Affordable Smart ECG Monitoring Using Arduino & Bluetooth Module

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***Abstract*— This project uses some sensors and Arduino to design and implement the Affordable Smart ECG Monitoring System. ECG monitoring is now becoming part of everyday life. Through ECG characteristics such as patient's heartbeats, heart conditions, and heart disease can be analyzed. The proposed system sensed the patient's ECG through 3 lead electrode system via AD8232 which amplifies minor and small bio-signals to the Arduino which processes them. This sensor was used to measure the heart's electrical activity called ECG. In this project, Arduino and Bluetooth module are used to collect and transfer the heart activity and send it to the mobile application. The current portable ECG technologies are costly so that anyone can't use that on their home for an emergency if they want and this new technology is less expensive.**

Keywords*— *ECG Monitoring system; Portable; Arduino; Bluetooth;

I. INTRODUCTION

In many cases, the patient requires continuous monitoring and it needs a long time to stay in hospitals which is expensive now a days. Traditional monitoring system enables monitoring of vital parameters requiring the sensors to be connected to bedside machines and the patient is essentially confined to bed. However, busy in today's world and the increase in sudden death events motivate a monitoring system that monitors patients remotely located on a continuous basis. With the technological advancement, it has become possible to design low-cost, home-based healthcare monitoring system in which the system records and displays the signals from the human body and transmits to any other location. Different studies have been carried out in connection with the development of remote healthcare systems, particularly heart rate monitoring systems.

II. LITERATURE REVIEW

UMHMSE introduced a real-time mobile healthcare system for monitoring elderly patients indoors or outdoors [6]. The main components of the system are a bio - signal sensor and a smartphone. The data that the bio - signal sensor collects is transmitted via the GPRS / UMTS network to an intelligent server. The system can monitor the elderly patient's mobility, location, and vital signs from a remote location.

In the Wireless Sensor Network Wearable Smart Shirt[7], a smart shirt has been designed. In order to monitor the continuous and real - time health of a patient, this shirt can measure electrocardiogram (ECG) and acceleration signals. The shirt consists mainly of sensors and conductive fabrics for the body signal to be received. The measured body signals are transmitted via IEEE 802.15.4 network to a base station and server PC. The wearable devices have low power consumption and are small enough to fit in a shirt. An adaptive filtering method was also proposed in this work to reduce the noise associated with the ECG signal.

While mobile devices are always considered a promising tool for monitoring and managing patients' own state of health, computational or data-intensive activities have some inherent limitations on these appliances. In Enabling Smart Personalized Healthcare[12], a new hybrid mobile computing solution has been proposed to overcome these limitations. A mobile cloud-based electrocardiograph monitoring system was implemented by the authors. The experimental results show that the proposed system can significantly improve the diagnostic accuracy, performance efficiency, and energy efficiency of the conventional mobile-based medical monitoring system.

In the ECG Remote Monitoring System and Human Body Temperature Signals[14], a remote healthcare system for monitoring electro-cardio graphic and temperature data has been described. The system consists of three modules namely (i) a hardware module, (ii) Bluetooth module, and (iii) display module. For data acquisition, the hardware module is used. As well for data transmission, the Bluetooth module is used. Finally, the display module displays the data. Using GPRS or Wi-Fi, the acquired clinical data is sent to a database server. The system performance has been tested on various patients

and the proposed change has been found to be very helpful to the physicians.

III. Methodology

A simple architecture has built here to monitor the Electrocardiogram. Here, Microcontroller is working as the core part of the whole system. Here the AD8232 sensor getting the analogue signal and send it to the microcontroller. Microcontroller converts it into digital data. Then holding the digital data, the microcontroller sends it to the android device via Bluetooth module.

