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A Novel System for Traffic Control Based on Emergency Vehicle Clearance, Congestion Control and Anti-Theft Assistance

ADI ANIL KUMAR[1], GAYATRI SHENWAI[2], DR. K. SRINIVASULU[3]

[1]PG Scholar, Dept of ECE, Narsimha Reddy Engineering College, Maisammaguda, Ranga Reddy, TS, India,
E-mail: aadhianil45@gmail.com.

[2]Assistant Professor, Dept of ECE, Narsimha Reddy Engineering College, Maisammaguda, Ranga Reddy, TS, India,
E-mail: gayatri.shenwai@gmail.com.

[3]Professor & HOD, Dept of ECE, Narsimha Reddy Engineering College, Maisammaguda, Ranga Reddy, TS, India,
E-mail: srinivasulu41@yahoo.com.

Abstract: This work mitigates the problem of traffic control at junctions. At each entry and exit way on the junction proximity sensors are installed in order to detect the traffic density on the way. Based on the traffic density, the signalling and the green light duration for the way at the junction are controlled. Each vehicle is equipped with an RFID tag. At the junction an RFID reader is placed, whenever the vehicle reaches at the junction, its ID is recorded at the junction. If there is theft complaint regarding that ID in the database, the junction intimates the traffic police staff through an alarm. Also it sends an SMS to the owner of the vehicle. Emergency vehicles are equipped with Zigbee module, so that they can get clearance from the junction by communicating with the Zigbee module installed at the junction.

Keywords: Zigbee, GSM, ARM7, Emergency Vehicle, Stolen Vehicle, Congestion Control.

I. INTRODUCTION

The number of vehicles in India is quickly increasing as a growing middle class can now afford to buy cars. As per an estimate by the Asian Development Bank (ADB), about 44 million people are added to India's urban population every year. Indian cities are also characterized by high population density. For instance, Mumbai is the second most densely populated city in the world. With such a rapid increase in urban population, there has been an increase in demand for mobility, and with it, an increase in motorized vehicle ownership. Technologies like ZigBee, RFID and GSM can be used in traffic control to provide cost effective solutions. RFID is an acronym for Radio Frequency Identification. This technology is embedded in tags, or chips, and works to communicate information. The RFID chip and the reader merely need to be within range of each other to communicate and not in line of sight as required in identification based on UPC codes (bar codes). There are different types of proximity sensors available each having its own merit and demerit. Some of these include photoelectric sensors, fibre optic sensors, laser sensors, inductive sensors, contact based sensors, ultrasonic sensors, vision sensors etc. Currently we are using photoelectric sensor which emits a light beam (visible or infrared) from its light-emitting element A reflective-type photoelectric sensor is used to detect the light beam reflected from the target. A thru beam type sensor is used to measure the change in light quantity caused by the target crossing the optical axis. GSM (Global System for Mobile Communications, originally Group Special Mobile), is a standard developed by the European Telecommunications Standards Institute (ETSI).

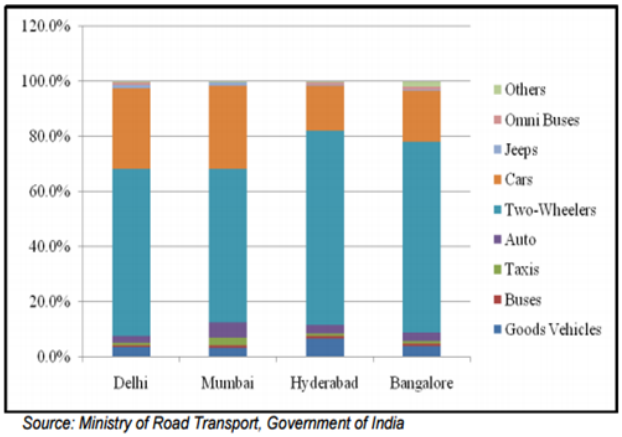


Fig.1. Share of Types of Motorized Vehicles in 2011.

