

Survey says that the mostly populated cities contain large volume of traffic. For example, In 2012 the Dhaka city contains 708 thousands Vehicle population whereas 1,752 thousands vehicles are in the entire country [2]. Among those, 54% are Motor cycles, 14% cars/ taxi, 12% rickshaw, others are 16% [3]. It is also found that the number of cars/taxis are increasing day by day at a large rate. As the number of vehicles

are increasing, traffic jam is increased. So, these large number of vehicles should be maintained. Hence, a mobile application is needed which can mitigate the sufferings of the people by saving his/her time.

Although there is hardly any effective system to get rid of the traffic jam. However, some techniques have already been established [4], [4], [5]. It has turned daily trips into nightmares. Endarnoto et al. propose a technique which focuses on the people of Indonesia. They extract the traffic information continuously from the Twitter and process natural language. Based on that natural languages, authors predict how much traffic exists into a single road [6]. However, the technique is rule based which uses the predefined model to define the condition of traffic. Sugiyama et al. provides experimental evidence that the emergence of a traffic jam is a collective phenomenon like dynamical phase transitions and pattern formation [7]. Horvitz et al. propose JamBayes where Prediction, Expectation, and Surprise traffic is measured [8]. However, none of these techniques collects traffic information in an effective way rather uses information from different sources.

In this paper, we propose 'Break the Traffic' where the main goal is to develop a mobile phone application which can give a relief to the people from the traffic jam nightmares. This application can help a person when he/she feels helpless in the traffic jam. In 'Break the Traffic', at first the condition of the traffic has been extracted using Global Positioning System (GPS), CC camera and vehicle detection. For finding a condition image processing vehicle detection technique has been implemented. Based on the identified vehicles number, the traffic jam severity has been measured. If the conditions of users chosen path has been changed, an alert is sent to the user by providing the current status of that road. To provide the alert, traffic status are also taken from previous history.

The rest of the paper is organized as follows. The proposed method is described in Section II. In Section III, the evaluation of the 'Brake the Traffic' has been performed. Section V concludes the paper with future research scope.

## II. PROPOSED METHOD

In this paper, a novel traffic jam avoidance technique named as 'Brake the Traffic' has been proposed. The proposed

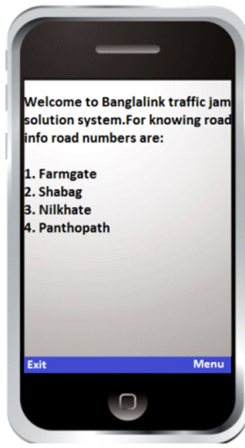


Fig. 1. Help line

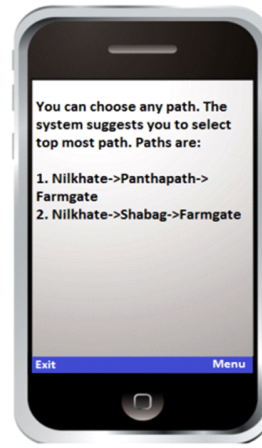
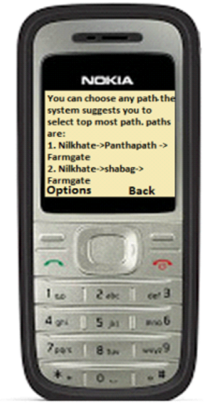


Fig. 2. Reply message



solution collects traffic information by detecting vehicles in a route and stores this information in a server. Afterwards, two types of service has been performed and those are SMS-based and Internet-based systems. In SMS-based system, all types of people specially the people who uses basic phone get the opportunity. Using Internet-based application, only smart phone users get facilities from ‘Brake the Traffic’. This proposed approach basically creates a communication between server and pedestrians so that pedestrians can easily aware of the condition of the traffic. In ‘Brake the Traffic’, pedestrians request the server to know the current condition of a specif traffic and based on that request, server replies to the pedestrians. The server also alerts the users when the conditions of the users considered paths have been changed. The overall procedure of ‘Brake the Traffic’ is illustrated in Fig. 3.

#### A. SMS-based Mobile Application

This system can be used by anyone who has a mobile phone either basic phone or smart phone. This technique is built on the concept of message passing. Here, pedestrians only send a message to the server by containing the code numbers of current location and destination. If the code numbers are not known to the pedestrians, users can send SMS to help line just typing Help for knowing the code numbers of the routes. After sending a SMS by writing "Help", a reply message is generated which is similar to Fig. 1. Based on that code numbers of the routes, pedestrians send message to the system by typing the code numbers of the routes.

For example, a customer wants to go from Nilkhate to Farmgate, she or he will send a message to a number like 9200. Provided that the message format will be  $\langle$  code number of Source Location  $\rangle$   $\langle$  Space  $\rangle$   $\langle$  code number of the Destination  $\rangle$ .

When a message is sent to the server, the system sends a reply message with all possible paths from the source to destination. Provided that all possible paths will be chosen based on the Shortest path containing less traffic jam. The

suggestion is performed based on the Algorithm 1. The path will appear sequentially on the basis of priority as shown in Fig. 2. The first one has the highest priority and so on.

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#### Algorithm 1: Selection of Effective Routes

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**Data:** Number of vehicles,  $n_{vehicles}$ ,  
Distance of Route to Route,  $D_r$   
**Result:** List of Routes,  $L_{routes}$   
 $Calculate_{jam} = (1-\gamma) \times n_{vehicles} + \gamma \times D_r$   
**while**  $Calculate_{jam} \leq \tau$  **do**  
|  $L_{routes} \leftarrow route$   
**end**  
sort  $L_{routes}$   
**if**  $L_{routes} \geq 7$  **then**  
| show the first 7 best routes  
**else**  
| show all the routes  
**end**

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After getting the list of condition of multiple traffic on the road, the users choose a best suited path and sends that path number to the system if the users want to know the update in all the time about the considered road. If any changes occur, the system notifies to the users. If one customer wants to get the update message via audio, she or he just selects the audio option otherwise text is selected by default.

#### B. Internet-based Mobile Application

In this phase, the users are informed through a Inter-based mobile application. Here, at first a traffic map has been developed. Afterwards, among two traffic points (nodes) of a traffic map is selected by clicking over those points. After selecting source and destination, users can see the entire possible shortest path between source and destination. For example, if one customer wants to see the current traffic condition between Nilkhate and Farmgate, after selecting those nodes the users can see all possible paths. If the number of possible paths is more than 7, the system will only show the

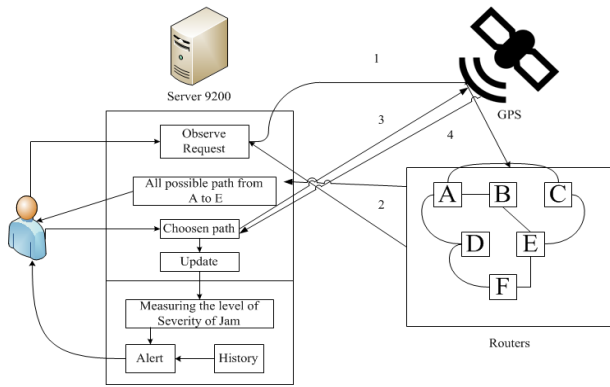


Fig. 3. Overall procedure of 'Break the Traffic'

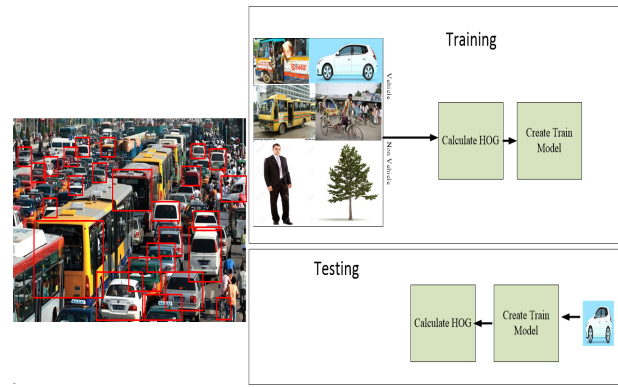


Fig. 4. Procedure of Object Tracking System

first 7 possible shortest paths. The whole process is depicted in Fig. 5.

Fig. 3 shows the overall procedure of Internet based Mobile application to know the conditions of the traffic. In Fig. 3, at first user selects routes where the users want to go. Server gathers this information and sends the requested routes information to the GPS or object tracking system. The object tracking system collects the information from the traffic and based on that traffic density has been measured. The proposed object tracking acts like Fig. 4. For tracking the vehicles, a machine learning based algorithm has been developed. Here, at first the system has been trained using multiple types of vehicles such as Bus, Cars, Trucks, Motor cycle Rickshaw, etc. For the purpose of training, HOG descriptor is used [9], [10] which is described in the next subsection. From this, a training model is developed. During the phase of testing, when a vehicle is come, HOG has been calculated for that image. For the detection of vehicles, Support Vector Machine (SVM) [11] is used. SVM classifies the images as vehicle or non-vehicle. By following this procedure, vehicles are detected and this information is used for providing the priority of the routes. The large number of vehicles represents that the route is densely populated.

These calculated information is also sent to the server. Based on that information, server colors the path of the road based on the traffic density and displays this to the users. This process is described in Fig. 5. Provided that all possible paths are chosen on the basis of Shortest path containing less traffic jam. Here, four colors have been used. Each Path is colored differently for different traffic conditions. Here, the red color means that route is highly jammed.

After finding the roads conditions, user selects one of the paths and informs to the server. After getting the chosen path, server finds continuous information of the selected routes until the user reaches his or her destination. The server alerts if any change has been occurred in the chosen routes. This is measured by using both the current information of a traffic as well as the previous history of that routes. Previous information has been considered because it may happen that a route which does not contain jam with a long period of time.

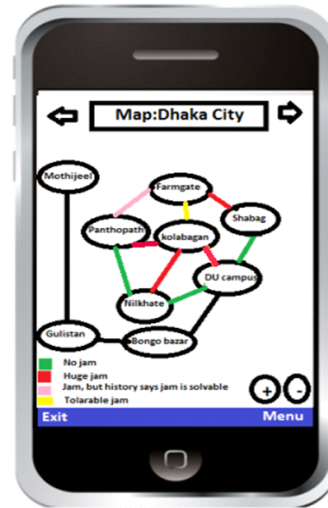


Fig. 5. Message sending process for quick service

Alert will be automatically stopped when a customer reaches his or her destination. Provided that automatically knowing a persons location is possible through GPS system.

### C. Histogram of Oriented Gradient (HOG)

The proposed solution collect information using vehicles information in a route. For vehicle detection, Histogram of Oriented Gradient (HOG) [9], [10] is used. A brief description of HOG is described in the following.

HOG takes weighted votes depending on the gradient L2-norm for an orientated histogram channel [9] of the vehicle image. HOG consists of several steps. The image is divided into small connected regions (e.g.,  $8 \times 8$  pixels) named as cells, and a histogram of gradient orientations is computed (e.g., using 1D centered derivative mask  $[-1, 0, +1]$ ) for the pixels within each cell. Each cell is quantized into angular bins based on the gradient orientation. Pixels in each cell are used as a weighted gradient to the corresponding angular bin. The histogram frequencies are also normalized using L2-norm to adapt with the variation of illumination. The final HOG descriptor is represented by combining these histograms.

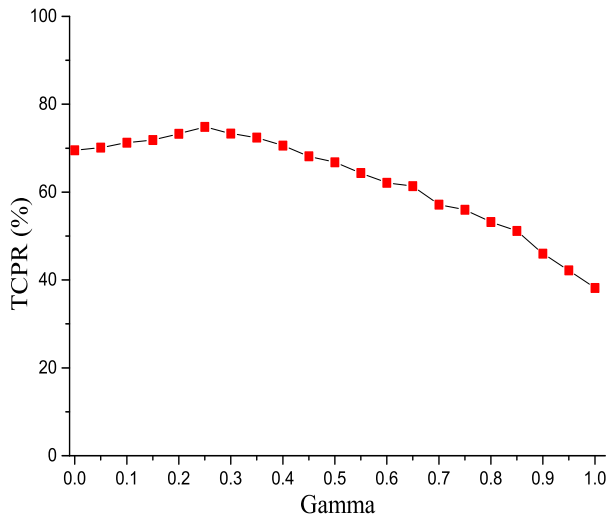


Fig. 6. TCPR for different values of  $\gamma$

### III. EVALUATION

Evaluation plan is in place to test the prototype and meet the usability requirements. To evaluate the system, we will conduct an experiment with several routes in Dhaka city. At first, we will observe the condition of Dhaka city and then a mobile application will be developed. Afterwards, the feedback of the efficacy will be collected from the citizens.

We have implemented ‘Brake the Traffic’ in the laboratory. Here, we have used the Matlab Simulink for this purpose. The simulation is performed for different values of  $\gamma = 0.25$ . We also use different density of traffic. The Traffic Correct Prediction Rate (TCPR) is measured for each simulation. TCPR is the average of the ratio of the predicted traffic rank by this system and the actual traffic ranking of all routes. The simulation results are presented in Fig. 6. This figure shows that, for  $\gamma = 0.25$ , ‘Brake the Traffic’ performs better.

### IV. THREAT TO VALIDITY

Several kinds of threats may be occurred which may degrade the accuracy of ‘Brake the traffic’ mobile based application. Some of the threats are given in the following.

- If the routes do not contain any camera to capture the scenario of the traffic.
- The image capturing devices may have low quality.
- If the camera fails to capture accurate image of traffic, then the object detection module will be failed though this is a common problem in most of the camera based application.

### V. CONCLUSION

‘Brake the Traffic’ is a personalized mobile application based on the traffic information system. Using mobile devices, users are informed about optimal routes for traveling, optimized with respect to his or her personal preferences. This notification has been performed using SMS-based and Internet-based application. If any condition occurs in any road,

the users are notified through the system. By the system implementation, the people of Dhaka city will be highly benefited. In near future, all other cities can be brought under the system by doing some minimum reconfigurations. This helps to take a decision of pedestrians which path should be considered. A smart phone application development of the proposed system is ongoing.

### ACKNOWLEDGMENT

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# Health Service for Identification of Mental Stress and Stress Factor

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**Abstract**— Mental stress is a fact of modern life. But it has a significant and negative impact on one's personal as well as professional life. Public knowledge about mental stress, medical conditions, and their evidence based treatment strategies in developing countries like ours is poorly or inaccurately understood. In this paper, we propose a smart-phone based health service system for identification of mental stress and stress factor. Here, we devised a Stress Response Inventory (SRI) questionnaire to calculate the score of personal events that increase the mental stress level. Multiple regression analysis is performed on the subsets of SRI questions to show the relationship with heart rates. We also evaluated our system by analyzing how mental stress differs for different age groups.

**Keywords**- heart rate; mental stress; stress response inventory; stress factor, multiple linear regression analysis.

## I. INTRODUCTION

Stress is a mental or psychological phenomenon formed through one's cognitive appraisal of the stimulation and is a result of one's interaction with the environment. Stress can be caused by environmental factors, psychological factors, biological factors, and social factors. An individual's reaction to the stress-causing event will determine whether the stress is positive or negative.

Mental stress occurs when we deal with high demands. All sorts of situations can cause stress such as work, money matters and relationships with partners, children or other family members. Stress may be caused either by major upheavals and life events such as divorce, unemployment, moving house and bereavement, or by a series of minor irritations such as feeling undervalued at work or dealing with difficult children. Sometimes there are no obvious causes.

