Smart Traffic, Ambulance Clearance, and Stolen Vehicle Detection

S. V. Viraktamath, Arfaali B. Naikar, Sharan N. Nargund, and Manjunath Gayakawad

Abstract The proposed system is to develop a density-based dynamic traffic system where certain signal timing varies intelligently depending on the quantity of traffic at each intersection. Because traffic congestion could be a big problem in most cities across the globe, it is time to change from a manual or fixed-timed system to one that may make decisions. The present traffic signal system operates on a fixed schedule, which can be wasteful if one lane is active while the others do not seem to be. A framework for an intelligent system has been designed to deal with the difficulty. Because higher traffic density on one side of the junction frequently needs additional green signal timing than the standard given time, a system is proposed wherein the fundamental measure of green and red light is assigned in support of the density of traffic existing at that time. Proximity infrared sensors (PIR) are commonly employed. Once the density has been determined, the microcontroller is employed to allocate the green light's glowing duration. The sensors on the road's edges detect the presence of automobiles and communicate this information to the microcontroller, which determines how long a lane will remain open or when the signal light's timing is adjusted. The framework's method was developed in later stages. This framework is employed to implement traffic congestion control, ambulance clearance, and stolen vehicle detection.

1 Introduction

India is the world's second-most populated country, with a rapidly expanding economy. Its cities are experiencing severe traffic congestion. Due to space and economic limits, infrastructure expansion is slower than that of the number of vehicles [1]. It requires traffic control systems, and efficient traffic flow management can

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help to mitigate the detrimental effects of traffic congestion [2]. The difficulty with the traffic system is that the automobiles on the four-way road will be heavy every minute and the traffic lights will be switched to each side for a set amount of time. Even if there are no automobiles on that side, the traffic signals will illuminate for a set period. As a result, on other lanes the automobiles must wait for the process to be completed. So, to prevent the waste of time, this system manages traffic depending on the heavy flow of automobiles on any given side. The density of cars on either side of the intersection gives the path to the side with the most traffic and maintains the stop position.

The main aim is to pass vehicles smoothly and to avoid wasting time. There is less need for human intervention to manage traffic. Traffic congestion can be controlled automatically and saves plenty of time. It is possible to identify stolen vehicle. On-time arrival of emergency vehicles could be a must. Wireless networks are increasingly popular in road transportation in recent years, thanks to their lower costs [3]. The proposed system mainly focuses on these concerned problems with the standard control system management, and this method is predicated on sensor networks and embedded systems (microcontroller 89C51). The issues faced by the manual working of traffic light management systems are resolved efficiently.

The system's design goal is to resolve the matter of traffic congestion while also minimizing violations of traffic laws. This is often concerned with the look of a secure and effective traffic flow system that aids within the reduction of road congestion. Dynamic flexibility in green light timing supported density at each lane appears to be favorable in terms of minimizing signal wait times and fuel consumption. Technologies like the amplitude-shift keying (ASK) transceiver and radio frequency identification (RFID) are samples of technologies that will be employed in control to supply cost-effective solutions. RFID is a wireless technology that sends data between an RFID tag and an RFID reader using radio-frequency radiation. Some RFID devices can only operate within some inches or centimeters, but others can operate at distances of up to 100 m (300 feet). During this case, if an ambulance approaches a traffic intersection, the traffic signals automatically halt and supply a green light to the ambulance. This program's main purpose is to ensure that emergency vehicles, like ambulances, get to hospitals on time, eliminating delays caused by traffic congestion. Each vehicle is provided with an RFID tag. When it comes into contact with the RFID reader, it will send a symbol to that. It compares to a database of stolen RFID tags. If the match is detected, the buzzer will sound, and therefore, the light will turn red. As a consequence, the vehicle is compelled to stop within the traffic intersection, allowing local authorities to take appropriate action.