It was created to describe the protocols for second-generation (2G) digital cellular networks used by mobile phones and is now the default global standard for mobile communications – with over 90% market share, operating in over 219 countries and territories. A GSM module or a GPRS module is a chip or circuit that will be used to establish communication between a mobile device or computing machine and a GSM or GPRS system. The modem (modulator-demodulator) is a critical part here. These modules consist of a GSM module or GPRS modem powered by a power supply circuit and communication interfaces (like RS-232, USB 2.0, and others) for computer. A GSM modem can be a dedicated modem device with a serial, USB or Bluetooth connection, or it

can be a mobile phone that provides GSM modem capabilities. AT commands are used to control modems. These commands come from Hayes commands that were used by the Hayes smart modems. Zigbee/Xbee modules are advanced RF transceivers operating in the license free 2.4GHz frequency band. Zigbee transceivers are used where a good robust RF communication with high noise immunity and guaranteed packet delivery is required. The most common application of Zigbee modules is the Sensor networks. These modules can be a very good replacement for the old RF transceivers. The whole paper is divided into 5 parts. Sections II talks about the literature survey. Section III discusses about the current problems that exist in making way to an ambulance and other vehicles. It also talks of how the proposed model will overcome the problems faced in developing Countries as well as developed countries. Section IV gives the implementation details of the proposed model. Section V presents the enhancement of this work.

II. LITERATURE REVIEW

A green wave system was implemented which provides clearance to emergency vehicles during rush hours [8]. A 'green wave' is the synchronization of the green phase of traffic signals. With a 'green wave' setup, a vehicle passing through a green signal will continue to receive green signals as it travels down the road. In addition to the green wave path, the system will track a stolen vehicle when it passes through a traffic light. Advantage of the system is that GPS inside the vehicle does not require additional power. The biggest disadvantage of green waves is that, when the wave is disturbed, the disturbance can cause traffic problems that can be exacerbated by the synchronization. In such cases, the queue of vehicles in a green wave grows in size until it becomes too large and some of the vehicles cannot reach the green lights in time and must stop. This is called over-saturation. An RFID based traffic control system was proposed that usually arise with standard traffic control systems, especially those related to image processing and beam interruption techniques [6]. This RFID technique deals with a multivehicle, multilane, multi road junction area. It provides an efficient time management scheme, in which a dynamic time schedule is worked out in real time for the passage of each traffic column.

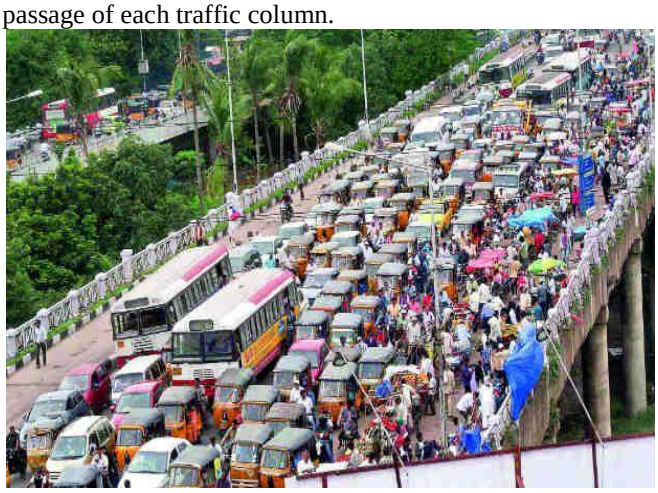


Fig.2. Traffic in Hyderabad.

The real time operation of the system emulates the judgment of a traffic policeman on duty. They proposed a self-organized traffic control scheme that helps facilitate emergency response operations (i.e., facilitate and expedite the movement of emergency vehicles through traffic in urban areas). In the proposed VTL-PIC scheme vehicles can resolve the ensuing conflicts at intersections by themselves and implement a priority scheme that can prioritize emergency vehicles at intersections. Their approach is based on a RFID tagging of traffic signals to convey their information to the car. The proposed on-board architecture is portable and easily adaptable to any commercial car with minimal modifications. The system shows promising results, since active RFID technology permits to detect the presence and identity of the traffic signals reliably and sufficiently in advance. An RFID and GPS based automatic lane clearance System for Ambulance was proposed [10].The focus of this paper is to reduce the delay in arrival of the ambulance to the hospital by automatically clearing the lane in which ambulance is travelling, before it reaches the traffic signal. This can be achieved by turning the traffic signal, in the path of the ambulance, to green when the ambulance is at a certain distance from the traffic junction. The use of RFID distinguishes between the emergency and non-emergency cases, thus preventing unnecessary traffic congestion. The communication between the ambulance and the traffic signal post is done through Zigbee. The system is fully automated and thus, requires no human intervention at the traffic junctions.