Research has shown that around 12 million adults in UK consult their General Practitioners (GP) with mental health problems each year. Most of them suffer from anxiety and depression and some of them has stress-related problem. Approximately 13.3 million working days are lost per year due to stress, depression and anxiety. It is not easy to measure the effect of stress on any given individual's health or to predict how that individual will respond to it.

Now a day's, mental stress related problems are increasing rapidly. As a result, some suicidal occurrences were happened. In our country, assistant for mental stress related issues are not yet gain popularity. However, most of the developed countries provide various facilities to relieve mental stress. Therefore, in this paper, we propose a low cost health service system to identify stress and stress factor efficiently. It identifies mental stress by answering stress response inventory (SRI) questions and heart rate. SRI questions are answered by the user after successfully sign in to the application. The SRI questions are categorized in different categories such as tension, aggression, somatization, anger, depression, fatigue, and frustration. SRI scores of people from different age groups are analyzed by multiple linear regression analysis. After answering the SRI questions new heart rates are calculated and checked if it is greater than 110 or less than 60. It will reduce the deleterious effect of long term exposure to stress. It will also reduce the different service costs such as traffic cost, processing cost, doctors operational cost etc.

## II. RELATED WORK

In recent years, a large number of applications have been developed for identifying mental stress but very few low cost applications have been developed in cross platform for identifying mental stress with stress factor.

A number of physiological markers of stress have been identified, including electrodermal activity (EDA), heart rate (HR), various indices of heart rate variability (HRV), blood pressure (BP), muscle tension, and respiration [1]-[4]. Detection of acute stress by heart rate variability using a prototype mobile ECG sensor was presented in [5]. Kawachi *et al.* [6] emphasized on the fact that the higher level of phobic anxiety has lower heart rate variability. They only gave an idea of stress but there are several more reasons for which user can have stress. The authors in [7] introduced a wearable stress monitoring system that uses a stress monitoring algorithm which is not very efficient in terms of analyzing stress for different age groups. Tan [8] proposed a heart rate monitoring system that utilizes some linear regression coefficient for different age groups but the findings are not correct for all age group. Most of these systems are platform dependent and did not consider the stress factor. In contrast to these systems, we propose a cross

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platform application which will not only help to identify stress, but also to identify stress factor efficiently. In addition, it provides the facility to keep track the records of the users for future reference.

### III. PROPOSED SYSTEM FRAME WORK

In this section, we have shown the frame work of our proposed system. An application implemented in a cross platform for calculating mental stress or distortion problems can help to reduce suicidal problems and different heart related problems. Two major feature of our proposed system is (i) to identify stress and stress factor and (ii) to keep track of previous records. Figure 1 shows the overall block diagram of the proposed system that contains the two main modules.

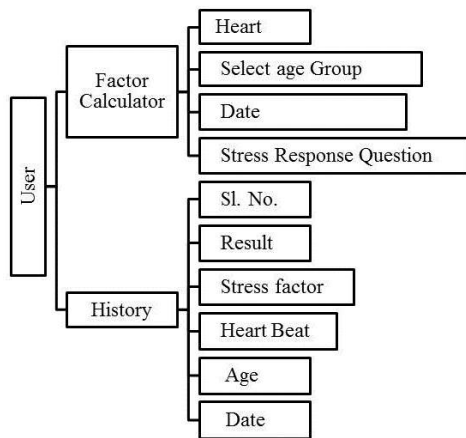


Figure 1. Block diagram of main modules of our proposed system

#### A. Identifying stress and stress factor

In order to identify the stress and stress factor users are asked to fill a form that asks about the current heart rate, user age group, date and some stress related questionnaires. These questions are reported in the references [9]-[11] done for different medical analysis and different stress related problem and are simply called SRI questions [12]-[15]. Table I contains the SRI questions with stress factor.

Users are asked to answer some questions and they should provide a grade according to the following rule: ‘Not at all’ (0 score), ‘Somewhat’ (1 score), ‘Moderately’ (2 scores), ‘Very much’ (3 scores), or ‘Absolutely’ (4 scores). The participants are divided into four age groups: 20 (20 ~29 years), 30 (30~39 years), 40 (40~49 years), and 50 (50~59 years). The SRI scores and heart rates are analyzed using multiple regression analysis.

Multiple regression analysis is performed to evaluate the relation between a set of SRI scores and heart rates at 95% significant level ( $p < 0.1$ ). For age group 20, the set of questions 10 and 13 are significantly related with heart rates ( $p < 0.1$ ). For age group 30, the set of questions 6, 7 and 13 are significantly related with heart rates ( $p < 0.01$ ). For age group 40, the set of questions 3 and 4 are significantly

related with heart rates ( $p < 0.01$ ). For the age group 50, the set of questions 4, 6 and 7 are significantly related with heart rates ( $p < 0.01$ ). After getting the answers of the questions heart rates are calculated. The calculated heart rates are shown in the Table II.

TABLE I. SRI QUESTIONS WITH STRESS FACTORS

Stress Factor	SRI Questions
Tension	1. Does your body tremble?
	2. Do you feel tense?
Depression	3. Have you lost incentive to do anything?
	4. Do you feel useless?
	5. Do you often stare blankly?
Frustration	6. Does your chest feel tight?
	7. Does your heart throbs?
	8. Do you feel on edge?
	9. Do you think everything bothers you?
Anger	10. Is your voice louder than as usual?
Fatigue	11. Do you feel exhausted?
Aggression	12. Do you act violently?
Somatization	13. Do you feel dizzy?

TABLE II. CALCULATED HR USING MULTIPLE REGRESSION

Age group	Multiple Regression	P value
20	$HR = UserHR + 9.45 * score4 - 4.6 * score6$	0.067
30	$HR = UserHR + 9.46 * score7 + 1.98 * score8 - 3.9 * score3$	0.009
40	$HR = UserHR + 3.63 * score4 - 8.5 * score6$	0.002
50	$HR = UserHR + 6.15 * score6 + 8.23 * score8 - 3.65 * score7$	0.001

These calculated heart rates are then used to identify the stress and stress factor. If HR value is greater 110 BPM for high heart rate or less than 60 BPM for low heart rate, then the user have stress otherwise the user have no stress. Fig. 2 shows the flow diagram that used to determine the stress and stress factor.

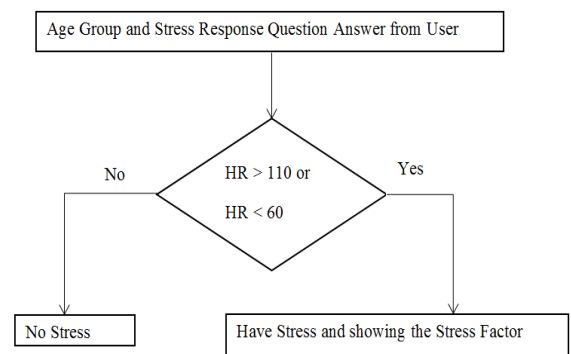


Figure 2. Detailed flow diagram of the algorithm

#### B. Keeping track of previous records

The answers of the SRI questions for each user are stored in the database. Therefore, a user can see his/her previous result to keep track of his mental stress.



#### IV. IMPLEMENTATION

The proposed system is implemented in cross-platform. Therefore, this application can be easily used by windows, android and i-phone users. Figure 3 shows the interface for different operating system. The application consists of a login window which also offers facility to sign up so that all users can have their own user profile for future reference. This application also provides password protection facility so that privacy of users is maintained. Figure 4 shows different user interface of our system.

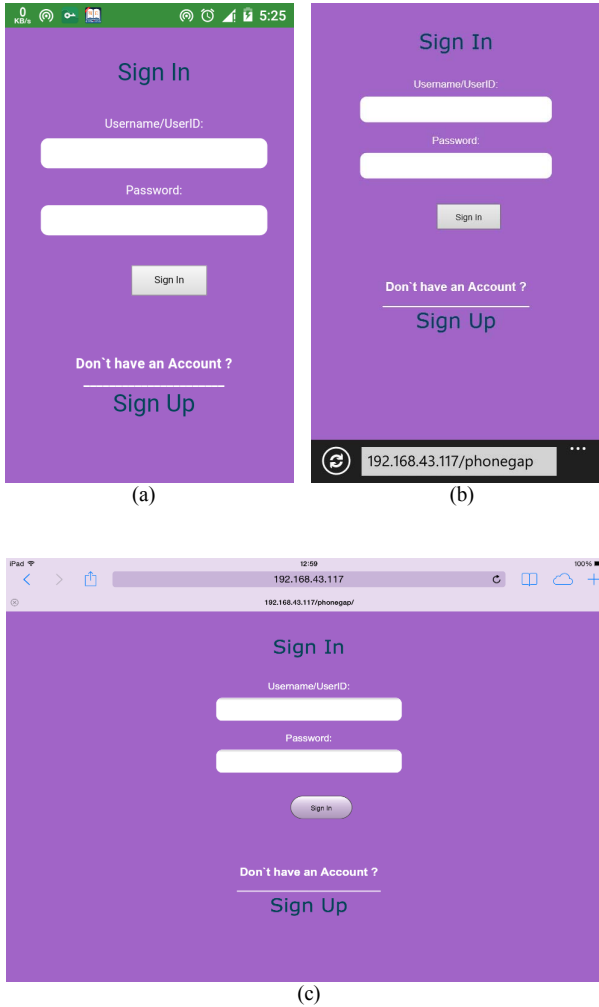


Figure 3. User interface for (a) android (b) windows and (c) iOS based mobile

#### V. EXPERIMENTAL RESULTS AND ANALYSIS

In this section, we have analyzed the results of around 120 people of different age group and gender. In addition, we have also classified the results of males and females into two categories of different age group.

Figure 5 shows various hearts rate for males and females of various age groups. From this figure we observed that as the age is increased, the man's stress is also increased. For

the age group 20, 4 out of 14 male and 4 out of 13 female have stress i.e., 28% of male and 31% of female have stress.

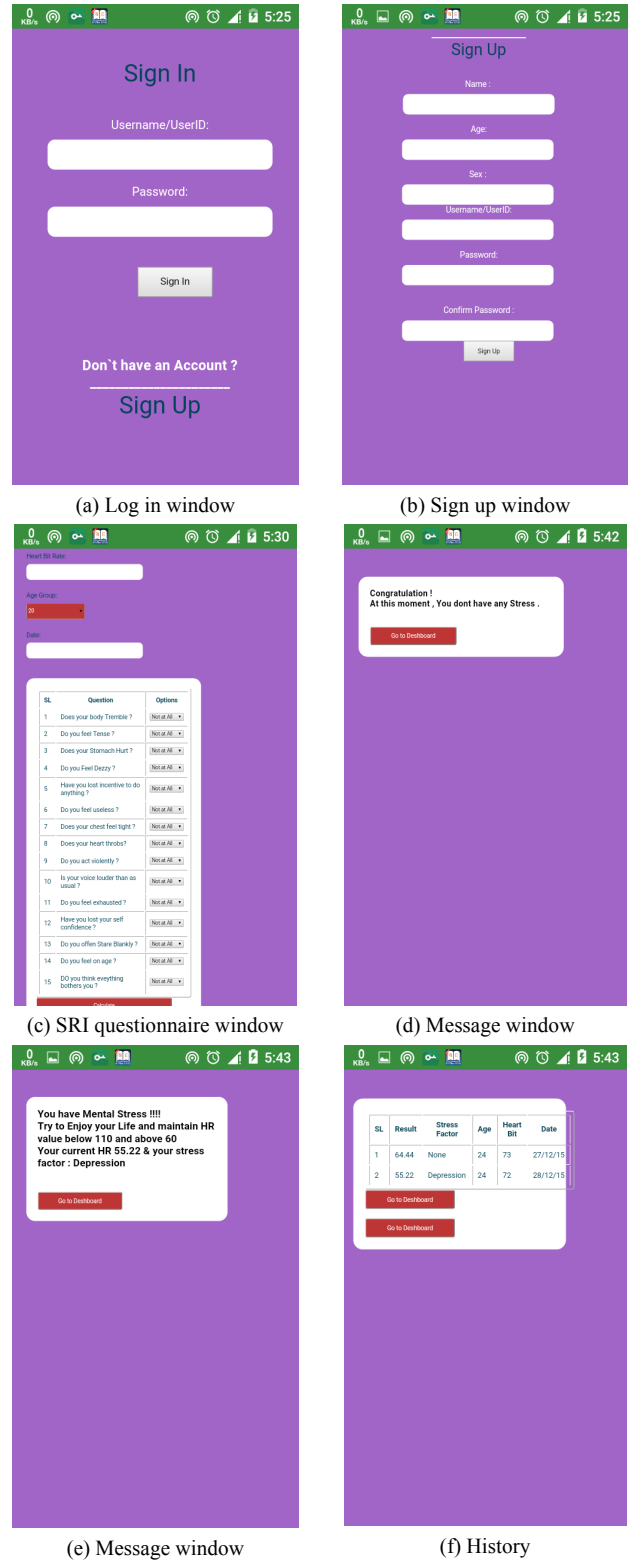
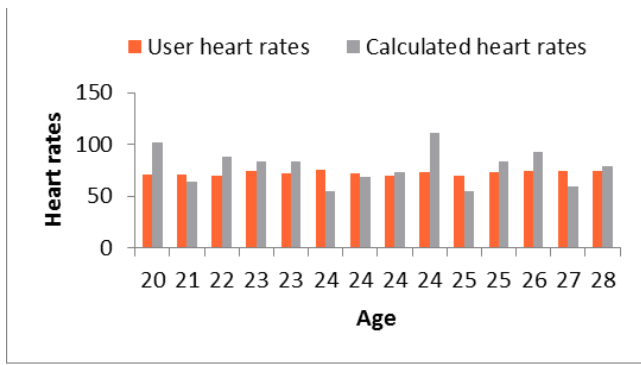
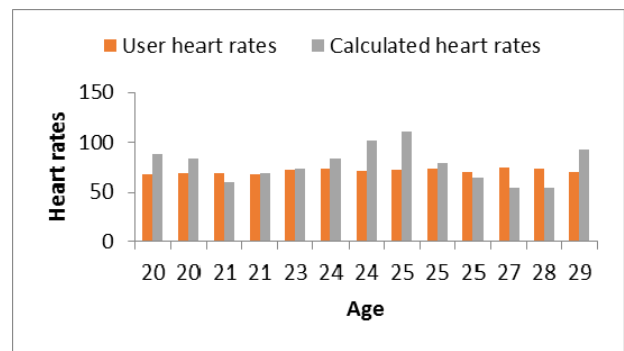


Figure 4. Proposed low cost health service application

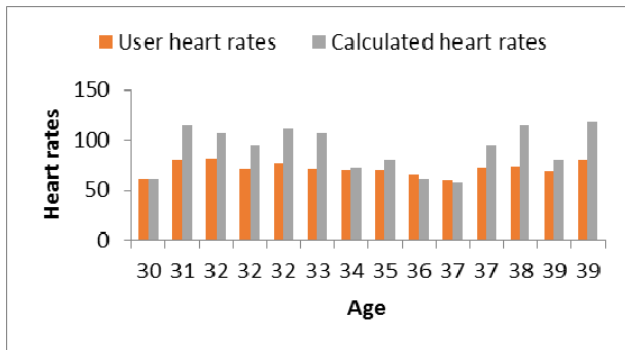
Therefore, 29.6% people of this group have stress. For the age group 30, 5 out of 14 male and 6 out of 14 female



