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Intelligent Traffic Control System for Congestion Avoidance, Ambulance Path Clearance and Stolen Vehicle Detection

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Abstract: *This paper presents an intelligent traffic control system to pass emergency vehicles smoothly. Wherein each vehicle is equipped with special radio frequency identification (RFID) tag (placed at a strategic location), which makes it impossible to remove or destroy. We use Arduino Uno and 125 KHz RFID card ID reader module. Arduino Uno counts the number of vehicles that passes in a particular path during a specified duration. It also determines the traffic congestion, and the green light duration for that path. If the RFID tag read belongs to the stolen vehicle, then a message is sent using GSM SIM800A to the nearest police control room. In addition, when an emergency vehicle is approaching the junction, the light will be turned to green and it will remain green until that ambulance or any other emergency vehicle passes that junction. This module uses ZigBee CC2500 pair and Arduino Uno for wireless communications between the ambulance and traffic light control. The prototype was tested under different combinations of inputs in our wireless communication laboratory and experimental results were found as expected.*

Keywords: *ZigBee CC2500, GSM SIM800A, Arduino Uno, 125 KHz RFID card ID reader, vehicle, stolen vehicle, congestion control, traffic junction.*

I. Introduction

India is the second most populous Country in the World and also a fast growing economy. It is seeing terrible road congestion problems especially in the city areas.[1]. At most places roads are single lane and chaotic. Intelligent management of traffic flow can reduce the negative impact of congestion. In recent years, wireless networks are widely used in the road transport as they provide more cost effective options [2]. Technologies like ZigBee, RFID and GSM can be used in traffic control to provide cost effective solutions. RFID is a wireless technology that uses radio frequency electromagnetic energy to carry information between the RFID tag and RFID reader. Some RFID systems works within the range of inches or centimeters, while others may work for 100 meters (300 feet) or more. A GSM modem is a specialized type of modem, which accepts a SIM card and operates over a subscription to a mobile operator, just like a mobile phone. The whole paper is grouped 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 Survey

Traffic congestion is a major problem in cities of developing Countries like India. Growths in population contribute significantly to the rise in the number of vehicles in the cities [6]. Congestion on roads results in slow moving traffic, which increases travel time, which is a major issue in metropolitan cities. In [7], green wave system is discussed, which is used to provide clearance to any emergency vehicle by turning all the

red lights to green on the path of the emergency vehicle, thus providing a green wave to the desired vehicle. A 'green wave' is the synchronization of the green phase of traffic signals. With a 'green wave' setup, a vehicle passing will continue to receive green signals as it travels through that path. In addition to the green wave path, the system will track a stolen vehicle when it passes through a junction. 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.

Fig 1: Traffic in Bangalore city

In [8], the use of RFID traffic control to avoid problems that usually arise with standard traffic control systems, especially those related to image processing and beam interruption techniques are discussed. This RFID technique deals with multivehicle, multilane, multi road junction areas. 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. The real-time operation of the system emulates the judgment of a traffic policeman on duty. The number of vehicles in each column and the routing are proprieties, upon which the calculations and the judgments are done. The disadvantage of this work is that it does not discuss what methods are used for communication between the emergency vehicle and the traffic signal controller. In [9], it proposed a RFID and GPS based automatic lane clearance system for ambulance. The focus of this work 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 traffic signal post is done through the transceivers and GPS. The system is fully automated and requires no human intervention at the traffic junctions. The disadvantage of this system is it needs all the information about the starting point and end point of the travel. It may not work, if the ambulance needs to take another route for some reasons or if the starting point is not known in advance.

Traffic is a critical issue in countries like India and China, where the population is increasing at higher rate. As shown in Fig 1. For example, Bangalore city, has witnessed a phenomenal growth in vehicle population in recent years. As a result, many of the arterial roads and intersections are operating over the capacity (i.e., v/c is more than 1) and average journey speeds on some of the key roads in the central areas are lower than 10 Km/h at the peak hour. junction. It will communicate the same to the local police officers for the necessary actions.

