An Intelligent Green Wave Traffic Light Control System for Emergency Purpose Vehicle

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***Abstract*— This proposed paper deals in providing valuable information about a prototype of an intelligent traffic light control system for emergency purpose vehicles. Since traffic congestion is a major problem in cities of developing countries like India, so sometimes it becomes a tedious job for the traffic police officers to manually control the vehicles. Growth in urban population and middle-class segment are responsible for the heavy consumption of vehicles resulting in raising the number of vehicles in the cities. Congestion on roads eventually results in slow moving traffic, which increases the time of travel, thus causing many problems especially when there are emergency cases at traffic light intersections which are always busy with many vehicles. As emergency vehicles like ambulance, police jeeps and fire brigade trucks need to reach their destinations at the earliest but if they spend a lot of time in traffic jams, which is predominant in peak hours, then lives of many people may be in danger. Therefore, an intelligent traffic light control system with RF based technology is designed to solve these problems.**

***Keywords*— Radio Frequency (RF) Communication, RF Module, RFID, PIC16F72, SIM 900**

I. INTRODUCTION

Traffic on roads may consist of pedestrians, ridden or herded animals, vehicles, streetcars, buses and other conveyances. No researcher can fully predict under which conditions a traffic jam may suddenly occur. It has been found that vehicles often come into conflict with other vehicles and pedestrians because their intended courses of travel intersect, and thus interfere with each other's routes resulting in a sustained traffic jam. It has also been recorded that due to overtime of ambulance or fire brigade there is a huge loss to the society. Mostly, the traffic light controller in use has a fixed predetermined schedule for traffic inflow for each direction in the junction which is not found to be very successful. Therefore, a fast real-time and robust intelligent traffic light control system is needed.

The following paper will help to reduce blockage of emergency vehicles in traffic. In this way, a lot of critical time and so many lives can be saved. The main objective of this paper is the smart management of traffic flow to reduce the negative effect of traffic congestion on emergency vehicles. In recent years, wireless networks are widely used in the road transport as they provide more cost effective options. Technologies like ZigBee, GSM and RFID can be used in traffic light control system to provide cost better solutions. Here, we are using high-frequency cost efficient RF-based technology for detecting an emergency vehicle in the traffic. The general principle established is one who has the right to go first is called "right of way" or "priority" i.e. one who has the right to use the conflicting part of the road while other to wait until the one does so.

II. LITERATURE SURVEY

To have the better understanding of the aforementioned problem and before undertaking the project, the literature review is decisive. The literature review provides information on the technologies available and methodologies used by other research counterparts around the world on the topic.

Suresh Sharma, A. Pithora, G. Gupta, M. Goel, and M. Sinha proposed a RFID based Traffic Control System [1]. The RFID-based traffic control system avoids problems that usually arise with standard traffic control systems, particularly those related to image processing and beam interruption techniques. This RFID-based traffic control system deals with multi-vehicle, multilane, multi-road junction areas. It provides an efficient time management scheme in which an active time schedule is worked out in real time for the road of each traffic column. The real-time operation of the system gives the judgment of a traffic policeman on duty. The drawback in this work is that it does not discuss what methods to be used for communication between the emergency vehicle and the traffic signal controller.

W.E. Brill introduced an Emergency Vehicle Detection System [2] which includes a sound signal producing unit mounted on an emergency vehicle, a sound signal detection unit mounted on a non-emergency vehicle, and a display unit remotely located on the non-emergency vehicle. The sound signal producing unit has a sound generator for producing and transmitting a sound signal. A switch is used for controlling the operation of the sound generator in combination with a siren. The sound signal detection unit has at least one sound transducer for detecting sound signal and producing an electric current upon detection of a signal. A comparator is connected to the sound transducer for comparing the current from the transducer to pre-programmed patterns. If there is a matching pattern, a signal output encoder connected to the comparator constructs an encoded signal and transmits it to a remotely located display unit through a transmitter. The display unit has a receiver for receiving the encoded signal and passing it to a comparator to compare the encoded signal to known the pattern and activate at least one illumination device upon detection of a matched pattern.