2 Literature Survey

Traffic congestion is a serious problem in developing countries due to growth in the city population and the rising number of vehicles in the cities [4]. Traffic congestion on roads leads to passive traffic, which lengthens travel times and is thus one of the most serious challenges in urban areas. The green signal system was used to grant permission to any emergency vehicle by converting all red lights in the emergency vehicle's path to green, giving the requested vehicle a complete green wave. Green waves have the drawback that when they are disrupted, they might cause traffic issues, which are compounded by the synchronization. In such instances, the green wave's line of cars builds until it becomes too big and some cars are unable to reach the green lights in time and must halt. This is referred to as "over-saturation" [5]. The use of RFID traffic control is to circumvent difficulties that generally come with regular traffic control systems, notably those relating to image processing and beam interruption techniques as described [6]. This RFID technology is used in locations with many vehicles, multiple lanes, and many traffic junctions. The work's main flaw is that it does not go into detail on the communication channels employed linking the emergency vehicle and the traffic signal controller [7]; the goal of this work is to shorten the time it takes for an ambulance to get to the hospital by clearing the lane automatically. At traffic intersections, the technology is automated and does not require human interaction. The downside of this method is that it requires full information on the start point and destination of the journey. It would not operate if the ambulance has to take a special route for a few reasons or if the start place is unknown. In Bangalore, a video traffic surveillance and monitoring system have just been installed. The traffic management crew must manually analyze data to calculate the length of traffic lights at each intersection. It will inform local police officials of the case to require the suitable action [6]. In some models an outside parking lot to work out the systems effective functioning on the terms of detection accuracy, false positive and also the false negative, true positive and therefore the true negative rates together with the typical speed of the in identifying the parking slot [8]. The terminals have certain limitations that crib their capability of processing cross-application and diversified services. Within the past, researchers have experimented with several technologies [9]. The advancements within the technologies associated with the wireless communication systems have made the vehicular networks a prominent area of research within the industry [10]. The following may be a quick overview of some traffic congestion remedies.

2.1 Embedded System Affiliations

Rotake and Karmore proposed "Intelligent Traffic Signal Control System" [1]. This system employs an AVR 32 microcontroller with configurable non-volatile storage, integrated 8-channel digitizer, and IR sensors. The IR sensors detect the presence of an emergency vehicle, and therefore, the microcontroller is programmed to send a red signal to any or all sides except the one where the emergency vehicle is parked.

2.2 Wireless Sensor Networks

"Road Traffic Congestion Monitoring and Measurement Using Active RFID and GSM Technology" by Mandal et al. [4] is mentioned in this methodology. Active RFID tags, a wireless coordinator, a wireless router, GSM modems, and monitoring station software are all employed in this system. The wireless devices are installed on each side of the road and collect data from active RFID tags. The monitoring station will gather all of the data through GSM and reply to the appropriate traffic signal.

2.3 Image Processing

Image processing can also help to alleviate traffic congestion difficulties to a larger extent. This is stated in Dangi et al. "Image Processing Based Intelligent Traffic Controller" [11]. A camera is utilized in this approach, and it is mounted on poles or another tall structure so that it can cover the whole traffic scene. The images retrieved from the videos are then evaluated and utilized to detect and count the vehicles, and the time allocated for each side is determined by the density.

3 Block Diagram

In this, the IR Tx and IR Rx sense the traffic density, three sensors kept beside a road, all IR Tx and Rx are connected to a microcontroller input port, the microcontroller receives signal from three input ports. Depending on the input port, the signal controller will give the signal to the output port to activate the driver circuit to control traffic lights and delay is provided by the microcontroller depending on the input port. With a carrier frequency of 433 MHz, ASK sends the bits in serial mode. This is kept in the ambulance. The encoder converts the parallel data into serial data and feeds it to the ASK transmitter for serial transmission. The digital data broadcast by the ASK Tx is received by the ASK receiver and routed to the decoder. The ASK receiver is connected to the traffic signal. The decoder converts the serial data into parallel data and feeds it to the double-pole double-throw (DPDT) relay to which LEDs are connected and the automatic signal will change; at the same time, vehicles will move automatically to give the path to the ambulance. The microcontroller is connected with a crystal oscillator along with a power-on reset circuit for the working of the microcontroller. The speed of execution of the microcontroller depends on the crystal connected to the microcontroller (Fig. 1).

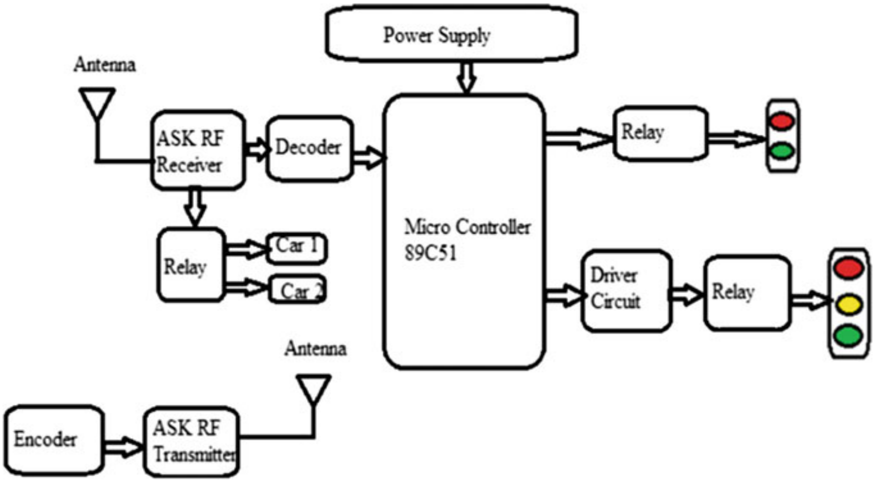

Fig. 1 Block diagram

4 Proposed Work

Existing technologies are insufficient to manage problems such as traffic control, emergency vehicle clearing, stolen vehicle identification, and so on as shown in the current problem section. To solve these problems, the proposal is to implement the Intelligent Traffic Control System.