III. Problem Statements

A] Traffic Congestion

Traffic congestion causes delay in reaching the destination. It may have different effects depending upon the severity of problem. The large amount of fuels is being wasted due to regular traffic jams, the burnt fuels causes air pollution due to emission of toxic gases like carbon dioxide and carbon monoxide. There may be wear and tear of vehicles due idling in traffic, frequent acceleration and breaking which leads to repairs and replacements. Stressed and frustrated motorists may encourage road rage. It can cause rise in accidents leading to reduced health of motorists. There are also chances of collision due to tight spacing Emergency vehicle clearance.

B] Ambulance
The delay in reaching the ambulance to hospital may lead to loss of individual's life

C] VIP vehicles
Barricading should be done for nonstop movement of VIP vehicle which causes enormous traffic jams

D] Stolen vehicle Detection
It can destroy the owner mentally as well as financially. It is difficult to track mobile stolen vehicle. There are chances that the stolen vehicle may be used for other unlawful and unethical activities by the name of the owner. Changing stolen vehicles color or taking it to other state makes it very difficult to detect it.

IV. Existing System

As the population of cities is increasing, the vehicle movement on the road is also increasing thereby leading to traffic congestion. The average number of vehicles in India is growing at the rate of 10.16% annually, over the last few years. Spending hours in traffic jam has become part and parcel of metropolitan life style. The traditional method for traffic control uses fixed traffic poles on the left side of the road at the traffic junctions that display the traffic light. The steady increase in the number of vehicles on the road has amplified the importance of managing traffic flow efficiently to optimize utilization of existing road capacity. Presently major cities are covered under the surveillance of CCTV camera so that the vehicles and humans are tracked.

- **LIMITATIONS OF EXISTING SYSTEM**

It may not obtain accurate and complete information of vehicle through CCTV cameras. Even if tracked, it takes a lot of time to collect the full details about the vehicle owner. Also it doesn't have any technology to track the moments of vehicles. It doesn't include any methods to track stolen vehicles.

V. Proposed System

Vehicles during RTO registrations are required to have a smart tag embedded into it, which can be used later to authenticate a vehicle and its owner information. While few sensors (or readers), installed on gantry or metal frame running across the road side, would capture the smart tag id every time a vehicle pass in front of it and even during the case of red light run, the system can now easily identify the correct vehicle on crime and even capture still images/videos for the purpose of issuing the fine or chalan. It will also provide a 24 hour feedback to the Traffic Management Centre for maintaining a record of all vehicles passing through a given area. So if the police want to check a vehicle for security reasons, they will just need to key in its registration number/tag id in the main system to learn about its movement across the city. When any vehicle skips the Red light, its complete details are obtained through the RFID card attached to the vehicle, further automatically a fine or chalan is raised and posted to vehicle owner address and its details are sent as a message on the concerned user's registered mobile number. With details of the offence available, traffic police processes the information at its Traffic Management Centre and obtain the registered owner's name from the Regional Transport Office and the offending vehicle is issued a notice to show cause and give information as to who was using the vehicle at that time and the required action will be taken as per the law.

- **APPLICATIONS OF PROPOSED SYSTEM**

Our proposed plan with this application is expected to go a long way in reducing the number of accidents. Keeping the application always active can be more advantageous for tracking the movements of vehicles in different areas. E.g. If any vehicle is been stolen, than using the current application we can easily track every movements of that vehicle when it passes through the traffic junctions. Creation of this application makes it surpass the expected behavior.

VI. Working Model

A] Automatic Signal Control System

In this module, for experimental purpose, we have used passive RFID tags and RFID reader with frequency 125 KHz. when RFID tag containing vehicle comes in the range of the reader than the receiver will transmits the unique RFID to the reader. The Arduino Uno connected to the RFID reader will count the number of vehicles present in the path. For testing purpose, if the count is more than 10, the green light duration is set to 30 seconds, if count is between 5 and 9, the green light duration is set to 20 seconds. If the count is less than 5, the green light duration is set to 10 seconds. The red light duration will be for 10 seconds and orange light duration will be for 2 seconds. Fig 2 shows the block diagram for automatic signal control system.