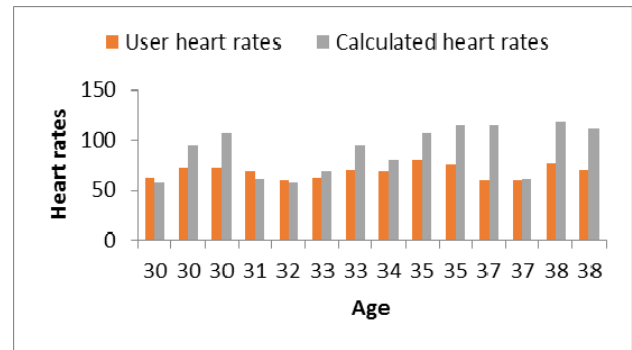
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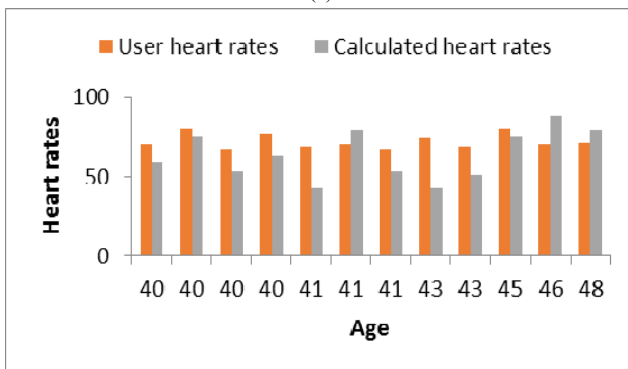
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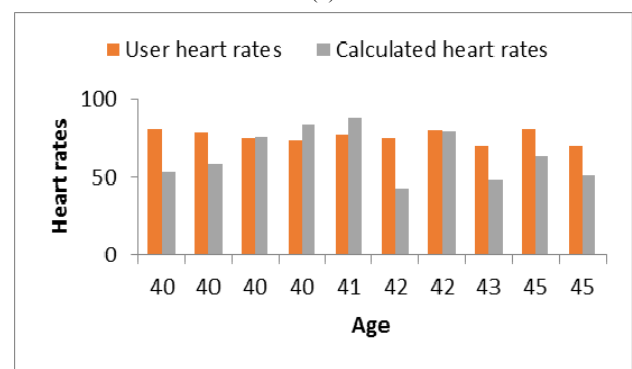
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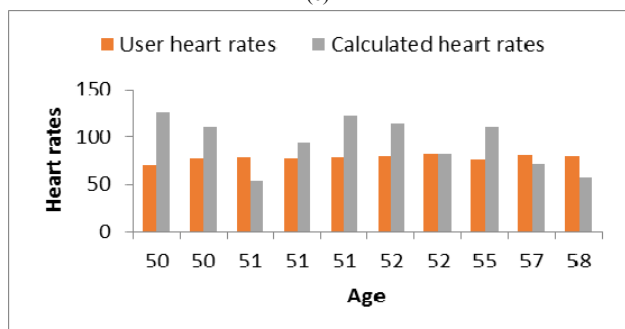
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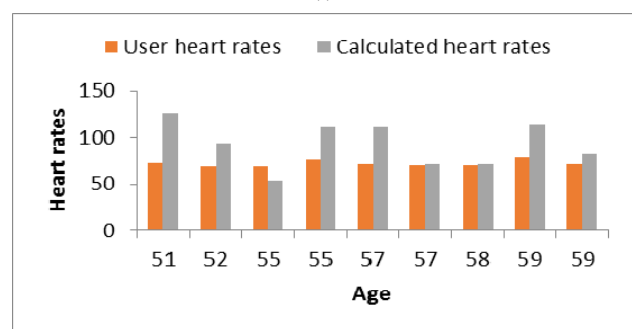
(e)



(f)



(g)



(h)

Figure 5. Heart rate of (a) males and (b) females who are in age group 20s, (c) males and (d) females who are in age group 30s, (e) males and (f) females who are in age group 40s and (g) males and (h) females who are in age group 50s

have stress i.e., 36% of male and 43% of female have stress. Therefore, 39.3% people of this group have stress. For the age group 40, 6 out of 12 male and 5 out of 10 female have stress i.e., 50% of male and 50% of female have stress. For

age group 50, 7 out of 10 male people and 5 out of 9 female have stress i.e., 70% of male and 56% of female of this group have stress. Overall, we can say that 63% people of different age group have mental stress. Figure 6 shows the

percentage of the people suffering from mental stress for different age group. From this figure we observed that the people of age group 20 have less stress than the people of age group 50.

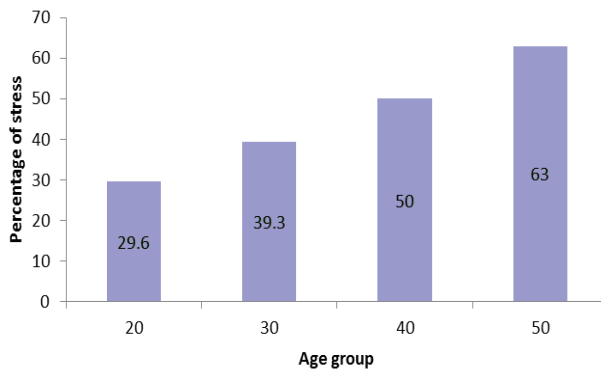


Figure 6. Percentage(%) of stress vs different age groups

## VI. CONCLUSION

A low cost automated health service system for identifying mental stress and stress factor using heart rate and SRI questionnaire was introduced in this paper. This application will help millions of peoples in Bangladesh to identify the metal stress. There is no such android, windows or iOS application through which we can calculate stress and stress related problems. The user can easily find stress without any problem. At any time he can access the application and find out his stress result. The history will help the user to maintain stress related problems. By using history he can easily maintain his stress level. It will save a lot time and will remove complexities. Most importantly this application is capable of generating a report and it will help the mass people to understand stress related problems.

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# Introducing Cache Tree to Manage Web Cache

A secondary index to reduce validation check request

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**Abstract**— Cached contents help to browse faster and also save web traffic. To use cached contents a browser have to send a validation check request to the server to check the freshness of that particular contents to be confirmed that the cached resources stored in browser cache are still fresh and users are not missing any valuable information. To complete this validation check procedure the browser and server have to communicate with each other and this includes some extra web traffics on the internet. To minimize this huge amount of requests developers may use ‘Max-age’ attribute of cached contents. But there is no appropriate value of ‘Max-age’. If the value is large than there are possibilities to loss some update and again if the value is small than the number of unnecessary request will increase. ‘E-Tag’ is an alternative solution of cache validation but it helps to check individual contents. The aim of this project is to find out an efficient and effective solution to reduce this validation check request. “Cache tree” will help to track and find any changes of cacheable contents of server side. Regular file system keeps track of all files through a table with their location, size, name and type. Cache tree will use that information and generate a tree based on the modification date of contents.

**Keywords**- Web cache, web traffice, HTTP request, internet browsing, cache management, cache tree.

## I. INTRODUCTION

Popular web sites have been browsed thousands times in a day. Most of the contents of those sites are dynamically generated [Result publication sites/ shear market] or few of them updates continuously [News portal / Blog]. On the other hand there are private, password protected data of social networking websites, Banks, E-mails and those are not cacheable.

There are some less sensitive contents on every regular websites, among them style sheets (CSS file), action scripts (javascript), images (logo/ photos) are very common and does not changed very frequently. If the administrator finds any bug or wants to alter the look or wants to add some new features then they change/update those contents. That means every sites have cacheable contents. Those cacheable contents are

being cached in cache server and locally stored in browser’s cache memory.

All cacheable contents could be distributed into different cache server. But there are some general issues related with distributed web caching architecture. Such as Extra overhead, size of cache, cache coherence problem, scalability, robustness, hit ratio, and Load balancing, low latency and so on. [1]

On the other hand web servers have to perfume lots of functionality to cautiously server the content. Here the validation check request is an overhead for server. [2]

According to HTTP Archive, amongst the top 300,000 sites (by Alexa rank), nearly half of all the downloaded responses can be cached by the browser, which is a huge savings for repeat pageviews and visits! Of course, that doesn’t mean that your particular application will have 50% of resources that can be cached: some sites can cache 90%+ of their resources, while others may have a lot of private or time-sensitive data that can’t be cached at all. [3]

The aim of this project is to find out an efficient and effective solution to reduce web traffic by optimizing validation check request.

## II. SCENARIO ANALYSIS

Suppose there is a website named abc.com and it contains few cacheable contents. User may visit those pages separately or one from other. This website contains

Content type	Cacheable content	Key content
Image file	3	1
CSS file	5	0
HTML file	0	1
Js file	2	0

Suppose there is a request for abc.com. Home page requires 12 files. According to the traditional system browse will send 12 different requests and download them to render the home page of abc.com. Among them there are 10 cacheable contents and

others are not cacheable. Browser will store/cache all of those cacheable contents.

During the second request for the same page browser will send 10 "freshness" check request to be ensured that all contents are fresh and 2 regular requests to download rest of the contents.

From the next request every request will contain 10 "freshness" check requests and 2 regular requests. Most of the time those "freshness" check requests will return with negative result. The main aim of this project is to reduce this validation check requests.

If 1 million Facebook users browse their sites 5 times in a day and each time browse five different pages in average and there are 10 files to check the freshness, then the total number of validation check request will be.

Facebook user	10,00,000
Daily visit	5 times
Number of pages	5
Number of Resources	10
Total: $1000000 \times 5 \times 5 \times 10 = 25,00,00,000$	

25cr validation check request for only one site..!! In most of the case those request returns with negative result that means there are no update for that resources. And also the servers have to process those request and send response message to the browser.

### III. HOW WEB CACHE WORKS

Every browser ships with an implementation of an HTTP cache! All we have to do is ensure that each server response provides correct HTTP header directives to instruct the browser on when and for how long the response can be cached by the browser. [3]

Follow the decision tree (Figure 1) to determine the optimal caching policy for a particular resource, or a set of resources used by your application. Ideally, developer should aim to cache as many responses as possible on the client for the longest possible period, and provide validation tokens for each response to enable efficient revalidation.[3]

These are the most common procedure are being followed

1. If the headers tell not to cache, it will not cache it.
2. If the request use secure layer(i.e., HTTPS), it won't be cached
3. A cacheable content is fresh if:
  - It has an expiry time/age-controlling header, and is still valid,
4. If the content is expired, then the origin server will be asked to *validate* it, is it good or any update is required.

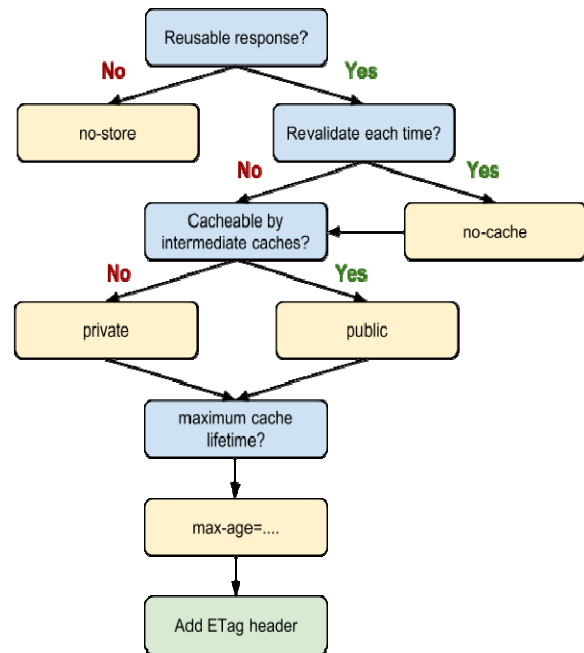


Figure 1. Optimal police for web caching [3]

Validators are very important; If no validator (an ETag or Last Modified header) is present on a response, *and* it doesn't have any explicit freshness information, it will usually but not always — be considered un-cacheable.[5]

The most common validator is the time that the document last changed, as communicated in Last-Modified header. When a cache has a representation stored that includes a Last-Modified header, it can use it to ask the server if the representation has changed since the last time it was seen, with an If-Modified-Since request.

HTTP 1.1 introduced a new kind of validator called the ETag. ETags are unique identifiers that are generated by the server and changed every time the representation does. Because the server controls how the ETag is generated, caches can be sure that if the ETag matches when they make a If-None-Match request, the representation really is the same.

Almost all caches use Last-Modified times as validators; ETag validation is also becoming prevalent.

```

HTTP/1.1 200 OK
Date: Fri, 30 Oct 1998 13:19:41 GMT
Server: Apache/1.3.3 (Unix)
Cache-Control: max-age=3600, must-revalidate
Expires: Fri, 30 Oct 1998 14:19:41 GMT
Last-Modified: Mon, 29 Jun 1998 02:28:12 GMT
ETag: "3e86-410-3596fbbc"
Content-Length: 1040
Content-Type: text/html
    
```

Figure 2. HTTP request message [4]

HTTP headers are sent by the server before the HTML, and only seen by the browser and any intermediate caches. Typical HTTP 1.1 response headers might look like figure 2.

Most modern Web servers will generate both ETag and Last-Modified headers to use as validators for static content (i.e., files) automatically;

#### IV. VALIDATING CACHED RESPONSES WITH ETAGS

When the server returns a response it also emits a collection of HTTP headers, describing its content-type, length, caching directives, validation token, and more. For example, in the above exchange the server returns a 1024 byte response, instructs the client to cache it for up to 120 seconds, and provides a validation token (“x234dff”) that can be used after the response has expired to check if the resource has been modified.

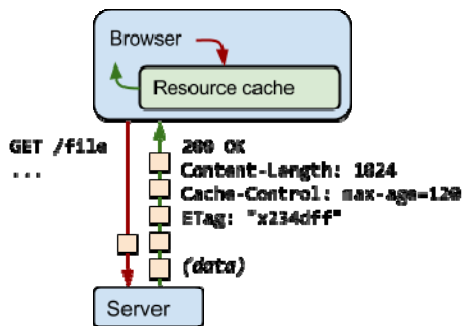


Figure 3. ‘ETag’ with response message [4]

Validation token is communicated by the server via the ETag HTTP header.

Validation token enables efficient resource update checks: no data transfer if the resource has not changed.

The client does not need to know how the fingerprint is generated; it only needs to send it to the server on the next request: if the fingerprint is still the same then the resource has not changed and we can skip the download.

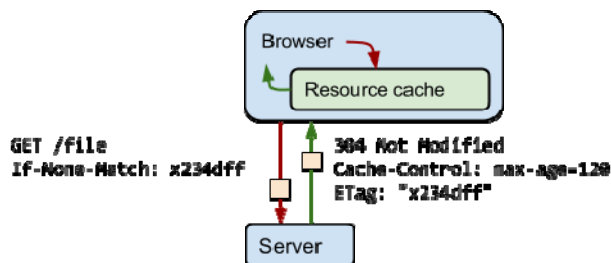


Figure 4. Content have been modified on server side [4]

In above example the client automatically provides the ETag token within the “**If-None-Match**” HTTP request header, the server checks the token against the current resource, and if it has not changed returns a “**304 Not Modified**” response which tells the browser that the response it has in cache has not changed and can be renewed for another 120 seconds. [3]

Note that here users do not have to download the response once more - this saves time and bandwidth.

The browser does all the work on our behalf. It will automatically detect if a validation token has been previously specified, it will append it to an outgoing request, and it will update the cache timestamps as necessary based on received response from the server. The only thing that’s left for developer is to ensure that the server is providing the necessary ETag tokens. [5]

#### V. PROPOSED SOLUTION

##### A. Cacheable contents

All contents will be grouped/categorized based on their properties

- All long live public cacheable content (LLpCC).
- Key content

There are different types of contents on every server. Among them some are very cache friendly and could be cached for long term (LLpCC).