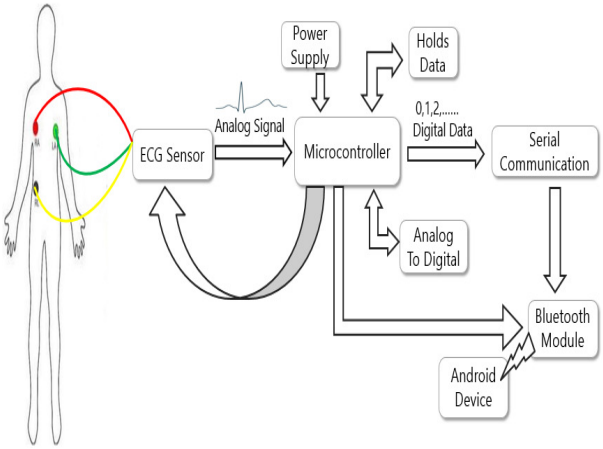


Fig. 1. Block Diagram of the Proposed System

A. Circuit Diagram

Here A8232 chip has 6 pins, we have used only 3 pins above them, which are output, voltage, ground. The Bluetooth module has 4 pins which are tx, rx, vcc, gnd. Arduino's TX1, RX0, 5V,GND pin are connected with the Bluetooth module through tx, rx,vcc and gnd respectively. The output, voltage, ground pin of AD8232 are connected with the Arduino's analog pin A0, 5V, GND. Arduino's VIN and GND is connected with the batteries positive and negative respectively.

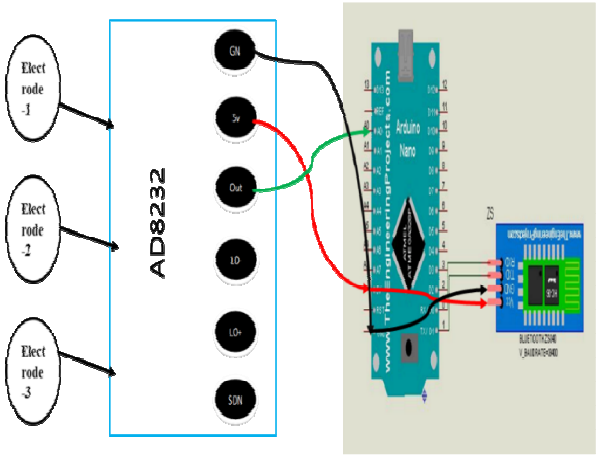


Fig. 2. Circuit Diagram of the Proposed System

IV. Designing Process of the Layout

After all the schematic circuit design process, the layout design process was done where several steps are required until the layout can be done properly. The layout design procedures are stated as follows:-

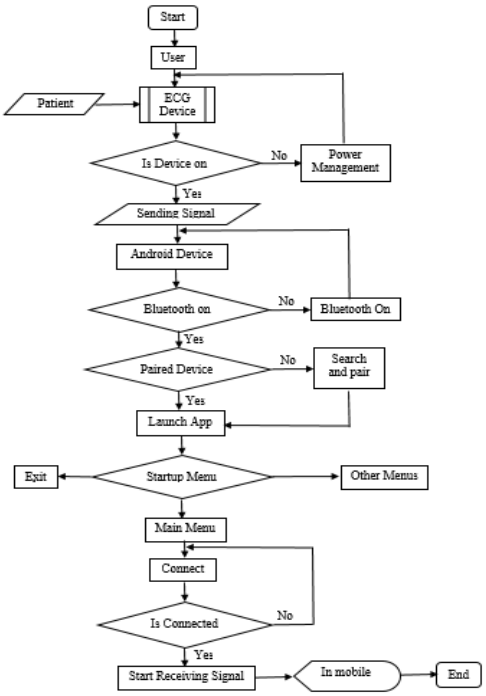


Fig. 3. Flow Chart

- Annotate the circuit of Portable ECG Monitoring Device.
- Run the Design Rule Check (DRC).
- Netlist process.
- Creating the circuit layout process.
- Rearrangement of the circuit.
- After all the process had been done, then the circuit will be route in automatically and so on, then it will be checked again using the design rule check.