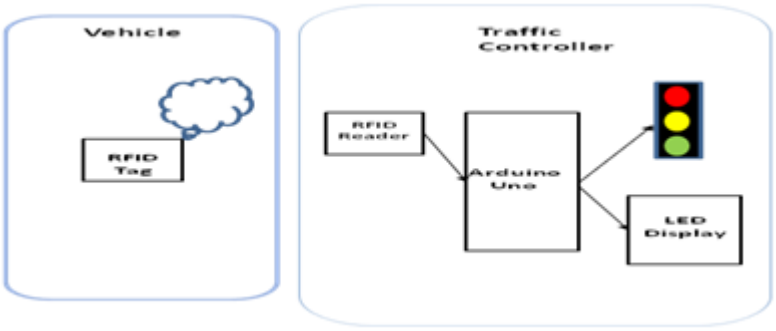

Fig 2: Block diagram for automatic signal control system

B] Stolen Vehicle Detection System

In this module, we compare the RFID tag read by the RFID reader with stolen RFIDs stored in the database. If a match is found, the traffic signal immediately turns to red for duration of 30 seconds. Also an SMS is sent specifying the RFID number by using SIM300 GSM module. The LCD display will indicate where the stolen vehicle is present. Fig 3 shows the block diagram for stolen vehicle detection system.

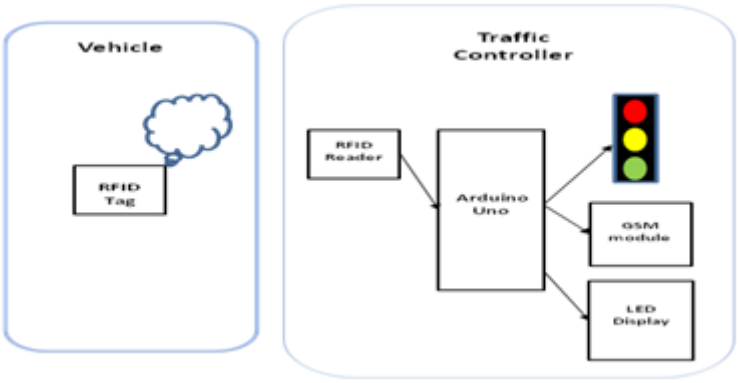

Fig 3: Block diagram for stolen vehicle detection system

C] Emergency Vehicle Clearance System

In this module, there are 2 parts, in first part a ZigBee transmitter is placed in the emergency vehicle. When a switch is pressed, it will transmit the signal. The signal contains unique id and security code. The transmitter contains Arduino Uno microcontroller and ZigBee module. The microcontroller sends the commands and data to the ZigBee via serial communication. Second part contains a receiver, which is placed at the traffic pole. It also contains Arduino Nano microcontroller and ZigBee module. The receiver compares the security code received with the security code present in its database. If it matches, then it will turn the green light on. For testing purpose, we use short range RFID reader in our prototype. First, the receiver part is turned on. The red and green signal will be on for 10 seconds duration and orange light will be on for 2 seconds duration one after the other. Secondly, we bring the RFID of stolen vehicle into the range of RFID reader. Then the signal will turn to red for duration of 30 seconds and a SMS is also send. Also we bring an emergency vehicle carrying ZigBee transmitter into the range of ZigBee receiver, and then the traffic light will change to green till the receiver receives the ZigBee signal. It is as shown in Fig 4.