- images (Logo and branding images)
- static images (Those does not change frequently)
- Downloadable Content/Media Files
- Style sheets (CSS files)
- Basic JavaScript files

There are few important contents on every websites known as Key contents. Key contents are the main part of each websites. Those key contents have to be cached very carefully and check the validation with high priority.

- HTML pages
- Content related images
- Frequently modified Javascript and CSS

Some contents are sensitive and should avoid caching, those are:

- Sensitive data (banking information, password etc.)
- Dynamic Content (based on request, result)
- Frequently changed contents (News portal)

A cache tree will be maintained as secondary index for all cacheable contents. All contents will be distributed into different cache trees. This tree will work as secondary index. A single file could be member of multiples trees. All cache trees could be categorized into two types.

- Grouped Cache Tree (required files of various types for a specific task).
- Regular Cache Tree(Based on MIME types)

Among those files LLpCC will not update frequently. Those are the static contents for a website. It may contain logo, style file and images to represent the theme of that website.

During each request all contents will be checked their freshness. This group will ensure that all required files are fresh or not. It will reduce the freshness check request and find out any changes with minimum time and process by using the cache tree.

To check any updates for a specific grouped contents browser have to send a validation check request with cached time and group name. If the last modified content of that grouped is older than cached time then no contents will be served from server.

“All contents” will contain all cacheable contents of a website. This tree will be simulated based on the file types.

**Linked list**

Modified Time | File address | Next file

All lists are connected through a linked list. List will be always rearranged based on the modification time of file. If a file gets modified then it will be inserted into first position. So always the top node is most new file or most updated file of this list.

Client’s browser will add the time last updated for each group of cacheable contents with request header. An attribute “cached-time: 15:30:00 1 Jan 2016” will be added with the HTTP request header. If any content of that group have been updated in the client side then the cached-time for that group will be changed.

1. **New user:** All contents will be sent to the clients Browser. Browser will store those file till there is no request to update those files from server.
2. **Server has update:** If server has any updates for a particular group of cacheable content. Then server will update its cache tree.
3. **Request from previous user:** previous user means, who have already browsed this site before. Client’s browsers have the cached contents. At this point there could be two scenarios.

- a. Server has new “Cacheable Public Contents”. It will compare the “cached-time” of client’s contents with the modified time with server content. If the server content is updated then new/modified contents of that group will be send to the client’s browser. All Contents will be up-to-dated, and also the cached-time will be updated.
- b. If the server has not any updates, then content will be server from browser cache and “Cached-Time” will be updated.

VI. SCENARIO ANALYSIS

Group a1 (required for page 1) requested on 5 January. All cacheable contents have been saved in browser cache.

A CSS file has been changed on 7 January and the cache tree of server side has been updated.

Group a1 is requested on 10 January. Browser will send the last updated time of server with http request. Server will compare this date with modification date of top node of list which contains all cache files for Page 1.

Server will send all content newer than "updated date".

5 January

Client Side

1.css	2.css	5.css		
Jan 5	Jan 5	Jan 5		

Server side

1.css	2.css	5.css		
Jan 1	Jan 1	Jan 1		

7 January

Server side

5.css	1.css	2.css		
Jan 7	Jan 1	Jan 1		

10 January

Client side:

Send request with “Last Update date: Jan 5”.

Server side:

Receive the request and send all newer content than Jan 5. Here “5.css” is newer.

Server will send the file to the client and client will also update its cache tree.

Client side:

5.css	1.css	2.css		
Jan 7	Jan 1	Jan 1		

15 January

Client side:

Send **request with** “Last Update date: Jan 10”.

Server side:

Will receive the request and checked it with the modification date of top node of Group a1.

If the modification date is same or older than no data will be send.

A negative response will be send. (8 different request and response messages have been resolved by only one request and response message. Here it also saves the server processing time)

File compression technology could be used to reduce more web traffic. If there are more than one newer file than we may send only one compressed file.

## VII. CONCLUSION

Web traffic of internet is growing day by day. Fetching contents over internet from server is not only slow but also expensive. Caching is a vital issue in aspect of optimizing the performance of internet browsing. Every website will maintain their own cache tree in both server and client side. This tree will help to find out any update in server side and check the freshness of client side contents in an optimized technique.

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# Android Apps Commanding Intelligent Service Robot (ASSIBOT) For Office Work

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**Abstract-** This Paper describes the concept of an office assistant robot (ASSIBOT) find its destination by following line. The task of this robot is to carry anything (files, documents, office accessories even snacks, tea or coffee) in an office environment. In order to complete the ASSIBOT's function, we integrated advanced line following concept, obstacle sensing, display system and an android apps to command the ASSIBOT. We used an IR sensor array to sense the line and a proportional integral derivative (PID) controller to follow the line. Interfacing of PID controller gives the robot fast and smooth motion. To avoid unexpected collision on robot path with any obstacle, ultrasonic sound sensor is used. Smart display system shows the file information and the current position of the robot. We also develop android apps to send command to the robot.

**Keywords:** Smart Office, Sensors, Android Application, Automatic Charging System.

## I. INTRODUCTION

Since the middle of the 20<sup>th</sup> century, robotics has become an essential component of the production industry and this field keeps growing. However, the next major challenge for robotics concern application for office environment and personal use. So we try to develop a robot which can serve human to transfer office document or any things from room to room. But to run a robot towards correct direction is a challenging task. To solve this problem we use line follower concept. A line follower robot is an autonomous robot that can move by tracking a line of white color on a black surface or vice versa. The idea of this project is to apply this principle of line following, the robot can be used as a service system. After transferring the file robot automatically returns to its station and connects itself in an automatic charging system. The robot can be controlled through an android application which is made the robot much more human friendly. For a busy corporate office, this robot could be an essential part.

## II. RELATED WORK

Some related application of line following robot are [7] 'Line following robot for library inventory management

system' published in Emerging Trends in Robotics and Communication Technologies (INTERACT) 2010 International Conference, [8] 'Development and Applications of Line following Robot Based Health Care management system' published in International Journal of Advanced Research in Computer Engineering and Technology (IJARCET) Volume 2, Issue 8, August 2013. [11] G. H. Tian, X. L. Li, S. P. Zhao, et al., "Research and Development of Intelligent Space Technology for Home Service Robot," Journal of Shandong University: Engineering Science.

## III. METHODOLOGY

An Array of infra-red sensors is used for tracking the line. The sensor is placed in front of the robot body. An Arduino Mega2560 is used as control part of the robot. It processes the data from sensors and sends to the motor driver which drives the motor. An ultrasonic sound sensor is also placed at the front side of the body to avoid obstacle. The display always shows its current location and the location it come from which is very informative. A proposed 3D view of the robot is shown in Fig.1.

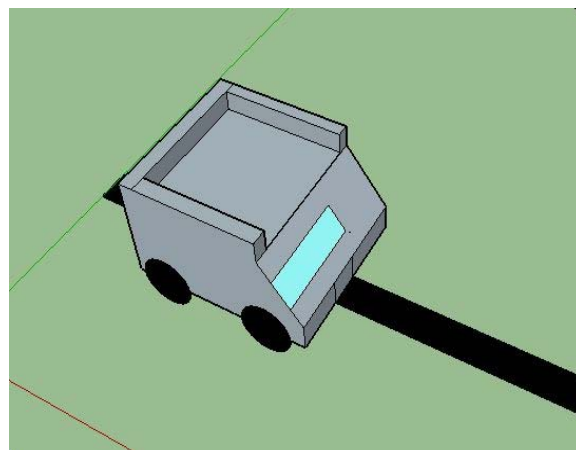


Figure 1: 3D View of Robot

The entire robot task can be controlled by an android application. The android application is connected to the robot through Bluetooth. A 6v rechargeable battery is used for the power source of the robot. Fig.2 shows the actual robot body.



Figure 2: Actual Robot Body

#### IV. DESIGN CONCEPT OF THE ROBOT TRACK

The track for the robot is designed such a way that the robot can serve office people within a short time. In office, the robot track should be placed where people do not usually walk. However, ASSIBOT's have the ability to avoid sudden collusion. The Fig.3 shows a simple robot track for an office. The track consists of a white semi-gloss painted road, with a centered black line of 2.5 cm to 3 cm wide. But the robot track can be change as per the office requirement. Fig.3 shows the robot track.

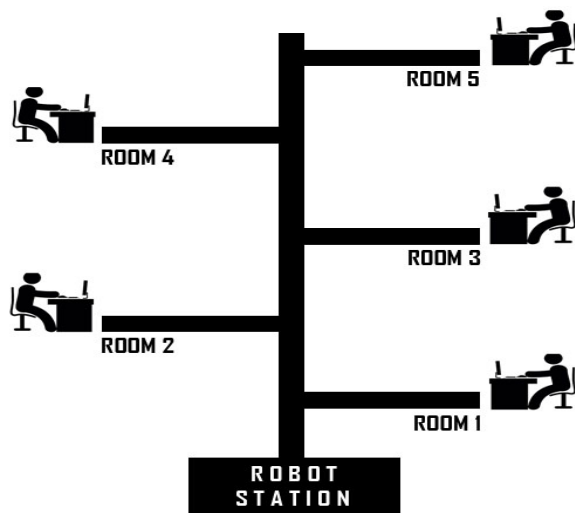


Figure 3: Robot Track in Office Environment

#### V. ROBOT CONTROLLER

A microcontroller is a small computer on a single integrated circuit containing a processor core, memory and programmable input/output peripherals microcontroller are used in automatically controlled devices. An Arduino mega2560 prototype board is used to control the robot. This is a micro-controller board based on ATmega2560 with 256KB Flash memory (of which 8KB is used by boot-loader), 8KB of SRAM, 54 digital I/O pins (of which 14 provide PWM output), 16 ADC, and clock speed of 16 MHz and so many features from the data-sheet. The board operates on 5v DC. The controller board processes the data from the sensors and sends the control data to the two DC motors. Fig.4 shows the control board.

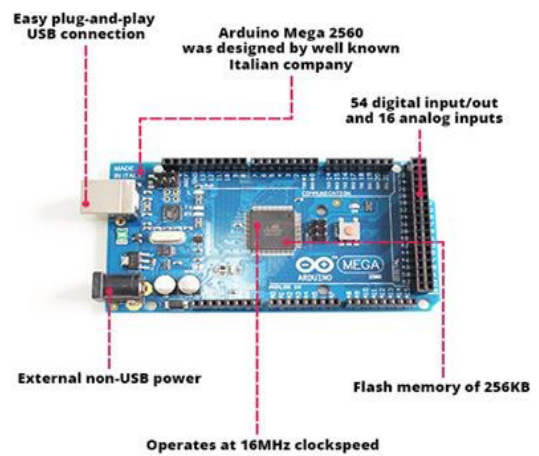


Figure 4: Arduino Mega

#### VI. TRACK DETECTION SENSOR (INFRA-RED LIGHT)

The sensor array is used to trace the line. The sensor module is based on Infra-red light. The module contains 5 pairs of infra-red light emitter and receiver. A sensor module and its working principle shown in Fig.5

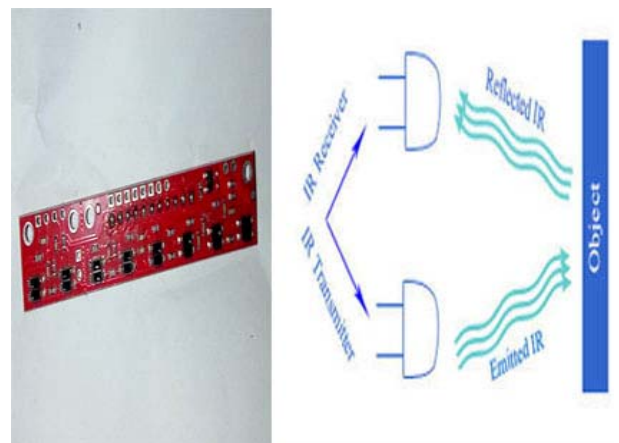


Figure 5: IR Sensor

## VII. ROBOT FEATURE

### A. Obstacle Avoidance

There are varieties of sensor available those can be implemented for detection of obstacle. Some of the very popular sensors are: Sonar, Infrared sensors, Cameras, which can be used as a part of Computer Vision, LIDAR which can directly measure the distance of thousands to hundreds of thousands of points in its field of view. Since reduction of cost is an important factor in the design of robot so we used sonar or ultrasonic sensor. We do not use Infrared sensor because they are usually most effective (though this depends on particular makes) at between 10cm to a maximum of about 1m. Fig.6 shows an ultrasonic sensor and its working principle.

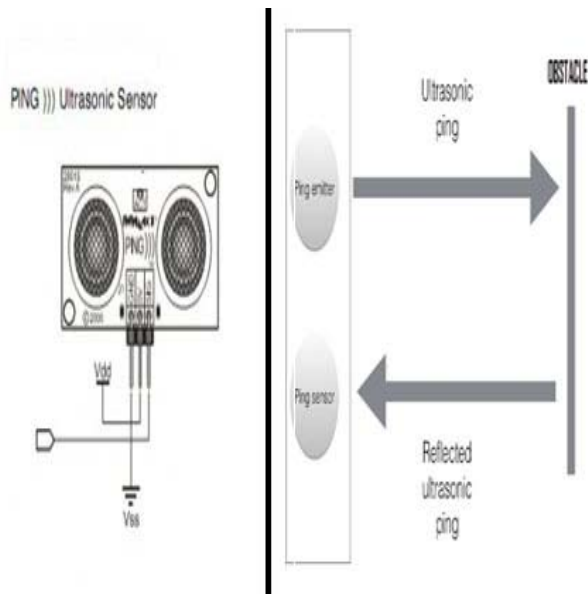


Figure 6: Ultrasonic Sensor

### B. Automatic Charging System

Powering robot is a big problem here. To keep robot 24/7 functional, the robot power supply need to continuous charging system. So we design the robot in such way that after doing the given task the robot back to its station and connect itself to the main power supply which keeps the robot battery charged.

