

RED LIGHT VIOLATION MONITORING AND REPORTING USING MICROCONTROLLER CONTROLLED WIRELESS COMMUNICATION

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Traffic accidents are now one of the main causes of death and economic loss in most of the developed countries. Noncompliance with traffic laws is severely impeding the safety of the road traffic system. In this paper a system for monitoring and reporting incidences of red light violations at the traffic intersection has been proposed. A prototype of the system was build and verified experimentally. The system comprises an infrared (IR) transmitter and receiver unit for detection of red light violation whereas for identifying the vehicle, microcontroller triggered wireless mobile network has been used. The microcontroller was programmed to automatically send message containing the car license no, date and time of breaking the rule to the numbers of traffic control units stored previously to the cell phone directory. Upon detection of the offender, the corresponding action can be performed by the traffic monitoring system. The proposed system is simple, cheap, reliable, and exempted from the effects of bad weather conditions, improper lightings etc. and thus more suitable for detection of a violation and identification of the vehicle involved.

Key words: Red Light Violation; IR transmitter and receiver; Microcontroller; Wireless communication

1. INTRODUCTION

Traffic signals, through use of time separation, are designed to reduce motor-vehicle crashes at intersections involving conflicting traffic movements. Noncompliance with traffic laws is severely impeding the safety of the road traffic system. According to an in-depth investigation of road accidents in France, 92% of traffic accidents are preceded by at least one traffic law violation [1].

In most of the developed countries traffic accidents are now one of the main causes of death and economic loss [2]. According to the Road Safety Action Program of European Commission, more than one million accidents a year cause over 40,000 deaths and nearly two million injuries on the roads. In addition, the direct and indirect cost has been estimated at 160 billion Euros, which is nearly two percent of the EU's GNP. Unfortunately these thrilling numbers are increasing every year [3]. In Bangladesh road accidents claim on an average 12,000 lives annually and lead to about 35,000 injuries [4]. Everyday around eight persons die in road accidents and the number of accidents has increased by 43% between 1982 and 2000, while

the number of fatalities has increased by around 400% within the same period [5]. This indicates that not only the occurrence of accidents is on the rise the severity of accidents is also increasing.

But motorization is increasing even faster than road death and injury [6]. Many low income countries have experienced rapid growth in their motor vehicle fleet. As said by the Bangladesh Road Transport Authority (BRTA) official statistics, the number of registered vehicles up to 2003 at Dhaka city in Bangladesh was 3,03,215 and the number increases to 5,62,815 as on June 2010 [7]. Over the years, crash statistics have deteriorated due to the ever-growing number of vehicles on the road and the increasing vehicle-miles traveled, and this situation is becoming a major concern of Federal, State and local authorities. Many drivers do not comply with traffic signal indications [8]. More than one million motor-vehicle crashes occur annually at traffic signals in the United States [9-13] and a major cause of such crashes is drivers disregarding traffic signals. A review of 4,526 police-reported crashes in four U.S. cities found that running red lights and other traffic-control devices such as stop signs is the most frequent type of collision in urban areas and the occupant injuries

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occurred in 45 percent of the red light running crashes, compared with 30 percent for other crash types [14]. This indicates that reductions in red light running crashes would be especially beneficial in reducing urban crash losses.

Monitoring of traffic intersections for red-light violations has historically been done in-person by one or more law enforcement officers [15]. But, the proliferation of intersections, combined with budget pressures, increase number of vehicles on the road and other resource limitations, have caused police departments to employ automated tools for intersection monitoring [16, 17]. Among some existing automated systems, fixed-position cameras, commonly named as red light cameras, increasingly are being used in many foreign countries since the 1970s [18, 19] to help communities enforce traffic laws by automatically photographing vehicles whose drivers run red lights. Over time there have been some minor variations and automatic enforcement has been extended to several types of violations and new technologies for detecting violations as well as for identifying the violating vehicles has appeared [17, 20]. Probably the most notable developments have been systems involving the use of digital video recording [21] with image processing, and systems for electronic recognition and identification of a vehicle. But though certain countries have used photo-enforcement with some degree of success, current systems of traffic enforcement using photographic techniques have disadvantages that generally do not facilitate effective automation and validation of the photographs required for effective use as legal evidence. For instance, the film-camera systems have required white light illumination generally in the form of flash units, to provide sufficient light to capture violation images in poor ambient light or at night. The use of flash illumination may be detrimental at night to oncoming traffic and has the potential to cause temporary driver blindness and consequent safety risks as well as preventing authorities from deploying systems covertly. Moreover, the detection system is invariably unable to provide a trigger point that is sufficiently consistent to ensure that the positioning of vehicles at the time of imaging is identical. Where digital cameras are used, systems either require the availability of high-speed communications lines to meet the demands of communicating high-resolution images, or else images and data must be collected manually.