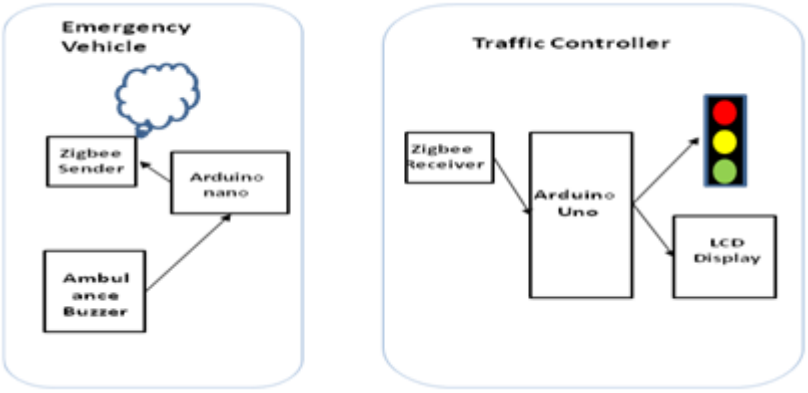

Fig4: Block diagram of emergency vehicle clearance system

D] COMPLETE BLOCK DIAGRAM

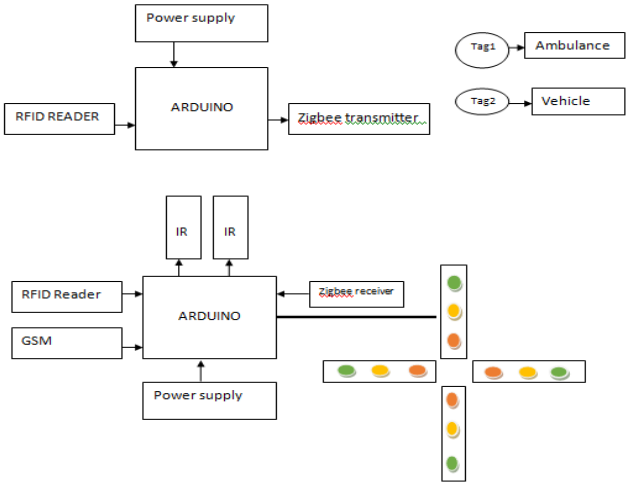

Fig 5: Block diagram for ambulance path clearance, stolen vehicle detection and congestion avoidance

E] ZigBee ModuleCC2500

The CC2500 is a RF module and it has transreceiver, which provides an easy way to use RF communication at 2.4 GHz. Every CC2500 is equipped with the microcontroller which contains Unique Identification Number (UIN). This UIN is based on the registration number of the vehicle. One of the important features is that it provides serial communication without any extra hardware and also no extra coding. Hence, it is a transreceiver as it provides communication in both directions. The microcontroller and CC2500always communicate with the microcontroller via serial communication. Fig 5 shows CC2500 ZigBee module having transmission range of 20 meters.

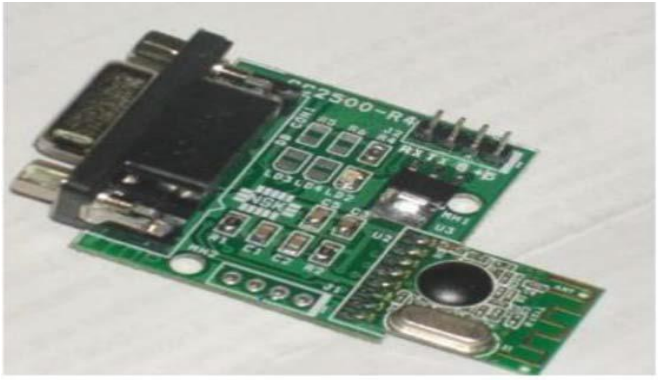

Fig 6: ZigBee module CC2500

F] Arduino Uno

Arduino can be used as an open source physical computing platform based on simple microcontroller board. It provides a development environment for writing software. It is based on ATmega328 [14]. It has 14 digital input/output pins of which 6 can be used as PWM outputs, 6 analog inputs, a16 MHz ceramic resonator, a USB connection, an ICSP header, a power jack, and a reset button. It has everything that a controller needs .It is a simple procedure to connect it with USB port to power it with AC-TO-DC adapter to start. It features AT mega 16U2 programmed as a USB to serial convertor. The ATmega328 has 32 KB (with 0.5 KB used for the boot loader). It also has 2 KB of SRAM and 1 KB of EEPROM. Each of the 14 digital pins on the Uno can be used as an input or output, using pin Mode (), digital Write ( ), and digital Read ( ) functions.

Fig 7: Arduino Uno

G] GSM Module SIM 800A

Here, a 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.