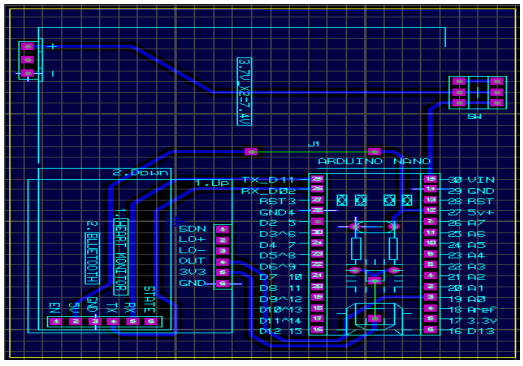


Fig. 4. Proteus Final Design

A. *User Interface*

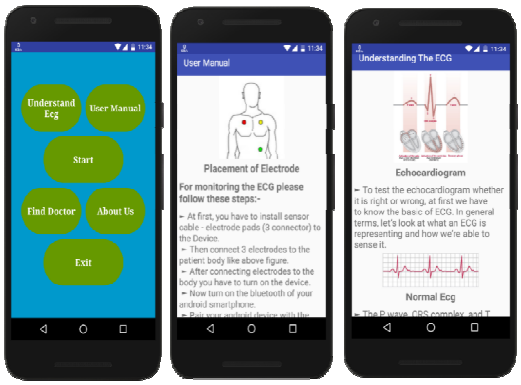
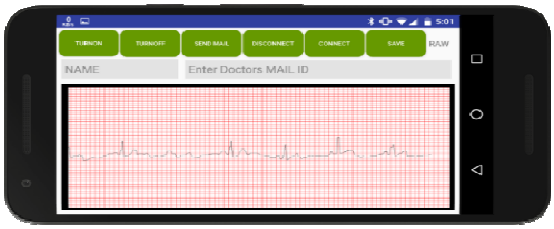
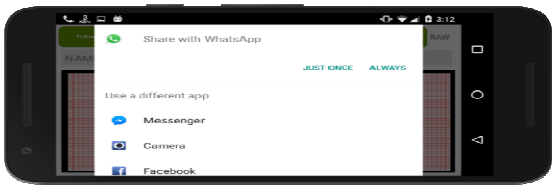


Fig. 5. (a) Startup Menu (b) User Manual (c) Understand ECG.



(d)



(e)

Fig. 6. (d) Showing ECG (e) Sharing Option

V. IMPLEMENTATION

Implementation takes a week to produce the printed PCB, completing each component located with the mark and drilled holes for mounting components. Firstly, this work printed the proteus design image on Photo Paper on a printer and make sure the output quality is the best.

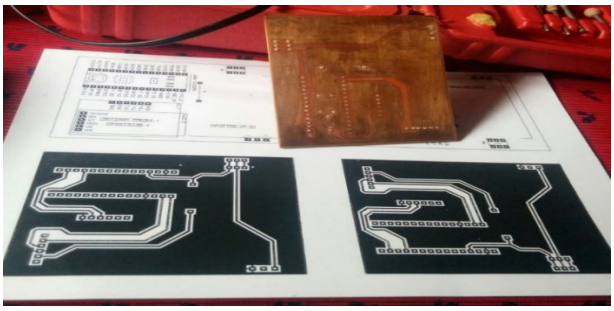


Fig. 7. Photo paper print

In this work placed the PCB transfer face down on the copper clad and set the household iron.

Fig. 8. Iron heat for making PCB

After 15 minutes, all the visible copper is gone, and then removed the PCB from the etchant and gave it a wash in cool water and dry with a towel. Then the board became ready to populate with parts.

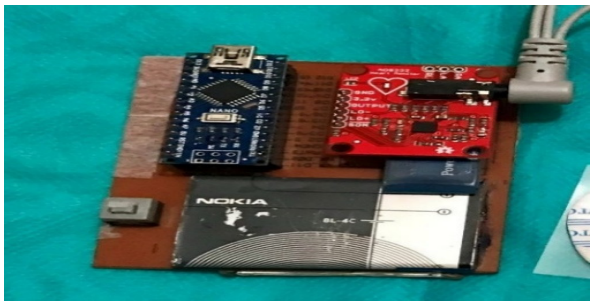


Fig. 9. Complete PCB

VI. OPERATING PRINCIPLE

In this system, Arduino is the main junction of all these peripheral devices and sensors. At first, we have to install sensor cable - electrode pads (3 connector) to the AD8232 sensor. Then connect 3 electrodes to the patient body like figure 10.