III. PROPOSED MODEL

The proposed system mainly consists of four parts. First part contains automatic signal control system. Here, each way is installed with proximity sensors placed at increasing distances from the junction. In case of high traffic density, the sensor farthest from the junction will be activated. Based on the traffic density the time duration of green light for the particular road is fixed. Second part is for emergency vehicle clearance. Each emergency vehicle contains Zigbee transmitter module and the Zigbee receiver will be installed at the traffic junction. Whenever the vehicle reaches junction and does not has clearance, the driver will press switch to indicate his source route and destination route. Based on this information, the vehicle will be given clearance by the system installed at the junction. Once the emergency vehicle passes through, the receiver no longer receives the Zigbee signal and the traffic signal becomes red. The third part is responsible for stolen vehicle detection. Here, when the RFID reader reads the RFID tag, it compares it to the list of stolen RFIDs. If a match is found, it sends SMS to the police control room and changes the traffic light to red, so that the vehicle is made to stop in the traffic junction and local police can take appropriate action. A SMS is sent to the owner of the vehicle. List of components used in the experiment are Tarang Zigbee module, PhilipsLPC2148, RFID Reader–125KHz– TTL and SIM900 GSM module.

Figure 3 shows the pin diagrams (or pictures) of components used.

Fig.3. Components Used

A. Tarang Zigbee Module

These modules are designed with low to medium transmit power and for high reliability wireless networks. The modules require very low power and provide reliable delivery of data. It has UART interface and operates within the ISM 2.4-2.4835GHz frequency band with IEEE 802.15.4 baseband. It provides a range of 50 kms with directional antenna in outdoor conditions. Its transmit power is upto 1 watt/ 30dB. The receiver sensitivity is upto -107dBm. These modules interface to a host device through a logic-level asynchronous serial port. Through this port, the module can communicate with any logic and voltage compatible UART or through a level translator to any serial device.

A. Microcontroller LPC2148

The LPC2148 microcontrollers are based on a 32-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, which combine the microcontroller with embedded high-speed flash memory ranging from 32 kB to 512 kB. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode reduces code by more than 30 % with minimal performance penalty. Due to their tiny size and low power consumption, LPC2148 are ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale. Serial communications interfaces ranging from a USB 2.0 Full-speed device, multiple UARTs, SPI, SSP to I2C-bus and on-chip SRAM of 40 KB, make these devices very well suited for communication gateways and protocol converters, soft modems, voice recognition and low end imaging, providing both large buffer size and high processing power. Various 32-bit timers, single or dual 10-bit ADC(s), 10-bit DAC, PWM channels and 45 fast GPIO lines with up to nine edge or level sensitive external interrupt pins make these microcontrollers suitable for industrial control and medical systems.

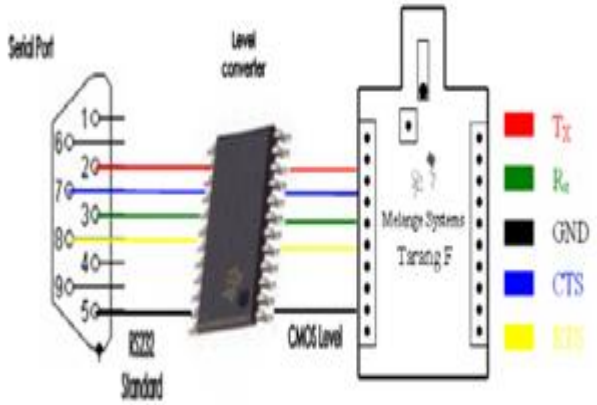


Fig.4. Interface with Microcontroller

B. GSM Module

GSM modem is connected with the microcontroller. This allows the computer to use the GSM modem to communicate over the mobile network. These GSM modems are most frequently used to provide mobile Internet connectivity, many of them can also be used for sending and receiving SMS and MMS messages. GSM modem must support an “extended AT command set” for sending/receiving SMS messages. GSM modems are a cost effective solution for receiving SMS messages, because the sender is paying for the message delivery. SIM 300 is designed for global market and it is a tri-band GSM engine. It works on frequencies EGSM 900 MHz, DCS 1800 MHz and PCS 1900 MHz. SIM300 features GPRS multi-slot class 10/ class 8 (optional) and supports the GPRS coding schemes. This GSM modem is a highly flexible plug and play quad band GSM modem, interface to RS232, it supports features like voice, data, SMS, GPRS and integrated TCP/IP stack. It is controlled via AT commands (GSM 07.07,07.05 and enhanced AT commands). It uses AC – DC power adaptor with following ratings DC Voltage: 12V/1A.