### C. Android Application

To control the robot we have built an android app named "ASSIBOT". Moreover, it is an essential feature of robot. We used Bluetooth communication for overall controlling the robot. A Bluetooth module is added to the robot to response to the users call. When the robot is in no order condition, it will be standby on its station. Firstly, the work one has to do is that he will have to switch on his smart phone's Bluetooth connection. Secondly, he will have to

start the "ASSIBOT" app. Then, he will have to press his room number to call the robot to his room. After receiving the call, robot will response to the caller and arrive to the room following the call. The caller post his file to the robot now and then he will have to press the room number where robot will start going towards the room where it is destined. After arriving that file to its destined room, it will go to its station and will wait for the next call. It is noted that each of the members must have to have the 'ASSIBOT' app in their smart phones to utilize the robot as office works. Fig.7 shows the android application

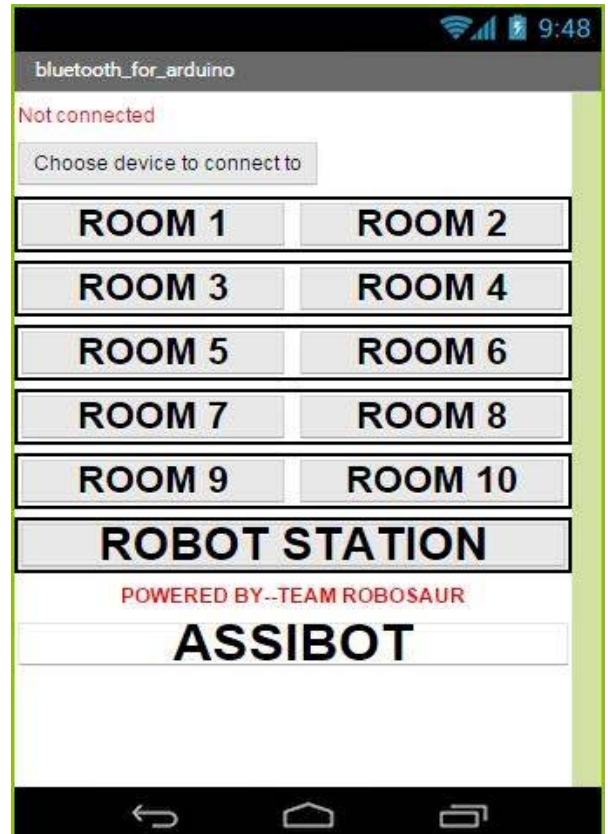


Figure 7: Android Application

### D. Smart Display

At the very front side of the robot a LCD is installed. The display will show the present activity of the robot. It'll show the "STATION" while the robot is in no order condition. When the robot will get any call from any room, it will show the caller room number in the LCD. Whenever, it'll get tasks to the caller's room to the destined room, it'll also show that room's number in the display. As for example: A caller calls the robot from room number "1", the robot's display will show "ROOM: 2". Let, he wants to send the file to the room number "5". The robot's display will show "ROOM: 2 to ROOM: 5". From this, one can know from which room the file is sent to which room. Fig.8 shows the display system.



Figure 8: Robot display

### VIII. CONTROL DIAGRAM

Overall control of the robot is shown in figure in a block diagram.

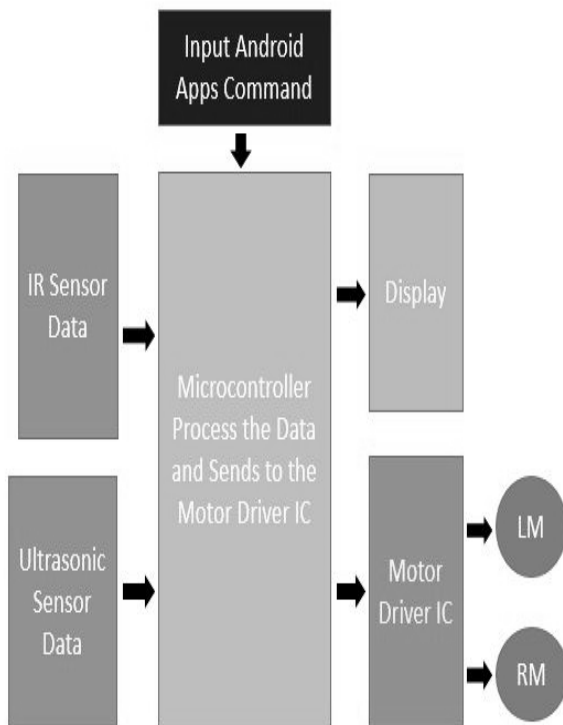


Figure 9: Block Diagram

### IX. MOTOR DRIVER

Since the DC motor consume more current, a driver circuit is needed to provide the amount of current. The driver is L293D integrated circuit. It accepts the standard TTL logic levels and drives inductive loads (such as relays, DC motor, solenoid etc.) The device is a switching power transistor. It draws 600mA output current per channel, and operating through 5v to 36v. A several pin configuration of the driver is shown in Fig.10

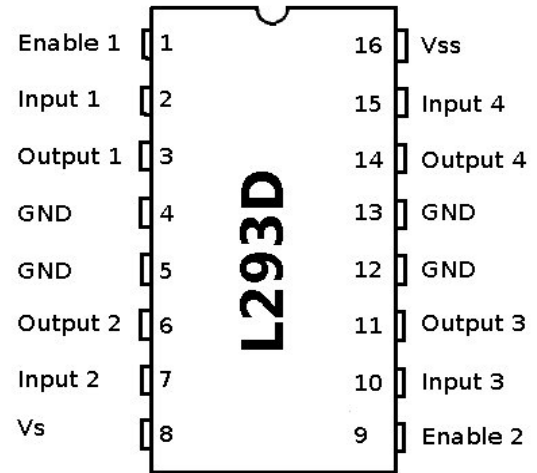


Figure 10: Motor Driver IC

### X. DISCUSSION

The performance of ASSIBOT in an office environment is quite satisfactory. Further study and development can be implemented to this kind of robot. They are

1. A video camera and image processing software can be used to detect human face.
2. Speech recognition technology can be installed for better communication with human.

### XI. CONCLUSIONS:

The service robot is used in many fields such that from the industrial level to domestic service. We succeed in satisfying the typical requirements on office service robotics: low-cost, short time to serve, reliability to perform in real world setting. Automation makes the life easier and reducing the time. This autonomous robot is also reducing the time and makes proper utilization of technology.

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# INTELLIGENT VEHICULAR TRAFFIC CONGESTION CONTROL SYSTEM FOR BANGLADESH

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**Abstract:** Growing number of road users and the limited resources provided by current infrastructures lead to ever increasing travelling times. A densely populated country like Bangladesh is facing problem with the traffic congestion that yields so many losses. Intelligent traffic congestion control system may be used to overcome this problem. In this paper, the development procedures of a system are demonstrated. The system enables the identification of congestion in an area through the use of sensors/detectors and cc cameras and processes the data in an intelligent way and generates the necessary instructions to the organization concerned. In this paper, the design of the components of the system is shown. Some scenarios about its applicability are also demonstrated here.

**Keywords:** *Intelligent Transportation System, Vehicle Infrastructure Integration (IVI), Intelligent Traffic Congestion Control System (ITCCS), Logic Programming, Logic Control Strategy.*

## I. INTRODUCTION

Road traffic congestion is a significant and growing problem in many parts of the world. Several systems have been proposed and some are also deployed to solve congestion like Intelligent Transportation System[1, 2, 3], Vehicle Infrastructure Integration (VII)[4,5] etc. Most of these systems are not financially feasible for the developing country like Bangladesh. Bangladesh has transportation system that operates manually. This system is little capable to handle today's huge traffic congestions / But this manual system cannot handle the congestions. In this paper we propose an Intelligent Traffic Congestion Control System (ITCCS) for the capital city of Dhaka, Bangladesh. This system is cost effective and can handle congestion intelligently. It does not require significant change of current transportation infrastructure of Dhaka.

### A. Road Transport System at Bangladesh

Bangladesh is a very densely populated country with 150 million peoples living in an area of 147570 sq. km. 26% of them live in urban areas. [6], which is very critical in the transportation point of view. Although Bangladesh is a land of rivers, road transport also plays an important role in terms of communication. The number of registered motor vehicles on road increased

steadily by 50% over the last five years from 9,29,760 in 2008-2009 to 13,96,226 in 2012-2013.

Dhaka is the capital city of Bangladesh. At present, its population is 13 Million with a growth rate of 8 percent per annum. Dhaka shares 8 percent of total country population and 33 percent of total urban population of Bangladesh. Road network of Dhaka consists of 3000 k. m. (with only 450km primary & secondary collector roads) length of roads. The total number of road vehicles of Dhaka is nearly 250,000. Due to over-densed population, increasing number of vehicles, poor traffic management system and three-wheel manual rickshaw, traffic congestion in Dhaka city is increasing day by day.

### B. Affects of Traffic Congestion at Dhaka city

Congestion causes loss of time, waste of resources, loss of worker productivity, delivery delays, and increases costs. According to the report of Dhaka Urban Transport Project of World Bank [7], Dhaka is becoming one of the largest cities in the world. With 13 million people, it is also one of the most traffic congested city. By 2020, the mega city's population is expected to rise to 22 - 25 million.

This rapid population growth together with the limited space available for new transport infrastructure will further aggravate the heavy congestion in Dhaka. Dhaka already has one of the highest traffic fatality rates in the world. For example, there was a severe traffic jam from 11 a.m. to 2 p.m. from Chawk Bazaar to Mitford area in Dhaka, where around 400-450 vehicles were waiting and there were two to three thousand people in those vehicles [8].

These kinds of intolerable traffic congestions of Dhaka City have become an everyday certainty and a nightmare for the city dwellers. Cost of congestion and accident is Tk 3,000 crore (US \$ 520 million) per annum [9].

Therefore, congestion controlling mechanisms are urgently needed.

### C. Some Methods to Control Congestion

The Organisation for Economic Co-operation and Development (OECD) established an expert panel to study and report on the worldwide state of the practice for traffic congestion control and demand management

[4, 5]. There are several systems that are being used and being proposed to solve congestion. Some of them are discussed below.

*i. Intelligent Transportation System (ITS)*

Intelligent transportation systems, or ITS, encompass a broad range of wireless and wired communications based information, control and electronics technologies [10]. When integrated into the transportation system infrastructure, and in vehicles themselves, these technologies help monitor and manage traffic flow, reduce congestion, provide alternate routes to travellers, enhance productivity, and save lives, time and money. The ITS is promising, but yet it is futuristic. In the context of Bangladesh, it may not appropriate at present.

*ii. Vehicle Infrastructure Integration (VII)*

It consists of Intelligent Vehicle Initiative (IVI), Operation Level and Telecommunications Technology. In this system, communications from vehicle-to-vehicle, satellite to vehicle (through GPS), vehicle to roadside are needed that are very costly for Bangladesh perspective.

*iii. Manual System*

The existing transportation system of Dhaka city is manual. The traffic signal control is done by traffic police or by signal lights with fixed time intervals. This system fails to control present traffic congestion at Dhaka. Hence, we need a system that will be cost effective as well as able to handle the congestion of Dhaka city. The conventional approach of “building more roads” is not feasible for socio economic reasons of Bangladesh. Rather, we propose a system that will use the existing road network and traffic infrastructure more efficiently and intelligently. We refer it as Intelligent Traffic Congestion Control System (ITCCS).

**II. INTELLIGENT TRAFFIC CONGESTION CONTROL SYSTEM (ITCCS)**

In existing system, when congestion occurs on an urban ring road or a highway network, then often local control is not sufficient anymore and measures on the network level are necessary to adequately deal with congestion. Selecting the appropriate measures is a difficult task for the operators in the traffic control centres. This entails estimating and predicting the effects of certain control measures on the traffic situation in the entire network. Moreover, the operator should have a good insight in the range of control measures that are available, and should be able to quickly perform an analysis of the current and future situation and then select the most appropriate measures. In general, the outcome of this process will depend heavily on the experience of the operator. Furthermore, the decision process is not structured and not uniform. Therefore, there is certainly a need for a system that can help the traffic operators. The inputs for the ITCCS are the current traffic situation (traffic densities, average speeds,

traffic demand, time of day, weather conditions, incidents, etc.). Based on the measurements, historic data and traffic simulation, the system predicts the future traffic situation. If necessary, the simulation can be repeated for several combinations of control measures. Afterwards, the operator can select the most appropriate control strategy.

*A. Architecture of ITCCS*

Our proposed ITCCS is designed based on two strategies:

The first one is the traffic signals of road intersections will be controlled intelligently considering the traffic volume of particular roads of intersection area and the other one is additional roadside signals will be used to inform whether there is incident/congestion ahead. So the vehicle drivers can use alternate route if there is incident/congestion ahead.

A Traffic Management Centre will monitor and Control the road network’s signal lights and roadside signals as shown in Fig. 1.

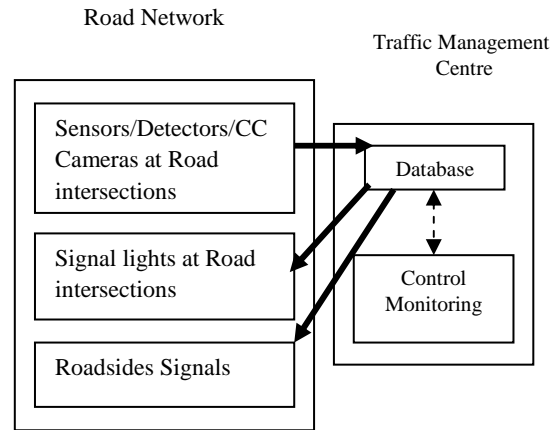


Fig. 1: Physical architecture of ITCCS

*B. ITCCS components*

ITCCS components can be divided into Physical and Logical parts.

*i. Physical Components*

As shown in Fig. 1, physical components comprises of:

- Sensors/Detectors provide information on average traffic speed and volume.
- Closed-circuit cameras at intersections provide live video information on traffic flow.
- Roadside signals inform vehicle drivers about incident/congestion ahead so they can choose alternate routes.
- The Traffic Management Centre is the supervisory authority for overall system.

*ii. Logical Components*

The logical component, as depicted in Fig. 2, is composed of different modules:

- Control Module requests traffic data, executes the logic program and produces the control decisions.
- Monitoring Module continuously monitors the performance of the control and the traffic detection system, notifying and recording any change of state in the system.
- Diagnostic Module checks the functioning of the cameras and of the detectors.
- Database Module: all the information on the state of the system (the traffic volumes, the diagnosed errors, and the signal setting parameters) are sent from each module to this module, which stores the data for future analysis in a relational database and produces synthetic reports.

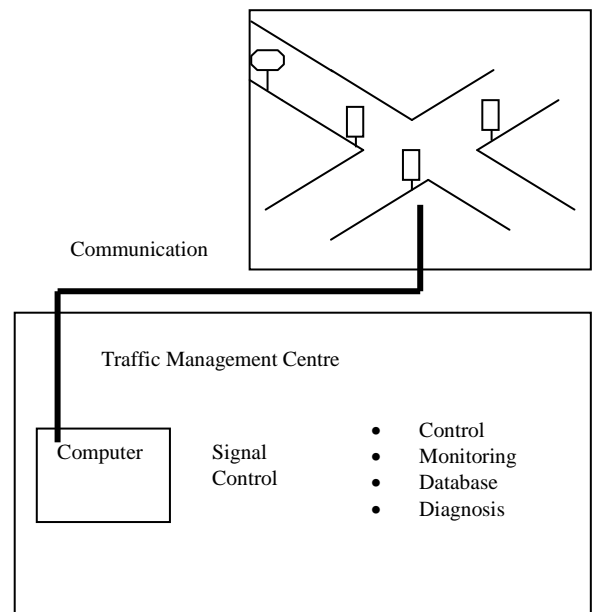


Figure 2: Components of ITCCS and their communications

### C. Operation Levels of ITCCS

The operation level of the purposed ITCCS is depicted in Figure 3. It has three levels. The Sensor/Detector level is responsible for input to the system. The Data level responsible for signal control programs and databases. The knowledge level tasks are to represent knowledge and to make inference. The data level and knowledge level processes the inputs and thus the system make intelligent decision regarding traffic light control at intersections and roadside light control. The knowledge layer supports development and on-line use of models of knowledge and expertise of traffic operators on the controlled area. It allows improving several traffic monitoring and management operations, including:

- Estimation of traffic load levels in space and time all over the network
- Analysis and understanding of traffic demand and routes in the area
- Detection (prediction) of critical traffic situations and bottlenecks
- Selection and implementation of congestion avoidance/reduction strategies.

### D. A Logic Programming Approach to Traffic Control in ITCCS

We describe the main components of the proposed system for traffic control in this section. The system uses of logic programming and has a decentralized nature. Independent control units, each associated with a single intersection in the network, receives as input traffic data related to the roads approaching the associated intersection.