2. OBJECTIVE

In this research we have thought out of a system which is simple, cheap, reliable, and of course

offers at least some fundamental advantages over the conventional automated systems. Here we have used microcontroller controlled wireless communication system which makes the system not only automatic but also flexible. Also it makes the system simple to track the vehicle even when the number of traffic is large and also helps the system to keep in pace with the motion/running body.

3. DESCRIPTION OF THE SYSTEM

The overall traffic violation processing system of the proposed design is shown in Fig. 1. The controlling system mainly comprises (i) detection of the violation, and (ii) identification of the vehicle involved.

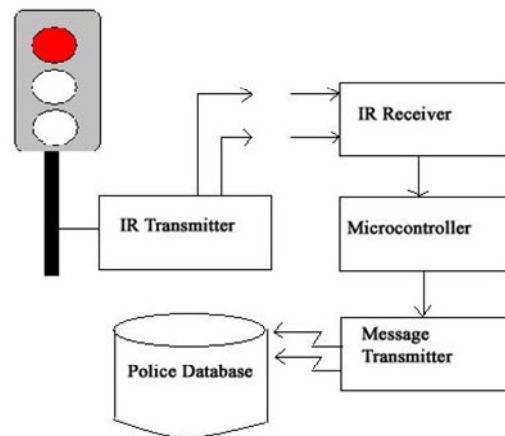


Fig. 1: Block diagram of the proposed traffic violation processing system

The IR transmitter and IR receiver cover the violation detection unit, while, for identifying the vehicles microcontroller triggered mobile communication system is used. For purposes of explanation, numerous specific details are set forth in order to provide an understanding of the present invention.

3.1 Detection of Violation

Fig. 2 shows the violation detection unit of the proposed scheme. Most conventional traffic surveillance systems use intrusive sensors, which include inductive loop detectors [22, 23] micro-loop probes, pneumatic road tubes, piezoelectric cables and other weigh-in-motion sensors for detection of violation. Some technologies are common to systems for detecting different violations, whereas, others are particularly tailored to the detection of specific kinds of violations. In our proposed system, infrared radiation (IR) transmitter and receiver units are used as a wireless sensor network with detection accuracy as good as

that of inductive loop for detection of traffic signal violation.

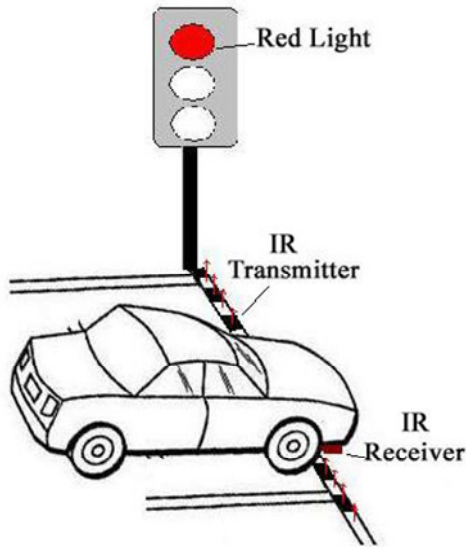


Fig. 2: Violation detection unit

When the red light on the signal post is ON, it will switch on the IR transmitters to continuously emit IR signals. The IR detector will be equipped in-car at the lower part of the vehicle. As soon as an alleged offender commits an offense at an intersection by violating the red light and crossing the line where he should stop, the IR detector in the car will receive the IR signal from the IR transmitter.

3.2 Identification of the Vehicle Involved

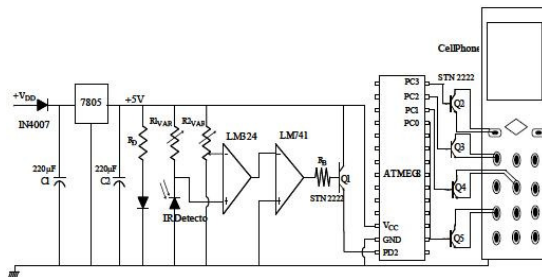


Fig. 3: Circuit diagram of the unit for identification of vehicle violating traffic rule

The hardware unit embracing the identification of vehicle violating the traffic rule mainly consists of a microcontroller operated automatic mobile communication system as shown in Fig. 3. The IR detector is connected through operational amplifiers (LM 324 and LM 741) to the base of the transistor Q1. The transistor output is attached to the input of the microcontroller unit. The microcontroller is

interfaced with mobile through four transistors connected to the bidirectional I/O port PC0~3 of the microcontroller. When the IR detector receives signal from the IR transmitter, it passes the signal to the operational amplifier. The operational amplifier compares a reference voltage with the voltage change made by the IR detector receiving the IR signal and supply base current to the transistor Q1 connected at the output. The transistor will turn on and give an interrupt signal to the microcontroller. The microcontroller sends pulse to the Port C according to interrupt subroutine and triggers the transistors Q2 ~ Q5 to activate the mobile. In accordance with the program loaded in the microcontroller an interrupt /sending message option will be performed by the cell. A message containing the car license no, date and time of breaking the rule is set to send automatically to the number(s) of traffic control unit stored previously in the cell phone directory. The law enforcing agency can easily identify the owner of the vehicle from the message received and can take appropriate actions against rule violation.