C. RFID Reader

Radio Frequency Identification (RFID) is an IT system that transmits signals without the presence of physical gadgets in wireless communication. It is categorized under automatic identification technology, which is well established protocol. The working of an RFID system is very simple. The system utilizes tags that are attached to various components to be tracked. The tags store data and information concerning the details of the product of things to be traced. The reader reads the radio frequency and identifies the tags. The antenna provides the means for the integrated circuit to transmit its information to the reader. There are two types of RFID categories, active and passive tags. The tags that do not utilize power are referred to as passive and they are driven by an antenna that enables the tag to receive electromagnetic waves from a reader. On the contrary, active tags rely on power and they have inbuilt power sources that enable it to send and receive signals from RFID reader. RFID range depends on transmit power; receive sensitivity and efficiency, antenna, frequency, tag orientations, surroundings. Typically, the RFID range is from a few centimetres to over hundred meters. RFID reader uses frequency 125 KHz with a range of 10 cm.

D. Proximity Sensors

It is the same principle in ALL Infra-Red proximity sensors. The basic idea is to send infra-red light through IR-LEDs, which is then reflected by any object in front of the sensor.

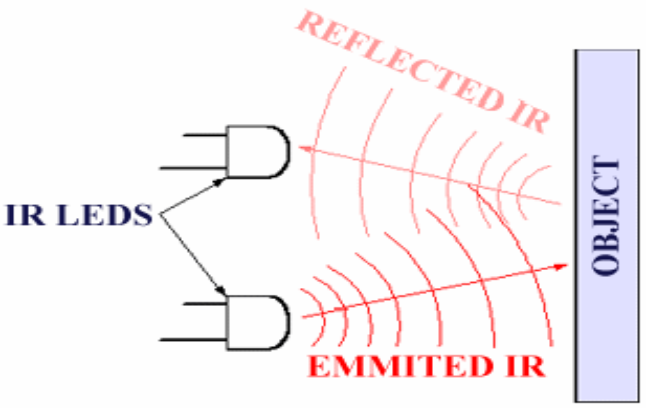
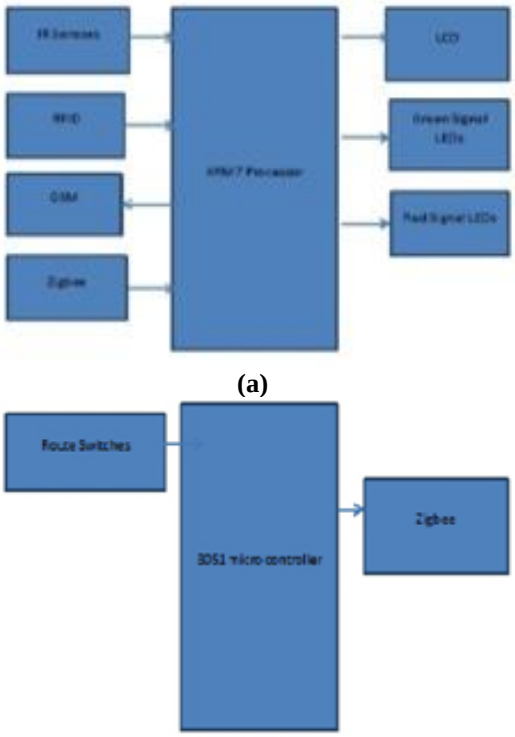


Fig.5. Working Principle of Proximity Sensor

Then all that needs to be done is to pick-up the reflected IR light. For detecting the reflected IR light, we are going to use a very original technique: we are going to use another IR-LED, to detect the IR light that was emitted from another led of the exact same type! This is an electrical property of Light Emitting Diodes (LEDs) which is the fact that a led produces a voltage difference across its leads when it is subjected to light. As if it was a photo-cell, but with much lower output current. In other words, the voltage generated by the leds can't be – in any way – used to generate electrical power from light, it can barely be detected. That's why as you will notice in the schematic, we are going to use an Op-Amp (operational Amplifier) to accurately detect very small voltage changes.