Pratyush Parida, Sudeep Kumar Dhurua, P. Santhi Priya put forward an Automatic Traffic Light Control System in an Emergency Case [3]. When an emergency vehicle (ambulance) approaches towards the traffic light, the traffic light is

forcefully driven to reset to green light at ambulance side and to the red light at other three sides. The ambulance has a transmitter which transmits the Infrared signal (IR). IR-LED (Light Emitting Diode) module can transmit IR rays up to a few meters and is connected in series. The traffic light has a receiver. The receiver uses an infrared module (photodiode). The output of the photodiode is connected to the microcontroller. Along with this, GSM (Global System for Mobile Communication) is also used to message the report to the hospital before the arrival of the ambulance.

K.Vidhya, A.Bazila Banu designed a Density-based Dynamic Traffic Signal System [4]. In this, the signal timing changes automatically on sensing the traffic density at the junction. Here, the traffic density measurement is done by using OpenCV tool as software for image processing. Firstly, the image is captured then processed and converted into a grayscale image. Then a threshold is calculated based on which the contour is drawn in order to calculate the number of vehicles present in the image. After calculating the number of vehicles the density at which side is high is known based on which a clear signal can be allotted to that particular side. The traffic density can also be calculated by using MATLAB tool but this cannot be used in real-time applications as it is very slow and the software is not free of cost like OpenCV.

From the literature survey it is found that among the existing technologies, RF is a suitable choice for a convenient wireless communication between an emergency vehicle and the traffic light. So, the prototype implemented here uses the ASK hybrid transceiver RF module of the frequency range of 434 MHz as RF ranges about 3 kHz to 300 GHz theoretically and a RFID system module operating at a frequency range of 125 kHz.

III. PROPOSED MODEL

There are five stages in the project as follows. First is to implement wireless communication (RF) between traffic light control system and an emergency vehicle. Second is to detect the lane on which the emergency vehicle is currently traveling. The third is to automatically switch the sequence of traffic lights to provide a clear path to emergency vehicles until their destination. Fourth is to send SMS to the control unit (in this case, it is the authorized user) providing the running status of the emergency vehicle. Fifth is to revert to the original sequence of a traffic light.

The various components used in the project are as follows:

A. Microcontroller

Peripheral Interface Controller (PIC) is a microcontroller developed by Microchip. It uses flash memory for program storage and can be reprogrammed. It mainly uses modified Harvard architecture and supports RISC (Reduced Instruction Set Computer). PIC16F72 is a CMOS FLASH-based 8-bit microcontroller with 28-pin package, 128 bytes data memory, 22 I/O pins, 3 timers and 8-bit five channel A/D converter.

B. RF Module

An RF Module is a small electronic circuit which is used to receive, transmit or transceive radio waves on one of a number of carrier frequencies. An RF transceiver module incorporates both a transmitter and receiver. The Tx-ASK is an ASK hybrid transmitter module and the Rx–ASK is an ASK hybrid receiver module. In such modules the digital data is represented by different amplitudes of the carrier wave, hence the modulation is known as Amplitude Shift Keying (ASK). The transmission rate is 1-10 Kbps. The Tx and Rx pair operates at frequency 434 MHz and has a range of 100 meters in open space.