This model contains congestion control, ambulance clearance, and stolen vehicle detection (Fig. 2).

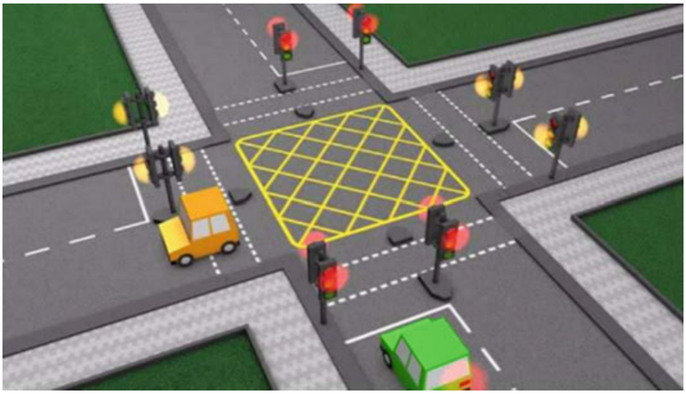

Fig. 2 Traffic signal junction [3]

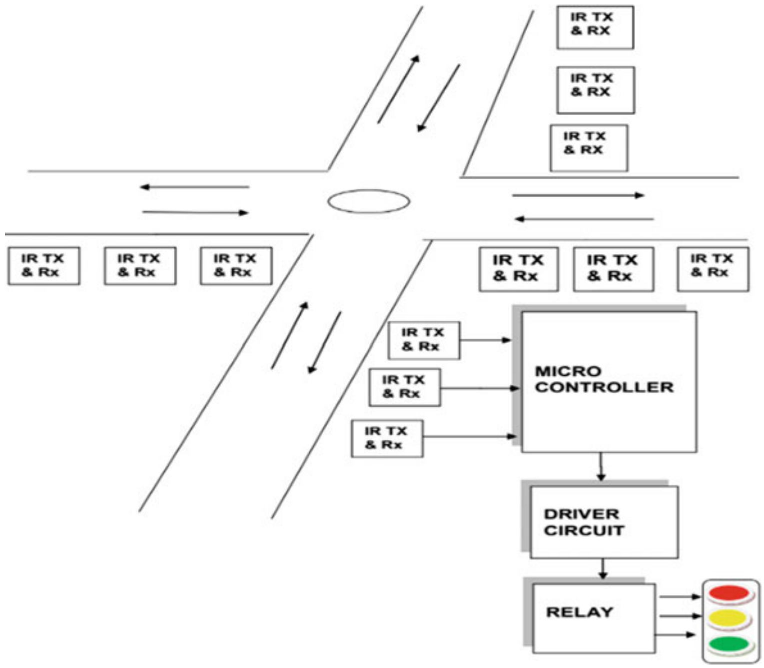

Fig. 3 Block diagram of congestion control [3]

4.1 Congestion Control

The IR transmitter (Tx) and IR receiver (Rx) are used to sense the traffic density, three sensors are placed on the roadside, and all IR Tx and Rx are connected to the microcontroller input port. There are a total of six proximity sensors which are used to detect traffic density, three sensors output directly fed to the input port of the microcontroller and three proximity sensors are connected in parallel to monitor traffic density of road. The microcontroller will get continuous input signal from the sensors and give output to 74LS245 IC and amplify signal level which is sufficient to drive LEDs at the output, to make red, green, and yellow LED ON/OFF depending on the input signal; the traffic signal is controlled using 5 V DC power which is sufficient to run the microcontroller (Figs. 3 and 4).

4.2 Ambulance Clearance

There are two pieces to the module: the first is the ASK transmitter, which is installed in the emergency vehicle. When the switch is pushed, it will broadcast the signal. An HT12E encoder is included in the transmitter. The commands and data are sent to the