IV. EXPERIMENTAL RESULTS



(a)

(b)

Fig.6. A Novel System for Traffic Control and Anti-Theft Assistance. (a) Block Diagram for Congestion Control System. (b) Anti-Theft Assistance.

(a)

Based on the traffic density on a particular route, the green signal duration of the route is changed. The traffic density is also displayed on LCD.

(b)

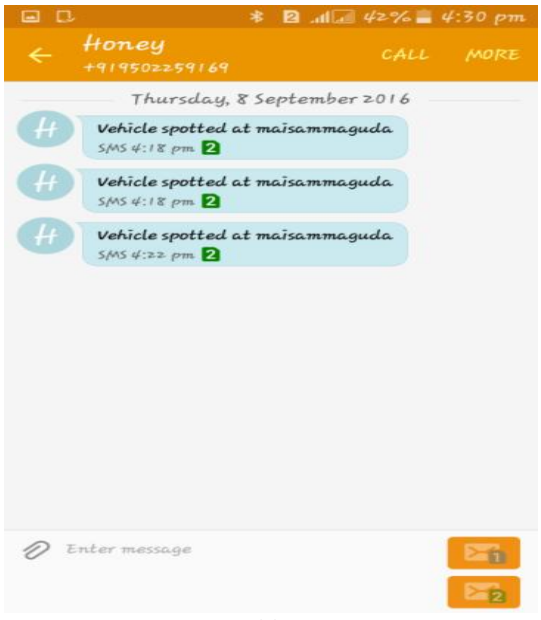
If the vehicle arriving at the junction is not stolen, then a relevant message is displayed on LCD.

(c)

Similarly, whenever the vehicle is stolen, a relevant message is displayed on the LCD

(d)

Also a relevant SMS is sent to the owner of the vehicle.



(e)

(f)

Fig.7. Proposed Model Kit Images. (a) Working Model of the Project. (b) LCD Display for Clearing Root. (c) LCD Display for Normal Vehicle. (d) LCD Display for Stolen Vehicle. (e) When Stolen Vehicle is Detected. (f) Display for Emergency Vehicle Clearing

V. CONCLUSION AND ENHANCEMENTS

With automatic traffic signal control based on the traffic density in the route, the manual effort on the part of the traffic policeman is saved. As the entire system is automated, it requires very less human intervention. With stolen vehicle detection, the signal automatically turns to red, so that the police officer can take appropriate action, if he/she is present at the junction. Also SMS will be sent so that they can prepare to catch the stolen vehicle at the next possible junctions. Emergency vehicles like ambulance, fire trucks, need to reach their destinations at the earliest. If they spend a lot of time in traffic jams, precious lives of many people may be in danger. With emergency vehicle clearance, the traffic signal turns to green as long as the emergency vehicle is waiting in the traffic junction. The signal turns to red, only after the emergency vehicle passes through. Further enhancements can be done to the prototype by testing it with longer range RFID readers. Also GPS can be placed into the stolen vehicle detection module, so that the exact location of stolen vehicle is known. Currently, we have implemented system by considering one road of the traffic junction. It can be improved by extending to all the roads in a multi- road junction.

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Author's Profile:

Adi Anil Kumar received his B. Tech degree in Electronics & Communication Engineering from Elenki Institute of Engg & Technology affiliated to JNTU, Hyderabad and pursuing M. Tech (ES) in Narsimha Reddy Engineering College, Maisammaguda, Ranga Reddy District, Telangana, India. His area of interest includes Embedded Systems.

Mrs.Gayatri Shenwai received her M.Tech degree in VLSI & Embedded Systems from DRK Institute of Science & Technology affiliated to JNTUH, Telangana, India in 2013. Presently she is working as an Assistant professor in Department of Electronics and Communication Engineering of Narsimha Reddy Engineering College, Hyderabad, Telangana, India. Her current areas of research interests include communications, Embedded Systems.

Dr.K.Srinivasulu has done his M.Tech in ES, JNTU Hyderabad. He received the Ph.D. from SR University, Alwar. Presently he is working as Professor and Head of the Department of Electronics and Communication Engineering in Narsimha Reddy Engineering College, Hyderabad, Telangana, India. He has over 15 years of experience in R&D, industry and teaching. He has published and presented 10 research papers in respective International/National Journals and Conferences. He is a life member of MISTE. His research area includes Electronic Circuits. Presently he is guiding one research scholar.