The first step in the formulation of the control strategy is to describe the traffic status via a set of input logic variables that, depending on the output of the sensors, may assume either a true or a false. A second step is to enrich the description of the traffic status by means of additional logic variables whose values depend on the input variables and on some of the logic statements that compose the control strategy. We call these two types of variables as state variables. As a third step, the decision variables are to be defined. These variables represent the control decisions and are typically associated with the decision of transition from the current phase to another phase of the signal cycle. By combining state and decision variables a set of logic statements is created, using the standard rules of propositional logic [11, 12, 13]; for example, if  $I_1$ ,  $I_2$ ,  $I_3$ ,  $I_4$ , and  $I_5$  are state variables and  $D_1$  and  $D_2$  are decision variables, the following logic statement can be assembled:

*if  $I_1$  and  $I_2$  and  $I_3$  and not  $I_4$  and  $I_5$  then  $D_1$  or  $D_2$*

A set of logic statements such as the one described above forms a logic program representing the control strategy. The control strategy is in charge of producing, at regular time intervals, a control decision, i.e., of deciding whether to change the configuration of the signal lights or not. This task is accomplished using theorem proving in propositional logic. A control unit, where the logic strategy is put into action, is associated with each signalized intersection.



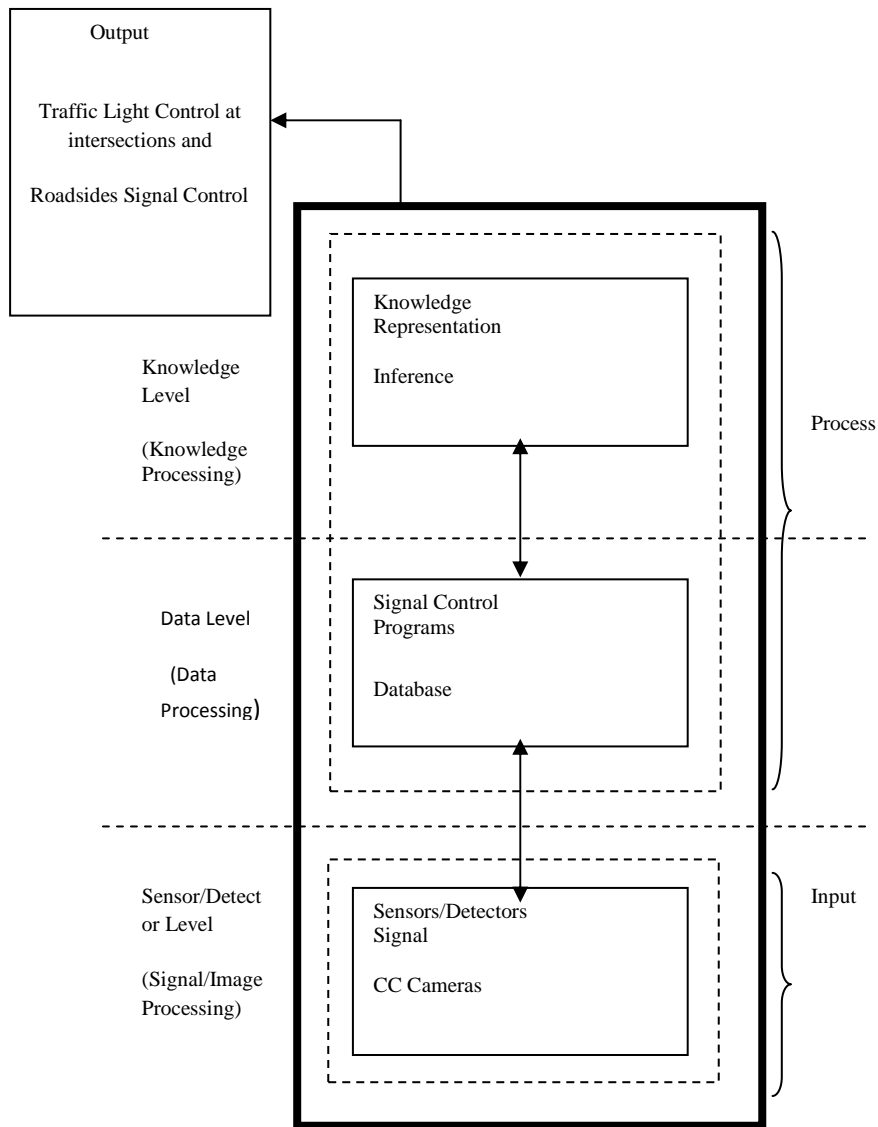


Figure 3: Operation level of ITCCS

#### E. Logic Control Strategy

Cameras provide, in real time, counts and occupancy times for presence detectors and queue detectors placed at the intersection. Every three seconds the data from the detectors is translated into logic values, the logic program is executed and a new control decision is made. The logic variables currently used are associated with the stretch of road close to the signal (approx 0 to 40 meters.) and to the next one (approx 40 to 100 meters.), for each one of the 4 approaches of the intersection. The logic program to develop for may be structured as follows:

- Volume logic statements: these statements are used to derive the true / false values of the logic variables that represent traffic levels from the counts provided by the cameras;
- Control logic statements: these statements associate the traffic levels to

the decisions of changing the current phase or changing the structure of the current cycle (2 or 4 phases); they can be subdivided into:

- *maxtime* logic statements, which decide to change phase when the maximum time allowed for the current phase is expired;
- *congestion* logic statements, which decide to change phase when there are many waiting vehicles;
- *empty* logic statements, which decide to change phase when there are few vehicles using the □current green phase;
- *camera* fault logic statements: the cameras have frequent faults and erratic behaviour. A diagnostic system is capable of detecting these problems and telling the control unit if a camera is not

working properly. In this case, certain statements produce an estimate of the traffic levels for the cameras that are not working; such an estimate is based on traffic volumes on the other approaches, on phase time, and on historical data.

### III. SOME CASE SCENARIOS

- We show some of the case scenarios using our proposed ITCCS as shown in Figure 4.

#### *Intersection I3 -There is Congestion Already:*

Vehicle V1 suppose to go its destination J from its current location B through the route B-I2-C-I3-F-I6-J. But there is congestion at I3. So this vehicle should find substitute route B-I2-I5-I-I6-J. A signpost S will inform the vehicle (by giving a sign produced from Traffic Control Centre) that

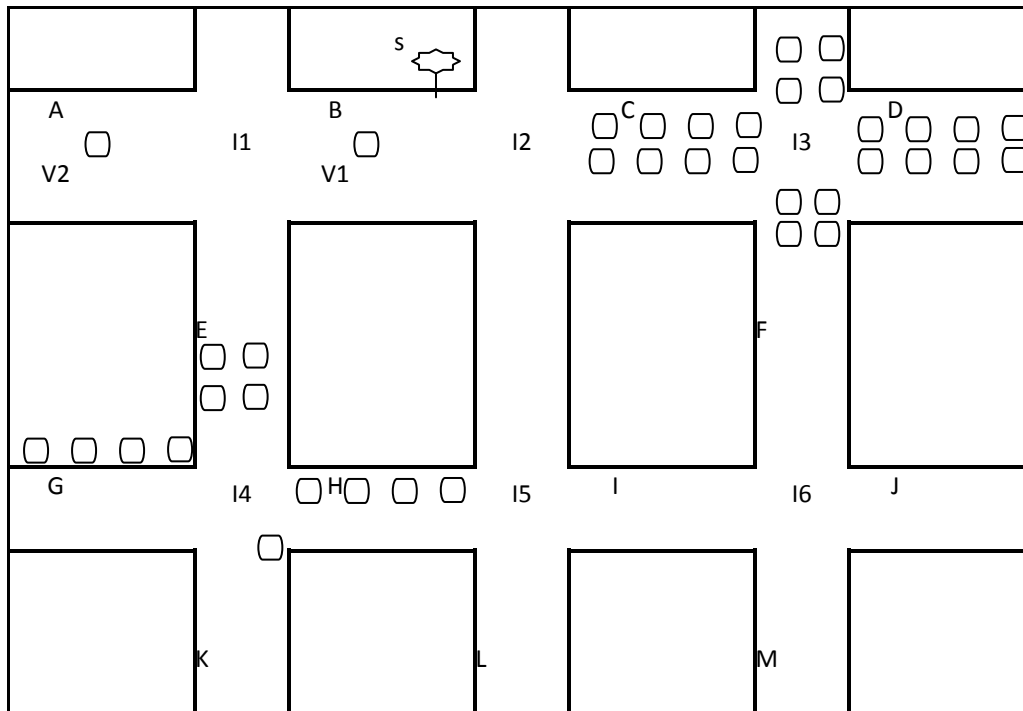


Figure4: Some case scenarios applying ITCCS

there is congestion at intersection after I2, i.e. I3. The route I2 to C will be blocked showing red sign at I2 till the congestion will be over at I3.

#### *Intersection I1- Low Traffic Volume:*

The traffic light will be green for A-I1-B and B- I1-A routes as ITCCM detect low traffic volume there.

#### *Intersection I4- Variable Traffic Volume at Different Roadside:*

Routes G-H and H-G have more traffic volume than that of E-K and K-E. So, ITCCM will enable the green light for longer period through G-H and H-G for a suitable time to clear the longer traffic volume.

### IV. CONCLUSION

In this paper, we have presented Intelligent Traffic Congestion Control System (ITCCS). This system does not require building up more

roads. Also there is no need to go for major infrastructure changes. It can replace the existing manual system for traffic control at Dhaka City and can handle the congestion intelligently. The system can be applied in other parts of the world as well. The system could form a basis to develop a robust intelligent-based decision technology in the near future.

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# Performance Study of n-type Quantum Well IR Photodetector (QWIP) for Different Heterostructures: A Review

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**Abstract**—Due to mature fabrication technology and uniformity in large focal plane arrays (FPAs), quantum well infrared photodetectors (QWIPs) have been on extensive research since last decade of the 20<sup>th</sup> century. In this work, single pixel n-type QWIPs with different heterostructures have been reviewed in terms of important figures of merit (peak wavelength, responsivity, dark current and detectivity) based on the works of numerous research groups. Prior to that a brief device physics of QWIP has been presented with the motivation of understanding this review with ease for those who are new in this field.

## I. INTRODUCTION

Infrared(IR) photodetectors have been of interest since the mid of 19<sup>th</sup> century due to its vast application that spans military (e.g. night vision, rifle sight, surveillance, missile guidance and tracking), astronomical studies, commercial (communications, medical imaging), public (e.g. atmospheric sounding, pollution control, meteorology, environmental monitoring and overall for academic domain [1-4]. IR domain occupies a wide range of electromagnetic radiation from 700nm to about 1um after visible spectrum which can be subdivided to different regimes : 1 – 3 $\mu$ m short wavelength infrared (SWIR), 3–5 $\mu$ m mid wavelength infrared (MWIR), 8–12 $\mu$ m long wavelength infrared(LWIR) and beyond 12 $\mu$ m very long wavelength infrared (VLWIR) or far infrared(FIR) regime[1-4]. Within the past few decades established technologies have grown into commercial success, nascent technologies have grown into thriving hubs of research and new technologies are on constant discovery and rigorous investigation. Observing the IR detector technology development history, a simple theorem can be stated: all physics phenomena in the range of about 0.1-1 eV can be proposed for IR detectors. Among these effects are: change in electrical conductivity (bolometers), gas expansion (Golay cell), pyroelectricity (pyroelectric detectors), photon drag, Josephson effect (Josephson junctions, SQUIDs), internal emission (PtSi Schottky barriers), fundamental absorption (intrinsic or bulk photodetectors), impurity absorption (extrinsic photodetectors), low dimensional solids [superlattice (SL) and quantum well (QW) detectors], different type of

phase transitions, etc. Out of all these, a pseudo-binary alloy semiconductor Hg<sub>1-x</sub>Cd<sub>x</sub>Te (MCT) has been widely used as IR detectors since mid of the 20<sup>th</sup> century after its detailed research of Lawson and co-workers [5]. The tremendous popularity of MCT lies on its tunable band gap which can cover the entire IR range (from visible to as high as 30 $\mu$ m), direct energy gap, ability to obtain both low and high carrier concentrations, high mobility of electrons, low dielectric constant, small change of lattice constant with composition and over all effectively room temperature operation (cooled IR detectors) [6]. The main motivations to replace HgCdTe are associated with technological problems associated with processing of this small bandgap material many of which originate with the weak Hg-Te bond, and the resulting bulk, surface and interface instabilities and moreover uniformity and yield issues specially in the LWIR spectral range[6]. Compared to MCT, quantum well infrared photodetection (QWIP) is a newer technology. Since the initial proposal by Esaki and Tsu and the advent of molecular beam epitaxy (MBE), interest in semiconductor superlattices (SLs) and quantum well (QW) structures has increased continuously over the years. First demonstration of such structures for IR detection by Levine et al. in 1987 [7] triggered the enormous interest and research on QWIPs which is moving on until now by introducing newer semiconductor hetero structures as well as various configuration of quantum well. The main motivation for QWIP lies on the fabrication maturity and ease of GaAs technology and the uniformity of growth in flat plane arrays (FPA).

In this review work, we will focus on different hetero structures of single pixel QWIP with n well configuration and analyze their performances based on different experimental works. But it will be preceded by a brief physics of QWIP operation to understand the structural and performance analysis with ease, especially to those who are new in this field. The performance analysis will be limited by the peak detection wavelength (wavelength at which maximum photo response occurs) used to separate detectors into different IR regimes listed previously , peak responsivity (amount of signal

current generated for a given input power), dark current density (current of the detectors without illumination) and specific detectivity which incorporates aspects of the both dark current density and responsivity of the device to provide a comparison of the amount of signal current generation for a given amount of noise at a specific wavelength (the more detectivity, the better signal detection).

## II. BRIEF DEVICE PHYSICS OF QWIP

### A. Semiconductor Quantum Well

The quantum well is formed by using an ultra thin layer of narrow bandgap semiconductor (e.g. GaAs) sandwiched between two thin wider band gap semiconductor (e.g. AlGaAs) barrier layers. The motion of the charge carriers perpendicular to the layers become quantized so that localized two dimensional (2D) subbands of quantized states are formed inside the well. Quantum wells may be formed in either of the valence band (VB) and conduction band (CB) or in both of them depending upon the type of hetero- structures (i.e. their band offsets). Both single quantum well and multi-quantum well (MQW) devices are found although typically MQW structures with 30-50 quantum well periods are used for QWIPs. In MQW, if the barrier layer is kept sufficiently thick (typically greater than 50  $\text{\AA}$ ), then the wells are not coupled and the particles in side every well behaves independently but if the barrier layer is sufficiently thin ( less than 50  $\text{\AA}$ ), then the discrete energy levels in the wells splits into mini bands. Such a composite material is then called a super lattice.