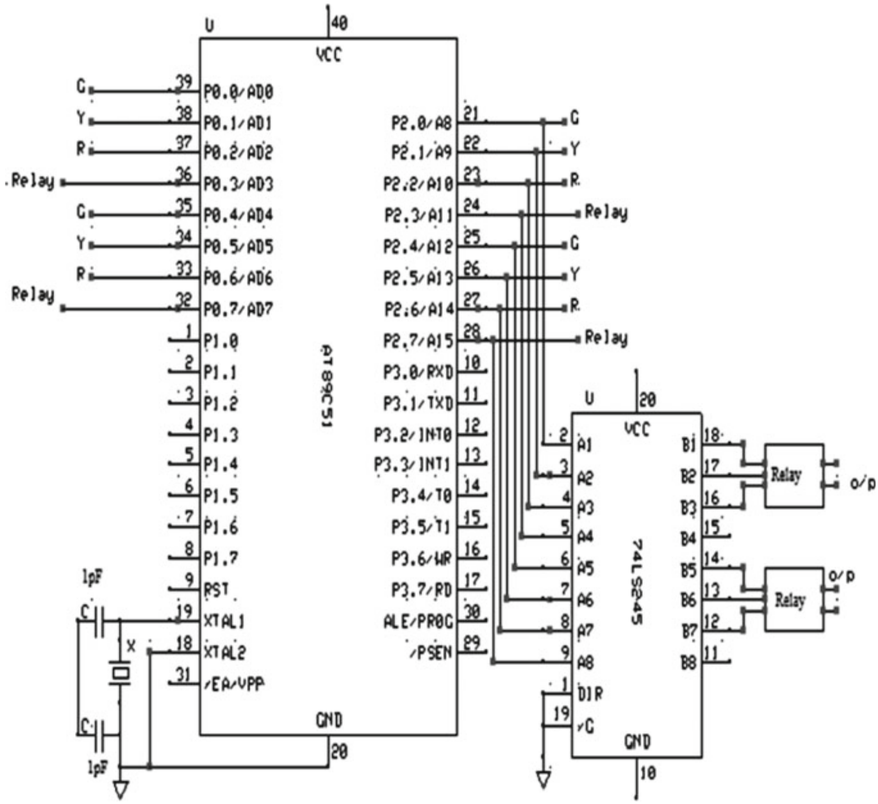

Fig. 4 Schematic of congestion control [3]

ASK Rx through a serial connection from the microcontroller. The receiver, which is mounted on the traffic pole, is the second component. The ATmega 16 microcontroller and the HT12D decoder are also included. The security code received by the receiver is compared to the serial bits stored in its database. The green light will turn ON if it is a match.

4.2.1 ASK RF Transmitter

ASK transmits the bits in serial mode with a carrier frequency of 433 MHz. This is kept in the ambulance. The transmission of RF waves happens at a particular frequency from an allowable set of frequencies (bandwidth) depending on the values of the crystal oscillator and air-core inductor/capacitor used in the circuit of the transmitter. Because 12-bit data is communicated, the first eight bits, known as address bits, must match on both the sending and receiving sides. As a result, these address bits serve as a kind of password until they match, at which point no data is allowed.

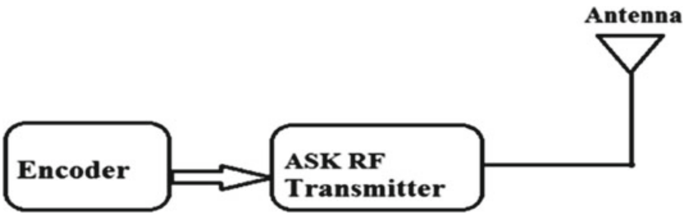

Fig. 5 ASK RF transmitter [12]

Assigning a common clock to both the transmitter and receiver circuits and changing their address bits in a predetermined sequence, or even using a sequence generator, is the safest and most high-level implementation. The data out pin of the HT12E encoder IC is received by an ASK-type transmitter set to 433 MHz; there are 8 number address lines and several data lines are present in HT12E. The data on the D0-D3 pin is transmitted serially and available at the data O/P pin. An RF transmitter of 433 MHz has a pin of data that is now connected to the serial data pin from HT12E. The respective Vcc (5 V) and ground pins are connected. A telescopic antenna has an antenna termination attached to it. The D0-D3 bits are broadcast serially and the 433 MHz transmitter transmits these bits in the form of RF waves through a transmitting antenna if the I/P data for the HT12E is 0001 (Binary) (Fig. 5).

The complete circuit of the transmitter encoder is shown in Fig. 6 . Here, the receiver address to be transmitted is set to 00 h (BCD), by connecting all the address line A0-A7 (pins from 1–7) to GND. The timing resistor 1 M is connected across OSC1 (pin 15) and OSC2 (pin 16), which produces a frequency of 3 kHz. The TE pin (14) is permanently connected to the ground to transmit the data continuously. Finally, the address of the receiver and the data to be sent are serially transmitted through the pin "DOUT" (pin 17) and then transmitted to the "DATA IN" (pin of the Tx433). In the RF transmitter module, the transmitter uses the ASK modulation algorithm to modify the digital data coming in the line "DATA IN" and sends it into the air through the antenna. Alternatively, the HT12E converts parallel inputs to serial outputs. It translates 12-bit parallel data to serial for radio frequency transmission. The 12 bits are divided into 8 address bits and 4 data bits.