3. RESULTS AND DISCUSSION

The proposed microcontroller based traffic rules violation monitoring and reporting system has been implemented with a laboratory model and verified experimentally. Fig. 4 shows the experimental setup of the proposed system. A remote control toy-car was equipped with the IR detector and the microcontroller operated mobile unit. Two IR LEDs (Light Emitting Diode) in series with a 100 Ω resistor supplied by 5V dc supply has been used as IR transmitter. A Photodiode fastened at the lower part of the car was used as IR detector to receive IR beam transmitted from the transmitter. The road was modeled with wooden frame and to house in the transmitter unit across the road a glass pane was used to bridge the pathway.

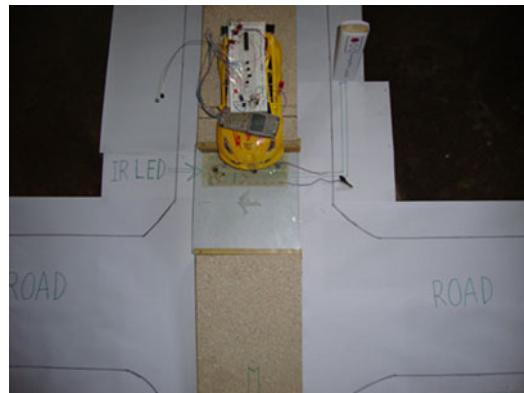


Fig. 4: Experimental setup of the proposed system

When the transmitter was switched on along with the red light on the signal post and the car crossed the transmitter and the intersection violating the red light, in reference to the program loaded in the microcontroller a message with a sample identification number was effectively sent to a predefined cell phone no. An illustration of the received message is shown in Fig. 5. The date and time of the sending message was obtained from the message property.

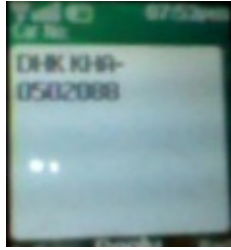


Fig. 5: Message received containing the car identification number

This way the laboratory model has substantiated the proposed scheme effectively. The system automatically monitored, reported and identified the disobedient offender using the simple microcontroller based wireless communication network. The effectual realistic execution of the research outcome can be intended to alleviate the high intensity of road traffic accident by effectively control the violation of traffic rule.

The conventional systems of [15-21] taking images of violating vehicles by red light cameras or video recorders suffer from significant drawbacks due to the poor environment many intersections provide for photography. Specifically, improper lighting resulting from hours of darkness, solar glare, reflections, and shadows may cause photographs taken by such existing systems to be of poor quality and, therefore, ineffective for identifying the operator or the license plate number of a violating vehicle. In addition, systems using fixed position cameras further suffer from problems of driver and/or vehicle identification resulting from occlusion of the violating vehicle by other vehicles. Moreover, the amount of information provided by existing systems regarding the context and/or circumstances surrounding an alleged violation is often insufficient for effective violation enforcement.

On the other hand, the proposed scheme is effective, and free from the effects of bad weather conditions, improper lightings etc. It can easily track the vehicle even when the number of traffic is large. Thus it is expected that the proposed system

would be more suitable to enforce the traffic rules by detecting a violating vehicle accurately and reducing the road traffic accidents significantly.

5. CONCLUSION

A novel, simple, improved and low cost system for monitoring and reporting incidences of red light violation at the traffic intersections has been suggested in this research. The proposed system consists of a traffic rule violation detection unit and the alleged offender identification unit. Upon detection of a predefined traffic law infraction at the intersection and recognition of the suspected convict, the corresponding action can be performed by the traffic monitoring system. The system is more reliable as it is free from the effects of bad weather condition, improper lighting which influence the performances of red light camera system for identifying the operator or the license plate number of a violating vehicle. As the overall system is automatic it is more secure. However, the prime obligation of the system is that there should be a dependable wireless mobile communication network through out the site of operation. In this regard the system can be made more economical and simple if the mobile phone unit can be replaced by a single RF transmitter IC TLP 434A and a receiver IC RLP 434. It would be also desirable that the proposed automated scheme for monitoring and reporting red light violations at the traffic intersections should be realized in practice. Furthermore, extended application of the proposed scheme, providing the capability to similarly monitor and/or record events occurring at railroad crossings, border check points, toll booths, pedestrian crossings and parking facilities, would specifically be desirable in future.

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