### B. Optical Absorption in QW

1) *Interband Transition and Intersubband Transition* : The Quantum well can be treated in the first approximation as a well-known particle in a box situation. Owing to strong confinement of free carriers in the small size region (where the electron mean free path or de Broglie wavelength is much smaller than the well dimension), size quantization produces 2D subbands. The position of energy levels, the subbands are determined by the height of conduction band offset,  $\Delta E_C$  and width of the well,  $d$ . Thus in QW structure the photon absorption can occur in two processes, a) Interband transition : transition of carrier between VB and CB; b) Intraband transition / intersubband transition : transition of carrier between the subbands of CB or VB. These two processes are shown in Fig.1. In contrast, for a bulk crystal the intraband optical transitions within the same band are forbidden and may only be induced by phonons or impurities to provide momentum conservation. For infinitely high barriers and parabolic bands the intersubband transition energy between the lowest ( $E_1$ ) and first excited state ( $E_2$ ) in the CB is given by  $E_{21} = 3\hbar^2\pi^2/2m^*d^2$ , where  $m^*$  is the (isotropic) electron effective mass in the quantum well. Consequently, by tailoring the quantum structure, it should be possible to achieve the situation when the incident photon energy coincides with  $E_{21}$ . For typical structure such transition energy is of meV range (maximum few hundreds of meV) which is same as the energy range of MWIR, LWIR and FIR. Thus inter subband

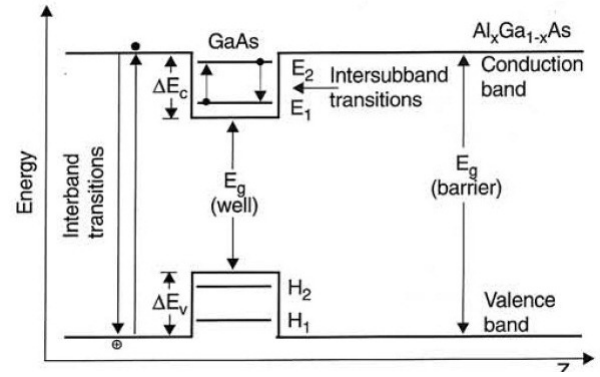


Fig. 1: Schematic band diagram of a GaAs/AlGaAs QW. Intersubband transition between  $E_1$  and  $E_2$  are indicated. Interband transition occurs between VB and CB

transition is a very effective mean to detect MWIR, LWIR and FIR whereas for NIR and SWIR detection interband absorption comes in effect in QWIP. In this way, QWIP can be utilized for wide range of IR detection.

2) *Different Intersubband Transitions*: Inter subband transition in a QW can occur in different processes like bound to bound (B-B), bound to continuum (B-C) and bound to quasi-bound (B-QB) configuration depending on the position of first excited state in the well. The desired configuration can be achieved by using different well width and barrier height (i.e. proper band gap engineering)

a) *Bound-to-Bound Transitions*: In such QWIP structure, the first excited state lies below the CB edge (roughly below 10meV) as shown in Fig.2(a). The excited carrier then tunnel through the barrier and gives the photo response. For such configuration absorption efficiency is higher but the barrier thickness becomes limited due the effective tunneling process. For such configuration dark currents remains lower because such transitions occur in relatively wider well which results lower ground state energy level giving less escape probability of electrons.

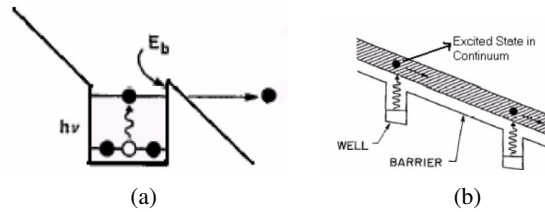


Fig. 2: Intersubband Transitions: (a) Bound to Bound (B-B) (b) Bound to Continuum (B-C)

b) *Bound-to-Continuum Transitions*: By decreasing the size of quantum well, the first excited state can be pushed up above the CB edge resulting a bound-to-continuum state absorption shown in Fig.2(b). The major advantage of this configuration is that photoexcited electrons can escape from the well without tunneling. Thus bias voltage required for the photoelectron to efficiently escape from the well can be

dramatically reduced which results lowering of dark current. In addition, the barrier thickness can be substantially increased without limiting collection efficiency.

c) *Bound-to-Quasi Bound Transitions*: If the well width and conduction band offset is such maintained that the first excited state is in resonance with the CB edge, then this is called bound-to-quasi bound absorption. This optimizes the advantages of the previous two configurations.

3) *Optical Coupling*: One of the major issue in QWIP is the proper optical coupling. West and Eglash [8] were the first who demonstrated intersubband transitions in GaAs/AlGaAs MQW system. They found, in accordance with the theoretical prediction, that the oscillator strength connected with this transitions was large and had only one nonzero component along the growth direction. This means that the optical electric field must have a component parallel to the growth direction in order to induce the intersubband absorption in conduction band of quantum well with isotropic effective mass. The plane polarized transitions can be observed in systems with anisotropic effective mass. All these implies that, for direct incident of light which is the most common process for any detectors, there will be very less or almost no response for a QWIP which is based on intersubband absorption principle. It is also evident from the following Fig.3 (from Ravikumar et al[32]), which shows the variation of photovoltage with different polarization angle. This is the reason why it very

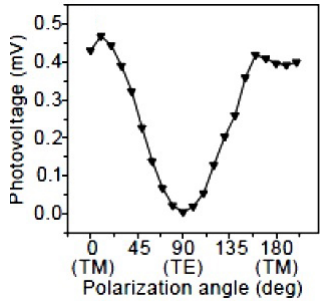


Fig. 3: Effect of optical coupling in the response of QWIP. It showed that with direct incident(TE) there was almost no response where at TM mode there occurred the maximum one (after [32]).

important to take necessary experimental measures in order to ensure good coupling efficiency of light. The most common coupling methods used are gratings, random scattering, microlenses, multipass waveguide and so on [12].

4) *Advantage and Disadvantages of QWIPs over MCT* : GaAs technology is standard and very matured and is widely used for growth and fabrication purposes. Efforts are made to improve the device performance by means of tuning and gratings designs. It has high thermal stability. The cost for the development of QWIP technology and QWIP production will be much less than other IR detecting systems in the future. The region where QWIPs have a performance advantage is low temperatures. Detectivity is better for GaAs/AlGaAs QWIPs in the spectral region below 14  $\mu\text{m}$  and at temperatures below 50

K. Large LWIR GaAs/AlGaAs FPAs with size up to 640x480 (640x512) pixels were denoted with outstanding uniformity and operability[10]. Uniformity plays a vital role in accurate temperature measurement, background subtraction, and threshold testing. QWIPs have added advantage for IR detection in VLWIR and multicolor detection. QWIP manufacturing takes complete advantage of the rapidly growing III-V GaAs industry. QWIP is expected to be cheap and promises high production yield.

The absorption quantum efficiency of QWIP is relatively small with a 2D grating[11]. For QWIPs, a higher bias voltage is used to increase quantum efficiency,  $\eta$ . An increase in the reverse bias voltage also increases the leakage current. Thus system performance is hindered. New grating designs are being studied and examined to improve  $\eta$ . Examples could be enhanced QWIP, antenna gratings, and corrugated gratings. Tidrow et al [11] presented a high performance QWIP made of only three quantum wells. Efficiencies up to 29% were obtained at a bias voltage of 20.8 V and at a peak wavelength of 8.5  $\mu\text{m}$ . The detectivity of HgCdTe is roughly higher, it decreases as the temperature is reduced. Typical LWIR QWIP dark current is about  $10^{-4}$  A/cm<sup>2</sup> at 77 K. The dark current is caused by defect-related direct tunneling at low temperatures. In the medium temperature range, thermal tunneling overtakes. As a result thermally excited electrons tunnel through the barriers by taking advantage of defects.

### III. QWIP WITH DIFFERENT HETEROSTRUCTURES

In this section salient features of single pixel QWIP with different heterostructures will be discussed along with a comparative view from the work of different research group.

#### A. Group III- V Compounds

1) *GaAs / AlGaAs QWIP*: A lot of interest lie in the long wavelength GaAs/AlGaAs quantum well infrared photodetectors(QWIP) because of its matured technology. As these QWIPs provide low 1/f noise, low power dissipation, high differential resistance and high radiation hardness, they are suitable for very long wavelength applications such as earth observing satellites[15]. These QWIPs can also be operated in large arrays.

In the early period of QWIP research Levine et al. [9] used 50 periodic structures of GaAs/Al<sub>x</sub>Ga<sub>1-x</sub>As with different compositions and well widths, thus engineered various types of transition along with different peak detection wavelength ranging from MWIR to LWIR. The main features of that research has been summarized in the TABLE I. From this work a significant feature revealed, that for bound to bound transition there is the possibility of maximum absorption where it becomes weaker for bound-to-continuum.

In the search of FIR detection, Perera et al [13] discussed a GaAs/AlGaAs QWIP structure consisting of 20 periods of 118 Å GaAs wells and 400Å Al<sub>0.7</sub>Ga<sub>0.93</sub>As barriers as shown in Fig.4. The energy bands were produced at 10.5meV and 53.5 meV with a peak response at 28.8 $\mu\text{m}$  for bound-to-bound transition. The dark current at low temperature is due to sequential

TABLE I: Structure parameters for different GaAs/Al<sub>x</sub>Ga<sub>1-x</sub>As QWIPs. Here d = well width, b = barrier width, x = composition, IST = intersubband transition,  $\lambda_p$  = peak detection wavelength,  $\alpha_p$  = peak absorption coefficient [after Ref[9]]

Sample	d(Å)	b(Å)	x	IST	$\lambda_p(\mu\text{m})$	$\alpha_p$ at 77K
A	40	500	0.26	B-C	9.0	410
B	40	500	0.25	B-C	9.7	670
C	60	500	0.15	B-C	13.5	450
E	50	500	0.26	B-B	8.6	1820
F	45	500	0.30	B-QB	7.75	875

resonant tunneling. The dark current increases sharply at high bias due to field assisted tunneling. The responsivity of the detector depends on bias. A peak responsivity of 0.265 A/W and detectivity of  $2.5 \times 10^9$  Jones was obtained at 4.2K. The responsivity is in good comparison with that of mid-infrared and long wavelength GaAs/AlGaAs QWIPs.

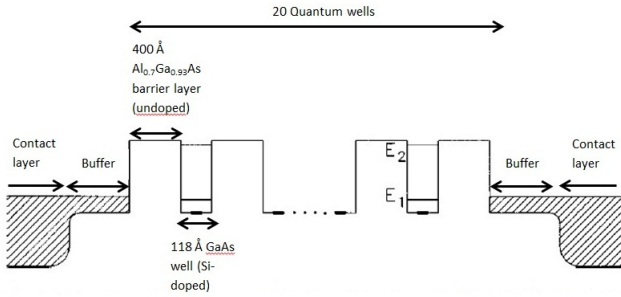


Fig. 4: Structure designed for the bound-to-bound GaAs/AlGaAs QWIP with a predicted peak response of  $28.8\mu\text{m}$ . The observed peak was  $27.2\mu\text{m}$ . The energy bands were at  $E_1=10.5$  meV and  $E_2=53.5$  meV. (after Ref[13]. Reproduced with permission. Copyright [1998], AIP Publishing LLC)

2) *InGaAs / GaAs QWIP*: The quality of the barriers is extremely important for optimum QWIP performance and the binary barrier QWIPs have been studied to have superior carrier transport properties[14]. With this motivation GaAs/InGaAs came into the keen eye of researchers where binary GaAs is being used as barrier instead of conventional ternary compounds.

Gunapala et al. [15] described a structure where non-lattice matched GaAs/In<sub>0.2</sub>Ga<sub>0.8</sub>As QWIPs were grown via molecular beam epitaxy on a semi-insulating GaAs substrate. In these structures the heavily doped contacts are made using the high bandgap (i.e. GaAs) semiconductor material in contrast to normal GaAs/Al<sub>x</sub>Ga<sub>1-x</sub>As QWIPs. These structures have two 600 Å thick GaAs spacer layers [Fig.5(a)] between the quantum wells and the top and bottom contact layers, which drastically reduce the tunneling injection current from contacts to the quantum well region resulting in a low dark current. Irrespective of the 1.2% lattice mis-match between In<sub>0.2</sub>Ga<sub>0.8</sub>As and

GaAs, good quality non-lattice matched GaAs/In<sub>0.2</sub>Ga<sub>0.8</sub>As and GaAs QWIP structures were grown. Three samples (A, B and C) were grown with different well widths:  $L_w = 50$  Å, 60 Å and 70 Å, in order to vary the absorption and transport properties. The results obtained are summarized below.

TABLE II: Comparison of peak response( $\lambda_p$ ), detectivity(D) and responsivity( $R_p$ ) for different intersubband transitions(IST) D and R measured at 0.3V bias and 50K (after Ref[15]. Reproduced with permission. Copyright [1994], AIP Publishing LLC)

Sample	$L_w(\text{Å})$	IST	$\lambda_p(\mu\text{m})$	D(Jones)	$R_p(\text{mA/W})$
A	50	B-C	12.3	$2.9 \times 10^8$	293
B	60	B-QB	16	$1 \times 10^9$	510
C	70	B-B	16.7	$3 \times 10^9$	790

The dark current decreases with increasing quantum well width  $L_w$  because the effective barrier height of the ground state electrons increases with the increasing quantum well width  $L_w$ . Tunneling and thermionic emission of ground state electrons into the continuum transport states decreases due to this increased effective barrier height, which in turn reduces dark current. The responsivity spectra of the bound-to-continuum QWIP (sample A) is much wider than the bound-to-quasibound (sample B) QWIPs or bound-to-bound (sample C)[15]. The value of peak absolute responsivity ( $R_p$ ) is much lower than that for the bound-to-bound or bound-to-quasibound QWIPs for the decreasing absorption coefficient. The absorption coefficient reduces due to the conservation of oscillator strength. The absolute responsivities of all three

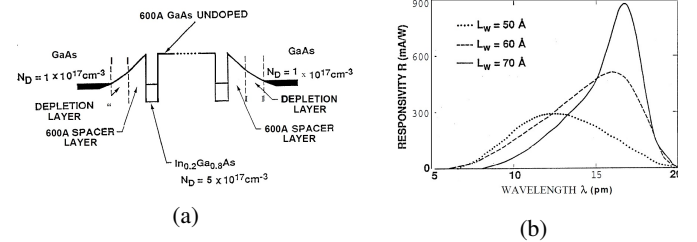


Fig. 5: InGaAs-GaAs QWIP: (a) Schematic of the conduction band structure of the device (after Ref[15]) (b) Responsivity spectrums of samples A, B, and C at temperature  $T = 50$  K. The peak responsivities are  $R_p = 293, 510,$  and  $790$  mA/W (at 300 mV bias) for samples A, B, and C respectively (after Ref[15]. Reproduced with permission. Copyright [1994], AIP Publishing LLC)

samples vary almost linearly with the bias. At  $V_b = 1.3$  V the responsivities are  $R_p = 0.85, 1.1$  and  $2.2$  A/W for the samples A, B and C respectively. Sample C (bound-to-bound) has a higher responsivity [Fig.5(b)] when compared to the samples A and B (bound-to-continuum and bound-to-quasibound) as the absorption coefficient of sample C is higher than the other samples. Greater tunneling probability due to lower effective mass in the GaAs barriers also accounts for high responsivity.

For  $\text{In}_{0.2}\text{Ga}_{0.8}\text{As}/\text{GaAs}$  QWIPs detectivity was found to be  $1.8 \times 10^{10} \text{ cm} \sqrt{\text{Hz}}/\text{W}$  with a cut-off wavelength of 18.3  $\mu\text{m}$  at 40 K.

Responsivity of  $\text{InGaAs}/\text{GaAs}$  is higher than  $\text{GaAs}/\text{AlGaAs}$  for very long wavelength QWIPs due to high optical gain and small carrier capture probability [15]. The high optical gains and the small carrier capture probabilities are responsible for the outstanding carrier transport in the  $\text{GaAs}$  barriers. The tunneling probability of electrons is higher in the  $\text{GaAs}$  barrier due to lower effective mass thus resulting in a higher responsivity for  $\text{InGaAs}/\text{GaAs}$  QWIPs. Detectivity is significantly higher ( $\sim 10^{13}$  Jones) for  $\text{InGaAs}/\text{GaAs}$  QWIPs at the same operating temperature in case of FIR performance [15].