4.2.2 ASK RF Receiver

The ASK receiver receives the digital data transmitted from the ASK Tx and is fed to the decoder. The ASK receiver is connected to the traffic signal. The data broadcast by the ASK RF transmitter is received by the ASK RF receiver. The HT12D decoder converts serial data into 4-bit parallel data D0–D3. For data transmission, the condition of these address pins A0-A7 should match the condition of the address pin in the HT12E at the transmitter. When successful data transfer happens from transmitter to receiver, the LED attached to the above circuit flashes. The 51 K

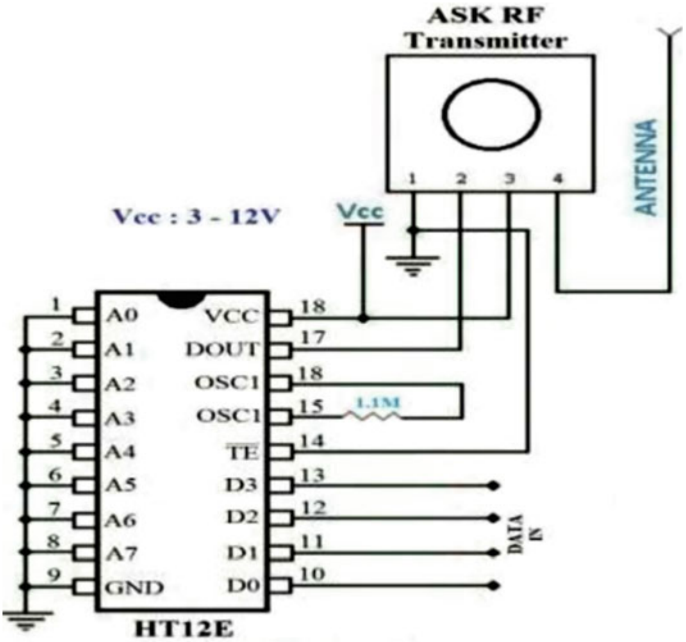

Fig. 6 Schematic ASK RF transmitter [12]

resistor will supply the appropriate resistance for the HT12D's internal oscillator (Figs. 7 and 8).

HT12D decoder decodes the serial data to parallel, and it is available at D1-D4 data bits; the oscillating resistor of 51 K is connected to its oscillating pins (pin15 pin16). Pin 17 is considered as going high when transmitter starts generating and sending RF wave, and the pin 17 is connected to a transistor and an LED which

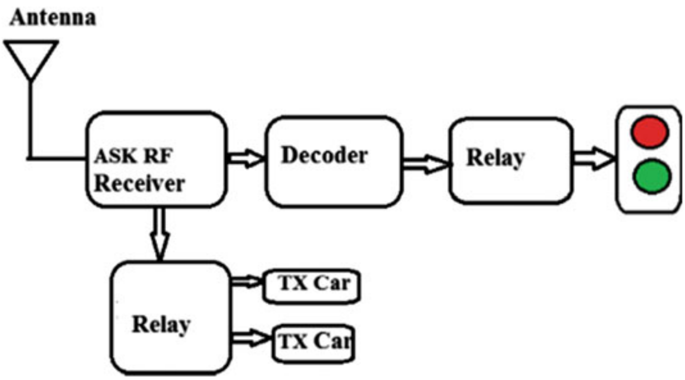

Fig. 7 ASK RF receiver [3]

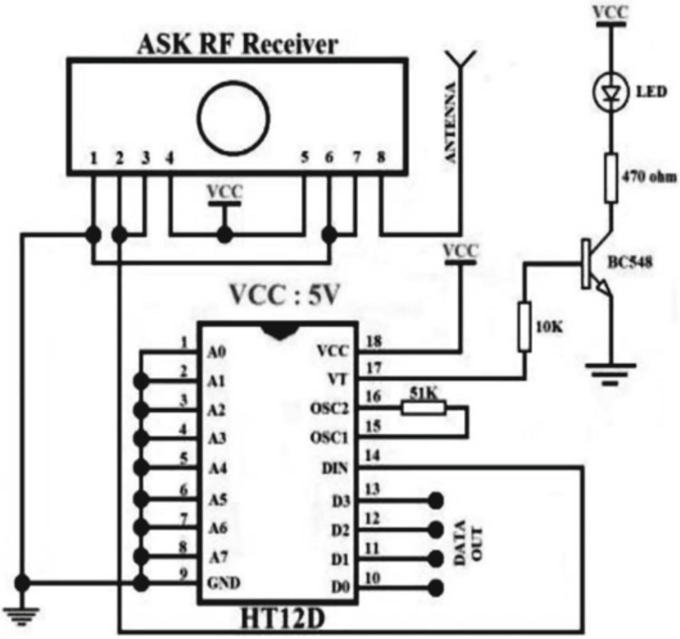

Fig. 8 Schematic of ASK RF receiver [12]

glows and indicates the link between transmitter and receiver. If a data bit of 1010 is applied to the D0-D3 of HT12E, then the data is transmitted serially. The frequency of 433 MHz is transmitted through the transmitter and the receiver receives the data bits and HT12D decodes the serial data bits to parallel and the same data, i.e., 1010 is available at D1-D4 pins of HT12D. The decoder outputs are connected to the microcontroller.