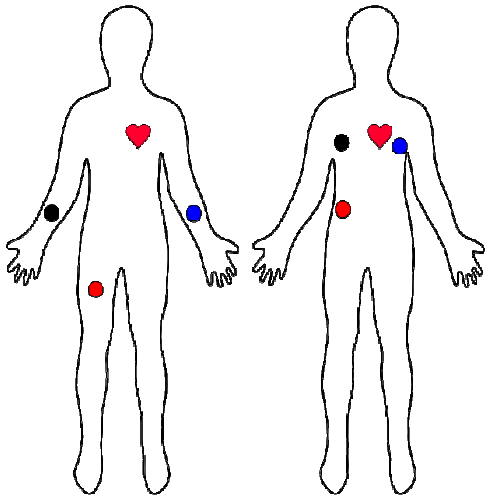


Fig. 10. Connecting Electrodes

After connecting electrodes to the body, have to turn on the proposed device and Bluetooth of the android device. Then this system have to pair the device with android device through via Bluetooth. Now we have to open the android app. Then press the start button. After opening the app, have to

press the connect button to connect with the ECG device. Then the device will show the electrocardiogram of the heart.

A. *Understanding the ECG*

To test the echocardiogram whether it is right or wrong, at first we have to know the basic of ECG. Generally speaking, let's look at what an ECG stands for and how we can feel it. The ECG is divided into two basic intervals, the interval of PR and the interval of QT as described below.

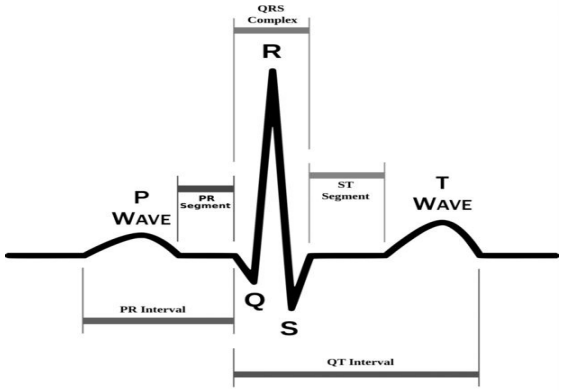


Fig. 11. .Basic ECG

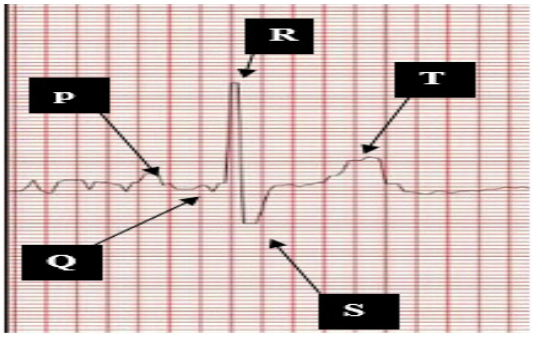


Fig. 12. Resultant ECG

In the above figure we compared our ECG with a normal ECG, which almost looks like. The P, Q, R, S, T segments are almost same in both pictures. Therefore, we can say that our system is showing normal ECG.

B. *Result*

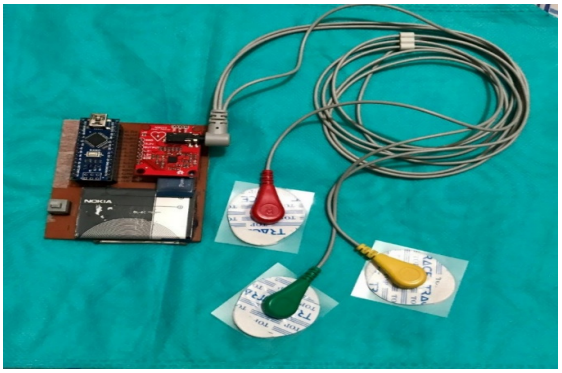


Fig. 13. Device Main view

Finally, in this season we are going to discuss about ECG monitoring and testing result. In this system, we will measure ECG through AD8232, Arduino and Bluetooth module and transfer it to the connected Android device. This project worked perfectly but sometimes it cannot give us the perfect reading due to ac noise.