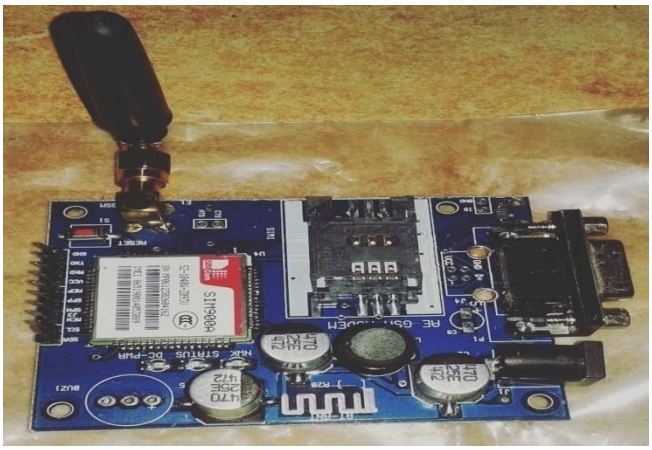

Fig 8: GSM Module SIM800A

H] 125 KHz RFID card ID reader

Radio Frequency Identification (RFID) is a system that transmits signals without the presence of physical gadgets in wireless communication. It is categorized under automatic identification technology, which is a 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.

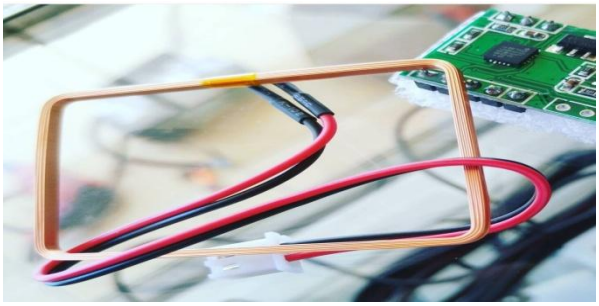

Fig 9: 125 KHz RFID card ID readers

VII. Conclusion

With automatic traffic signal control based on the traffic density in the route, the manual effort of the traffic policeman is saved. As the 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. With emergency vehicle clearance, the traffic signal turns to green as long as the emergency vehicle is present in the traffic. The signal turns to red, only after the emergency vehicle passes through. This application is working properly and meeting all user requirements. This component can be easily plugged in many other systems. The system has been developed with much care that it is free of errors and at the same time it is efficient and less time consuming. The important thing is that the system is robust. and avoid malfunction from outsiders. It goes through all phases of software development cycle. So product is accurate. Also provision is made for future developments in the system.

VIII. VIII OUTPUT

Transmitter Part

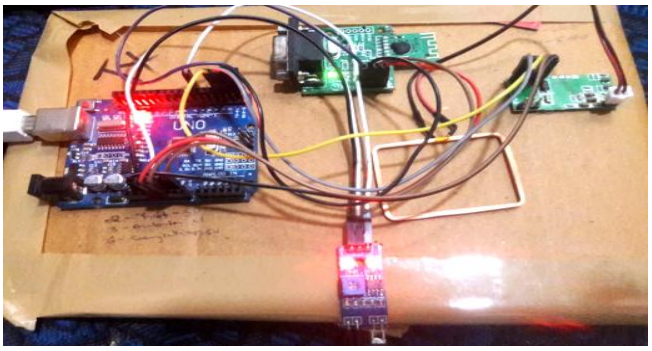

Fig10 : Transmitter Part

The transmission part senses the data from the RFID reader and IR sensor and sends the data to the ZigBee module which will send the information to the Arduino and the Arduino will use serial communication to transmit the information to the receiver module.

Receiver Part

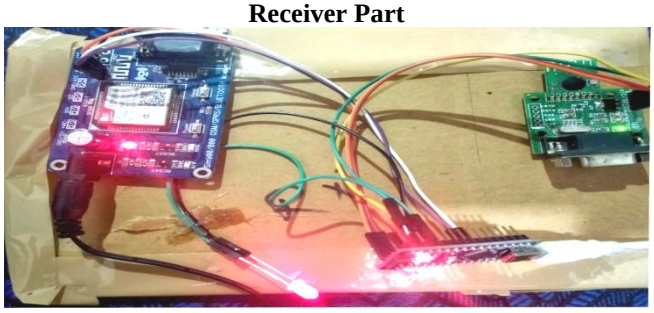

Fig11: Receiver Part

With the information received from the Transmitter part the Arduino communicates with ZigBee at the receiver using serial communication then using the information Arduino will control the traffic light and the GSM module used to send SMS.

IX. Future Enhancements

Changes can be made to this 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. Though it is well modulated system, it has been limited to certain restrictions. By understanding trends in technology we can sometimes make accurate predictions about what will happen in the future. This Project can be enhanced by adding the Check Posts with cameras.

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