4.3 Stolen Vehicle Detection

Non-contact technologies that employ radio waves to automatically identify persons or things are referred to as radio frequency identification (RFID). The most frequent way of identifying is to record a “unique serial number” that identifies a person or thing on a microchip that is connected to an antenna. An “RFID transponder” or “RFID tag” is a combination antenna and microchip that works in conjunction with an “RFID reader” (sometimes called an “RFID interrogator”).

In Fig. 9, “RFID reader” is used to detect the stolen vehicle. The “RFID tag” will be attached to the vehicle, and the reader is kept near the traffic signal. The stolen vehicle number will be stored in the microcontroller as a blacklist. When the vehicle is near the traffic signal, the “RFID reader” transmits the signal and the “RFID reader”

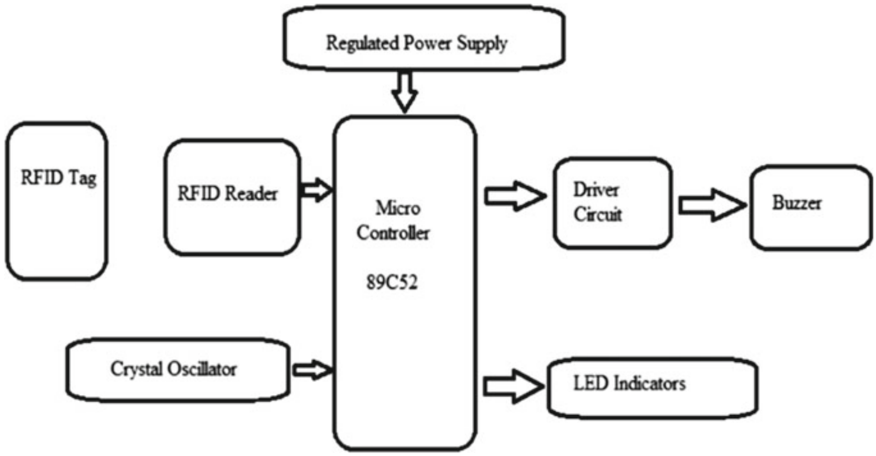

Fig. 9 Stolen vehicle detection [13]

reads the "RFID number" and feeds it to the microcontroller. Microcontroller verifies the number; if it is in blacklist, then it will give output signal to the driver circuit to make buzzer ON for indication and then red led is switched ON (Fig. 10).

5 Results and Discussion

5.1 Traffic Lane

Figure 11 represents the traffic light control which is an automated way of controlling signals by the density of traffic on the roads. At set distances from the junction signal, IR sensors are deployed throughout the whole intersecting route. The traffic signal's timing delay is determined by the number of cars on the route. IR sensors are used to measure traffic density [14]. The microcontroller alters the glow time of the green LED of the appropriate junction to control the traffic light effectively.

5.2 Ambulance Clearance

Figure 12 represents the transmitter module placed on the ambulance. It consists of an ASK RF transmitter module of 433 MHz and encoder HT12E. When the ambulance is entered into the junction, the switch placed in the transmitter is pressed.

Figure 13 represents the RF receiver used to receive the 433 MHz RF signal that has been sent by the RF transmitter in the ambulance. When the RF receiver receives