C. RFID

Radio-Frequency Identification (RFID) is an automatic identification method which uses the radio waves to read information stored on a tag attached to an object and transfer data to the reader. A tag can be read from up to several feet away and does not need to be within direct line-of-sight of the reader to be tracked. A basic RFID system consists of three components- an antenna or coil, a transceiver, a transponder (RF tag). The RFID system operates at four major frequency ranges. These frequency ranges are Low Frequency (125-134.2 kHz and 140-148.5 kHz), High Frequency (13.553 - 13.567 MHz), Ultra High Frequency (858 - 930 MHz) and Super High Frequency (2.4 to 2.5 GHz). This technology uses digital data contained in a RFID tag which is made up of integrated circuits having a tiny antenna for transferring information to a RFID transceiver. The choice of the antenna depends on the distance between the RFID reader and the tags that it needs to read. This distance is called read range. RFID reader antenna operates in either "near-field" (short range) or "far-field" (long range). In near-field applications, the read range is less than 30 cm and the antenna uses magnetic coupling so the reader and tag can transfer power. In near-field systems, the readability of the tags is not affected by the presence of dielectrics such as water and metal in the field. In far-field applications, the range between the tag and reader is greater than 30 cm and can be up to several tens of meters. Far-field antenna utilizes electromagnetic coupling and dielectrics can weaken the communication between the reader and tags.

D. GSM Module

A GSM/GPRS module is a chip or circuit used to establish communication between a mobile device or a computing machine and a GSM or GPRS system. Global Packet Radio Service (GPRS) is an extension of GSM that enables higher data transmission rate. A GSM/GPRS module consists of a GSM/GPRS modem assembled together with power supply circuit and communication interfaces (like RS-232, USB, etc.) for the computer. A GSM/GPRS modem requires a SIM (Subscriber Identity Module) card just like mobile phones to activate communication with the network. Also, it has an IMEI (International Mobile Equipment Identity) number similar to mobile phones for its identification. SIM900 is a complete Quad-band GSM/GPRS module which provides the benefit of small dimensions and cost-effective solutions. It delivers GSM/GPRS 850/900/1800/1900 MHz performance for voice, SMS, Data, and Fax in a small form factor and with low power consumption. It comes with an RS232 interface, which allows it to connect to a PC as well as to a microcontroller.

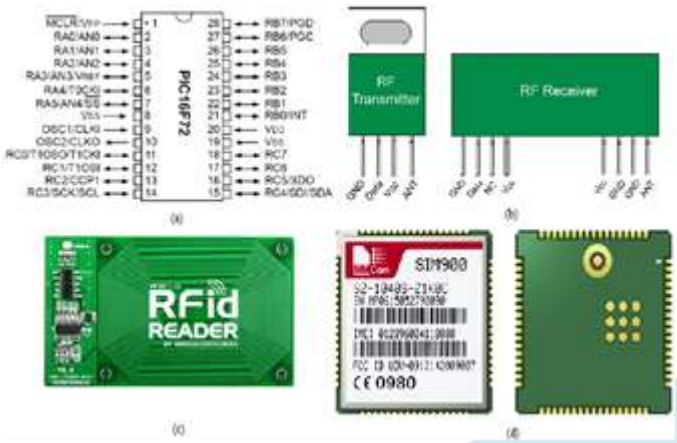

Fig. 1. (a) Pin diagram of PIC16F72, (b) Pin diagram of RF Module, (c) RFID Reader 125-kHz, (d) GSM SIM900

IV. WORKING

The working can be explained properly by means of the following block diagram:

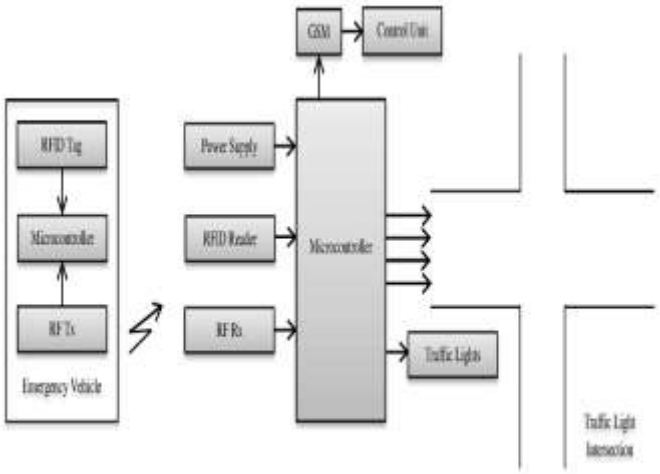

Fig. 2. Block Diagram

The emergency vehicle, which while on its way to a destination, approaching towards the traffic signal of a junction sends an RF signal since it is equipped with an RF transmitter module. The RF receiver module placed away from the source of transmission receives the transmitted signal and establishes a one-way communication between the emergency vehicle and traffic control system.