VII. Conclusion

The project developed and implemented an affordable Arduino - based ECG monitoring system. The system aspects are developing a low - cost portable ECG monitoring system to analyze the heart conditions of the patient. This project proposes an effective heart attack detection system that helps to reduce deaths caused by heart attacks as the main cause of deaths from heart attacks is due to delay in proper treatment. This can be avoided as with the ECG report, the system will notify the doctor. In this work, an android application has been proposed that can receive ECG signals from the acquisition device wirelessly, detect QRS complexes, calculate heart rate and plot the real-time ECG signal for the cell phone display. It can also send this information to the physician concerned for medical decision by means of a server. Experiments show that the system proposed is unobtrusive and that the user can use it comfortably during daily activities.

Reference

[1] mHealth App Developer Economics(2014) available at http://mhealtheconomics.com/mhealthdeveloper-economics-report/

[2] Bourouis, A., Feham, M., and Bouchachia, A.(2011), " Ubiquitous Mobile Health Monitoring System for Elderly (UMHMSE)", International Journal of Computer Science and Information Technology, Vol.2, No. 3, June, pp. 74-82

[3] Lee, Y.D. and Chung, W.Y. (2009) "Wireless Sensor Network Based Wearable Smart Shirt for Ubiquitous Health and Activity Monitoring", Sensors and Actuators B: Chameical, Vol. 140, No. 2, July, pp. 390-395

[4] Orlando R. E. P., Caldeira, M. L. P. Lei S., and Rodrigues, J.P.C (2014), "An Efficient and Low Cost Windows Mobile BSN Monitoring SystemBased on TinyOS", Journal of Telecommunication Systems, Vol. 54, No. 1, pp. 1-9

[5] Yuce, M. R.(2010)" Implementation of wireless body area networks for healthcare systems", Sensor and Actuators A:Physical, Vol. 162, No. 1, July, pp. 116-129

[6] Lei Clifton, David A. Clifton, Marco A. F. Pimentel, Peter J. Watkinson, and Lionel Tarassenko (2014)," Predictive Monitoring of Mobile Patients by Combining Clinical Observations with Data From Wearable Sensors", IEEE Journal of Biomedical and Health Informatics, Vol. 18, No. 3, May , pp. 722-730

[7] Parane, K.A., Patil, N.C. ; Poojara, S.R. ; Kamble, T.S(2014) "Cloud based Intelligent Healthcare Monitoring System", In the proceedings of International Conference on Issues and Challenges in Intelligent Computing Techniques (ICICT), February 7-8, Ghaziabad, Indian, pp. 697-701

[8] Xiaoliang Wang ; Qiong Gui ; Bingwei Liu ; Zhanpeng Jin et al (2014), "Enabling Smart Personalized Healthcare: A Hybrid Mobile-Cloud Approach for ECG Telemonitoring", IEEE Journal of Biomedical and Health Informatics, Vol. 18, No. 3, May, pp. 739 – 745

[9] Dunsmuir, D., Payne, B. ; Cloete, G. ; Petersen, C.(2014), "Development of m-Health Applications for Pre-eclampsia Triage", IEEE Journal of Biomedical and Health Informatics, Vol. PP, No. 99, January , pp. 2168-2194

[10] Tello, J.P. ; Manjarres, O. ; Quijano, M. ; Blanco, A. et al(2013) , " Remote Monitoring System of ECG and Human Body Temperature Signals", IEEE Latin American Transaction, Vol. 11, No. 1, February, pp. 314-318