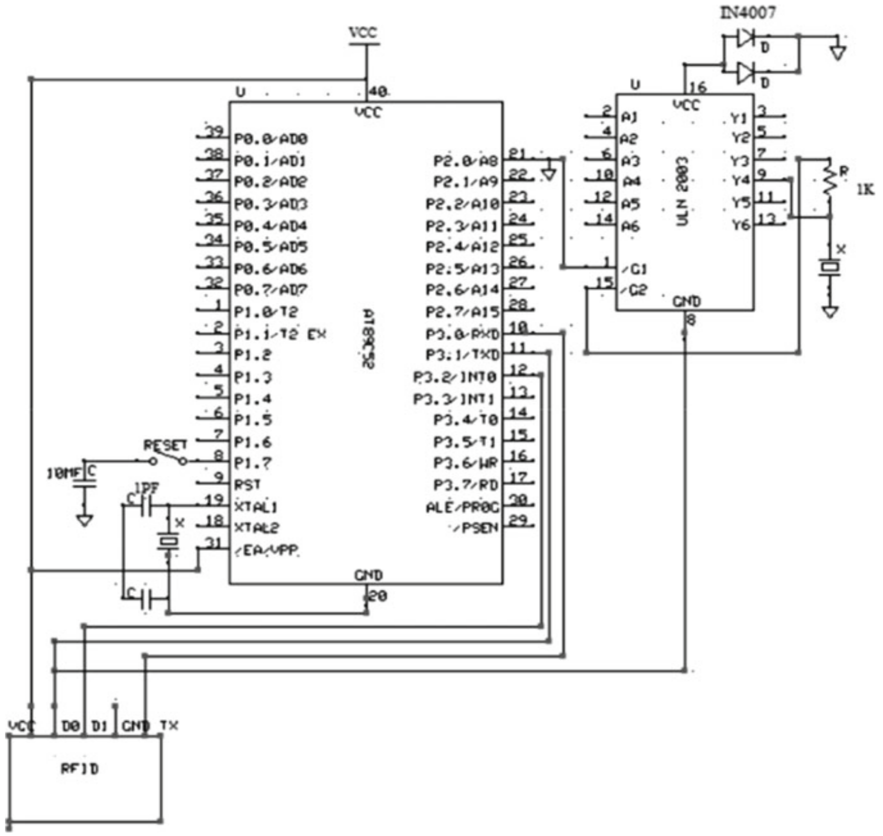

Fig. 10 Schematic of stolen vehicle detection [13]

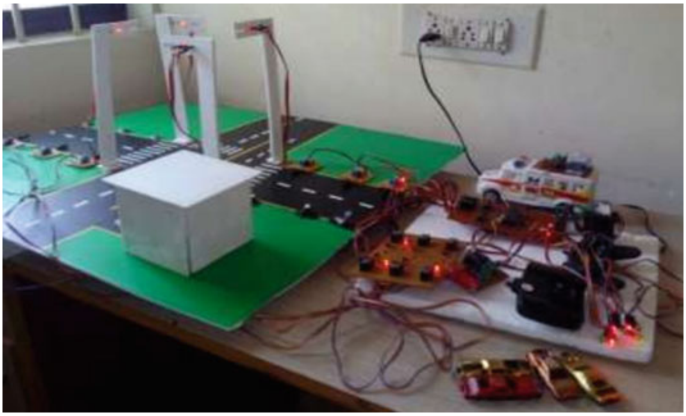

Fig. 11 Initial condition at traffic junction

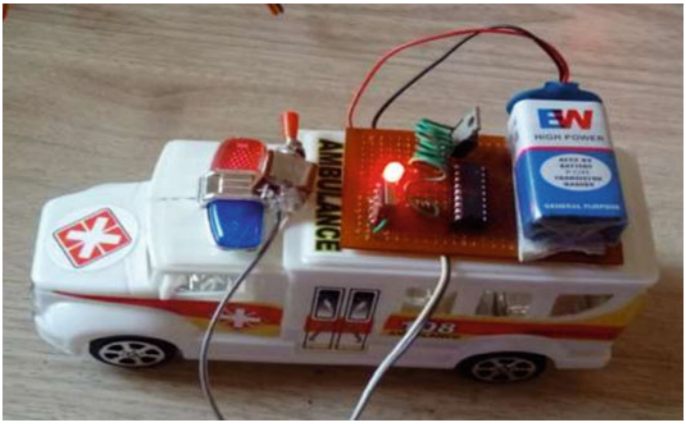

Fig. 12 Ambulance transmitter part

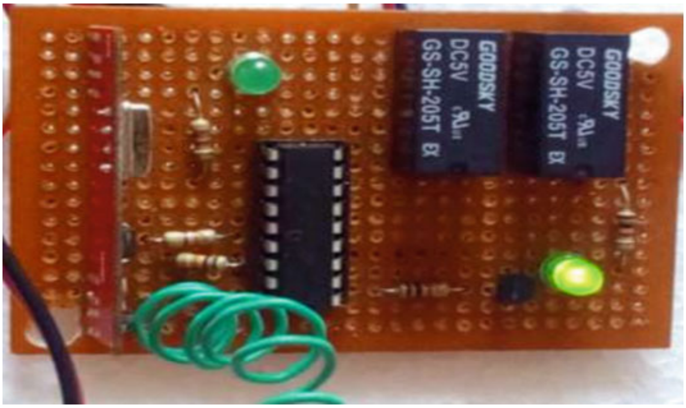

Fig. 13 Receiver part placed at traffic pole

the RF signal, then it will decode the signal and send it to the microcontroller which will alert the traffic unit to make way for the ambulance.

Figure 14 shows the emergency vehicle while crossing the intersection. As said, it consists of an ASK RF transmitter which includes an HT12E encoder and the receiver which is preset at pole has an HT12D decoder. If the ASK RF transmitter is in the range of the ASK RF receiver, then the traffic light will change to green till the receiver receives the signal.