When an emergency vehicle equipped with a RFID tag comes in the range of a RFID Reader, it sends a signal to the RFID Reader in order to determine the course of the path on which the vehicle is currently traveling. The RFID Reader needs to be installed at a certain distance before the traffic signal.

After the course of the path is determined, the traffic light of that particular pathway is set to green and rests are set to red. If more than one emergency vehicle is present on more than one pathway and is traveling then the priority of the emergency vehicle needs to be set.

When the emergency vehicle has passed the traffic signal an SMS containing all the important details of the vehicle is sent to the control unit so that appropriate preparations can be made, accordingly.

At last, the traffic signal automatically comes back to its normal working condition depending upon the delay provided while programming the whole system.

The following flow chart gives the basic algorithm for the whole system.

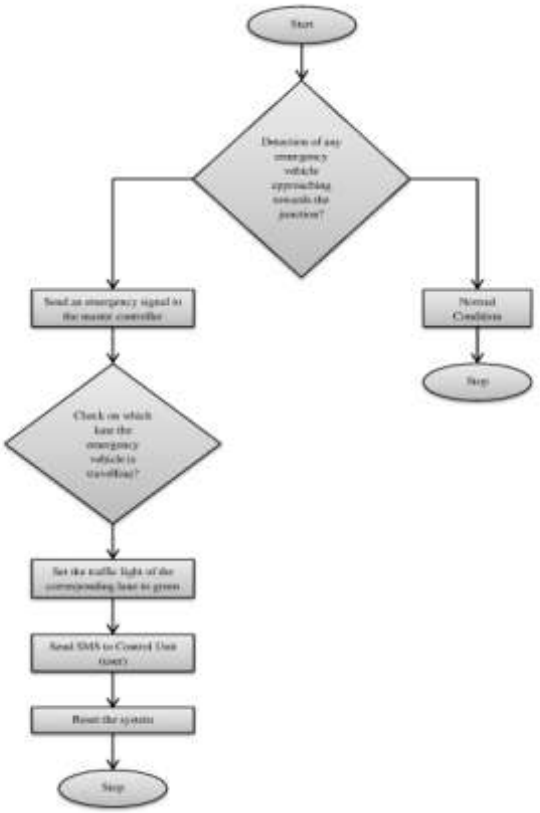

Fig. 3. Flow Chart

V. CONCLUSION

The system designed is fully automated and intelligent enough to take a decision in many critical situations. It requires very less human intervention. The system can produce most accurate results with the help of latest technology implementations like a pipeline. It can also take multiple parameters at a time and intelligently perform multiple processes in parallel. The installation of the system at a real time is very easy. So, in future, the same technological system can be tested in a real-time environment. Hence, by using this system configuration the possibilities of delay of emergency vehicles due to traffic jams can be reduced.

Further several enhancements can be done to the prototype such as: extending it to all the roads in multi-road junctions, integrating it with local road networks, testing it with a longer range of RFID readers, putting in a GPS kit to know the exact location of the emergency vehicle, using it with a solar-powered GSM system to reduce power requirement, using a video detection based real time image processing technique for registration of density of vehicles and number of incidents on road, detecting vehicles in motion within a limited detection

area especially on highways using several different detector technologies (such as radar detection) and linking to the traffic light control system to a centrally coordinated control unit in order to collect and store traffic data so that timely and accurate traffic information can be provided which allows driver of the emergency vehicle to make reliable decisions during their way to the destination.

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