3) *InGaAs / InP QWIP*: Lattice-matched  $\text{InGaAs}/\text{InP}$  technology is enormously used in optical communication systems. n-type  $\text{InGaAs}(\text{P})/\text{InP}$  QWIPs have much greater responsivity and photoconductive gain than n-type  $\text{AlGaAs}/\text{GaAs}$  QWIPs for a specific peak wavelength.  $\text{InP}$ -based QWIPs can detect two-colors in the mid wavelength infrared (MWIR) and long-wavelength infrared (LWIR) ranges using  $\text{In}_{0.53}\text{Ga}_{0.47}\text{As}$  /  $\text{Al}_{0.48}\text{In}_{0.52}\text{As}$  and  $\text{InGaAs}(\text{P})/\text{InP}$  MQWs respectively [16].

Majumder et al. [16] developed a structure by growing  $\text{In}_{0.53}\text{Ga}_{0.47}\text{As}/\text{InP}$  quantum-well infrared photodetectors using metal-organic vapor phase epitaxy (MOVPE) which is a low cost alternative of MBE process. The structure was grown on Fe-doped semi-insulating  $\text{InP}$  substrate. The photoactive area consists of 30 periods of 68- $\text{\AA}$ -wide  $\text{In}_{0.53}\text{Ga}_{0.47}\text{As}$  QWs, separated by 340- $\text{\AA}$ -thick  $\text{InP}$  barriers. The energy gap between the ground state  $E_1$  and the first excited state  $E_2$  in each QW was simulated to be  $E_{21} = 145 \text{ meV}$ .  $E_2$  was 23 meV below the  $\text{InP}$  barriers, giving rise to a bound to bound transition [Fig:6(a)]. The peak wavelength was reported to be 8.55  $\mu\text{m}$  and 8.35  $\mu\text{m}$  under positive and negative bias, respectively.

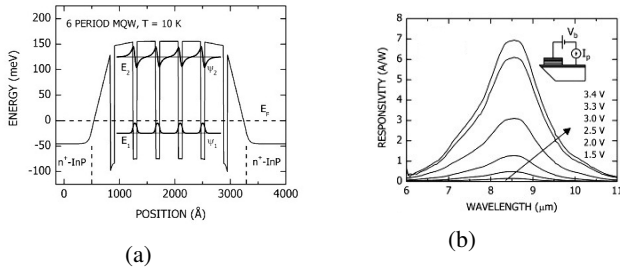


Fig. 6:  $\text{InGaAs}/\text{InP}$  QWIP: (a) Simulated conduction band diagram of a 6-period  $\text{In}_{0.53}\text{Ga}_{0.47}\text{As}/\text{InP}$  MQW structure at temperature  $T = 10 \text{ K}$ . The first two energy levels are  $E_1$  and  $E_2$  with wave functions  $\psi_1$  and  $\psi_2$ .  $E_F$  is the Fermi level (after Ref[16]) (b) Responsivity of the detector at a temperature  $T = 10 \text{ K}$  and under different positive bias. Inset: scheme for applying bias  $V_b$  to and measuring photocurrent  $I$  of an edge-coupled detector (after Ref[16]. Copyright 2005 IEEE)

The high responsivity was the prime feature of the device. The values of peak responsivity were 6.9 and 5.6  $\text{A}/\text{W}$  at 3.4V and -3.5V bias at  $T=10\text{K}$  respectively [Fig.6(b)]. These values are quite higher than those obtained with the previous

MBE-grown n-type  $\text{In}_{0.53}\text{Ga}_{0.47}\text{As}/\text{InP}$  QWIPs for similar peak wavelengths. The peak responsivity was found to be five times larger than that of widely used  $\text{GaAs}/\text{AlGaAs}$  structures. The reasons behind this were reported to be higher mobility of electron in  $\text{InP}$  barrier as compared to  $\text{AlGaAs}$  barriers [17] and large capture rate in the  $\text{GaAs}$  QWs in comparison to the capture rate of  $\text{InGaAs}$  QWs [18] which was the consequence of both saturation velocity and L valley population [19]. The detector dark current is greater than expected and can be decreased by optimizing the MOVPE growth conditions. The highest value of peak detectivity is  $54 \times 10^9$  Jones at  $= 2.9\text{V}$  and  $T= 77 \text{ K}$ , while for  $T < 65 \text{ K}$ , the background-limited detectivity has negligible bias dependence.

4) *InGaAs / AlGaAs QWIP*: The necessity of using both 8-12  $\mu\text{m}$  (LWIR) and 3-5  $\mu\text{m}$  (MWIR) atmospheric IR made researchers interested to fabricate a dual color device on the same substrate. But for LWIR detection lattice matched  $\text{GaAs}/\text{Al}_x\text{Ga}_{1-x}\text{As}$  structure grown on  $\text{GaAs}$  substrate is very suitable but for MWIR range it fails to show its efficiency because it requires large band offset. By increasing Al content it is not feasible to achieve because at higher Al content ( $x > 0.45$ ) the thermal activation energy becomes lower than the optical one, leading to poor temperature performance, hence higher dark current [20-21]. Moreover, high defect density at those high Al content also results carrier freeze out, high generation recombination noise, thus degrading device performance [22]. From this necessity a different hetero structure with larger CB offset like strained  $\text{InGaAs}/\text{AlGaAs}$  grown on  $\text{GaAs}$  substrate came to light. Fiore et al. [23] showed such a structure consisting of 100 repetitions of the following single well: 2 $\text{\AA}$  AlAs, 8 $\text{\AA}$  GaAs, 25 $\text{\AA}$   $\text{In}_{0.16}\text{Ga}_{0.84}\text{As}$ , 8 $\text{\AA}$  GaAs, 2 $\text{\AA}$  AlAs separated by a 336 $\text{\AA}$  thick  $\text{Al}_{0.37}\text{Ga}_{0.63}\text{As}$  [Fig.7(a)] Layers of AlAs is given to raise slightly the 2nd energy level. The peak resonance of the device was reported to be 4.5  $\mu\text{m}$  wavelength with relatively lower (but still comparable) responsivity of 0.012  $\text{A}/\text{W}$  at 80K and 10V bias (quite large). But the overwhelming feature of this QWIP turned out to be the very low dark current (pA range at lower temperature) shown in Fig.7(b). This resulted in good detectivity of  $4 \times 10^{10}$  Jones at  $T < 95\text{K}$ .

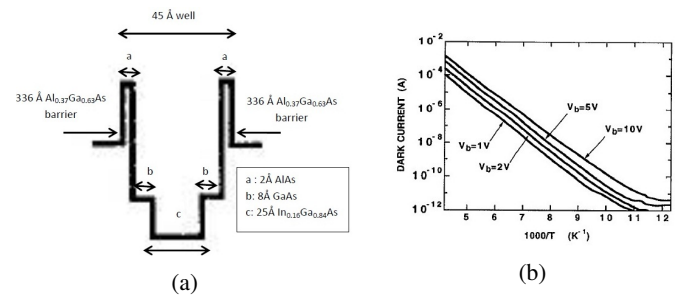


Fig. 7:  $\text{InGaAs}/\text{AlGaAs}$  QWIP: (a) Schematic of CB Structure of the QW (b) Arrhenius Plot of  $\text{InGaAs}/\text{AlGaAs}$  QWIPs dark current for various applied biases (after Ref[23]. Reproduced with permission. Copyright [1994], AIP Publishing LLC)



In a recent research, Nedelcu et al.[24] designed such structure to have bound to quasi bound transition. This device resulted 28% external quantum efficiency along with a detectivity of  $7 \times 10^{11}$  Jones at 77K temperature which is working below  $4.1\mu\text{m}$ . In spite of better performance against dark current this structure suffers with a severe issue of In desorption in the well due to higher growth temperature of AlGaAs ( $>600^\circ\text{C}$ ) than the starting temperature of In desorption in InGaAs well ( $\sim 520^\circ\text{C}$ ). This makes the In content inside the well become quite unstable that affects the precise peak wavelength control. Shi et al.[25] demonstrated that using a thin AlGaAs layer grown at low temperature could prevent the In composition from losing thus highly reproducible peak response wavelength of InGaAs/ AlGaAs became possible.

5) *InGaAs / InAlAs QWIP*: Another QW structure that works very well in terms of dark current is InGaAs/InAlAs grown on InP substrate (unstrained structure). Such a QWIP was demonstrated by Tidrow et al. [26] in which 20 periods of  $400\text{\AA}$   $\text{In}_{0.52}\text{Al}_{0.48}\text{As}$  barrier and  $32\text{\AA}$   $\text{In}_{0.53}\text{Ga}_{0.47}\text{As}$  wells were grown on InP substrate with back surface illumination mechanism. The peak response was reported to be at  $4.1\mu\text{m}$  wavelength (MWIR) at  $-3\text{V}$  bias. The dark current of this device was found to be pA range [Fig.8(b)] at lower temperature and at lower bias which is very much comparable with the InGaAs/ AlGaAs structure previously described in this work.

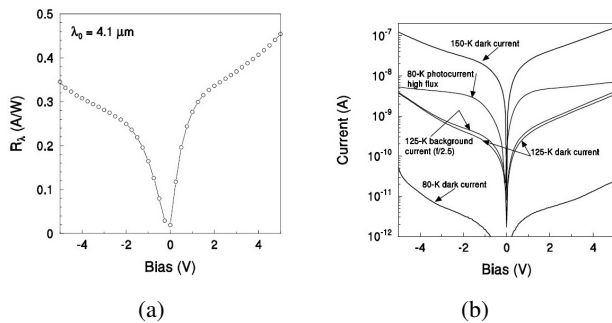


Fig. 8: InGaAs-InAlAs QWIP: (a) Peak responsivity versus bias showing responsivity for  $4.1\mu\text{m}$  peak wavelength (b) Dark current for a variety of sample temperatures and applied bias. Note background-limited operation at 125-K sample temperature (after Ref[26])

But there is a significant amount of improvement in responsivity than the previously mentioned structure. The responsivity was  $0.34\text{A/W}$  at  $-5\text{V}$  bias and about  $0.46\text{A/W}$  at  $+5\text{V}$  bias [Fig.8(a)], whereas for InGaAs/ AlGaAs it was  $0.012\text{A/W}$ . Peak detectivity was on the order of  $2 \times 10^{10}$  Jones at 150K temperature. However, due to having InP substrate this QWIP was not as economical and fabrication technology efficient like the previous one which used GaAs substrate.

### B. Group II- VI Compounds

1) *ZnCdSe / ZnCdMgSe QWIP*: Although As-based III-V materials are used for high performance QWIPs, the performance suffers in SWIR and MWIR due to lack of

higher CB offset required for short wavelength operation. Strain compensated III-V materials, which can provide larger band offset suitable for short wavelength operation described in the previous section of this work, suffers from poor responsivity and operation in room temperature. Recently, the II-VI ZnCdSe/ ZnCdMgSe material system is being studied in the place of InGaAs/InAlAs material system for intersubband devices[27-30]. Moreover, II-VI compounds have a higher electron effective mass which in spite of reducing optical dipole matrix element allows design with thinner barrier without tunneling resulting the accommodation of more active stages than III-V compounds. Such structures can be grown on lattice matched InP substrate with the ZnCdMgSe bandgap tunable over a large range (from 2.1 to  $3.5\text{eV}$ )[31]. Due to large CB offset ( $\sim 1.2\text{eV}$ ) such structures can be used for a wide range of IR detection ranging from small wavelength to very far one. Ravikumar et al. [32] worked with such structures where they successfully demonstrated high performance MWIR detection at room temperature. In this work, the active region, which is grown by molecular beam epitaxy (MBE) consisted of 50 periods of  $21\text{\AA}$   $\text{Zn}_{0.51}\text{Cd}_{0.49}\text{Se}$  well with  $250\text{\AA}$   $\text{Zn}_{0.29}\text{Cd}_{0.26}\text{Mg}_{0.45}\text{Se}$  barrier. The QWIP was designed based on a bound to quasi bound transition centered at  $3.6\mu\text{m}$  as shown in Fig.9(a).

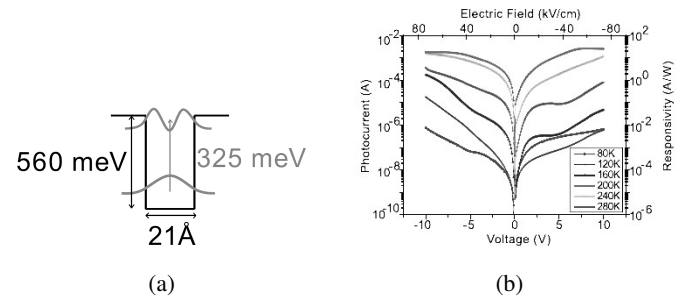


Fig. 9: ZnCdSe-ZnCdMgSe QWIP: (a) Bound to quasi bound transition (after Ref[32]) (b) Variation of responsivity with temperature and applied bias. This shows high responsivity at room temperature (after Ref[32]). Reproduced with permission. Copyright [2013], AIP Publishing LLC

The peak detection wavelength was obtained at  $4\mu\text{m}$  at 80K temperature. The dark current obtained from the devices were on the range of  $10^{-8}\text{A}$  and  $10^{-3}\text{A}$  at 80K and 280K temperature respectively at around  $2.5\text{V}$  applied bias. The striking feature of this research was that the peak responsivity was obtained to be over  $30\text{A/W}$  at 280K temperature [Fig.9(b)] which is quite large compared to the other QWIPs operated in MWIR range at room temperature which we have already discussed in the previous section. This responsivity was found to increase exponentially for low bias as well as increase with temperature. A large photoconductive gain arising from a low capture probability was verified to be the prime reason for such comparatively high responsivity at room temperature. The dark current limited detectivity of  $2 \times 10^9$  Jones and  $4 \times 10^7$  Jones were measured at 80K and 280K respectively, which

closely corresponds to the theoretical calculation of maximum detectivity of  $10^7$  Jones at room temperature [32].

In another work, Ravikumar et al. used the same II-VI structure to design a QWIP with peak response wavelength at  $8.7\mu\text{m}$  although the responsivity was found very poor (some  $\mu\text{A/W}$ ) at higher temperature[33].

#### IV. CONCLUSION

In this work, we have represented an introductory view on the physics of QWIP operation followed by a detailed review of n-type QWIP using different hetero structures, widely studied so far in IR detector research covering the study of last two decades in this field. The relative positive and negative aspects have also been included for different hetero structure pairs. It has been found from all these works that the conduction band offset and QW width gives the prime tuning mechanisms for wide range IR detection which has already led IR detection research towards the multi spectral devices ( $3^{\text{rd}}$  generation IR detection technology). On the other hand, the type of barrier layer used (ternary or binary), the electrical properties of the barrier layer, the capture probability of the well, type of intersubband transitions and lattice matched QW structure are the controlling factors of different figure of merits like responsivity, dark current and detectivity. With advanced fabrication technology, newer structures will be studied in this respect which will overcome the major limitations (operating temperature, efficiency etc.) of QWIPs over the conventional IR detection process (MCT, bolometers and so on) and thus will open a newer dimension of integrated devices. Further study on group II- VI compounds based QWIPs will open the door for newer structures with better performances along with stable structures. It is hoped that this review will aid the researchers in this field upto certain extent.

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