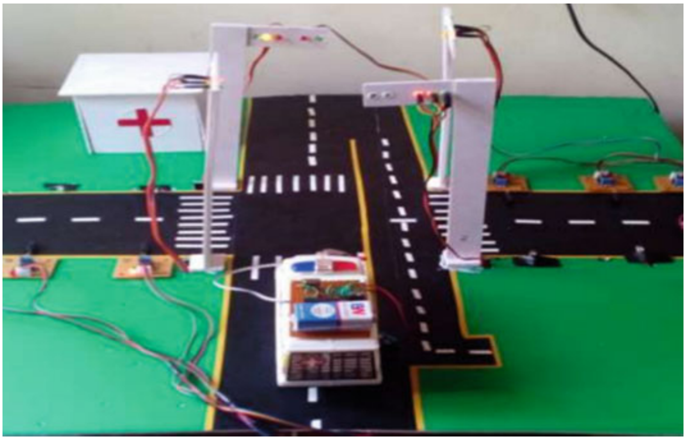

Fig. 14 Traffic signal changes during presence of ambulance

5.3 Stolen Vehicle Detection

In Fig. 15, for testing purposes, the system will compare the unique “RFID tag” read by the “RFID reader” to the stolen “RFIDs” stored in the system. Each vehicle is equipped with an “RFID tag.” It will transmit a signal to the “RFID reader” then it is scanned, verified, and checks the status in the database to see if it is stolen or not. If a match is identified, then the traffic light is instantly turned red for 30 s. The buzzer will be activated if the vehicle is stolen.

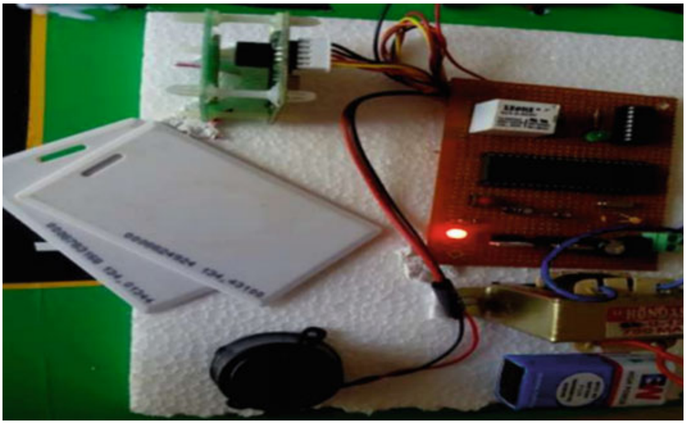

Fig. 15 Stolen vehicle detection

6 Conclusion and Future Work

A traffic light system had been conceived and implemented with correct hardware and software integration. The microcontroller was connected to the infrared sensors. This interface is in sync with the entire traffic system operation. Knowledge of sequential systems, electrical and electronics applications was demonstrated here. It can be programmed in any way to regulate the traffic light model automatically, and it will be valuable for road system design. This module's design and execution are specifically geared at traffic management so that emergency vehicles such as ambulances and fire engines on the road have a clear path to their destination in less time and with no human interference. When there is heavy traffic on the road, this mechanism will assist traffic cops in allowing the ambulance to pass. The buzzer will be activated when a stolen vehicle is detected, allowing the police officer to take proper action. The prototype may be improved further by testing it with longer-range "RFID scanners." Additionally, GPS may be integrated into the stolen car detection module, allowing for the precise position of the stolen car to be determined. Currently, it is using a method that only considers one of the traffic junction's roads. It can be made better by extending it to all of the roads in a multiroad intersection.

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References

1. D. Rotake, S. Karmore, Intelligent traffic signal control system using embedded system. Innov. Syst. Design Eng. **3**(5) (2012). ISSN 2222–1727 (paper) ISSN 2222–2871 (online),
2. Traffic Congestion in Bangalore-A Rising Concern, http://www.commonfloor.com/guide/traffic-congestion-in-bangalore-a-rising-concern-27238.html
3. K.R. Shruthi, K. Vinodha, Priority based traffic lights controller using wireless sensor networks. Int. J. Electron. Signals Syst. (IJESS) **1**(4) (2012) ISSN 2231-5969
4. B.P. Gokulan, D. Srinivasan, Distributed geometric Fuzzy multi-agent urban traffic signal control. IEEE Trans. Intell. Transp. Syst. **11**(3), 714–727 (2010)
5. A.K.R. Mittal, D. Bhandari, A novel approach to implement green wave system and detection of stolen vehicles. in *Proceedings IEEE Conference on Advance Computing*, (2013), pp. 1055–1059
6. S. Sharma, A. Pithora, G. Gupta, M. Goel, M. Sinha, Traffic light priority control for emergency vehicle using RFID. Int. J. Innov. Eng. Technol. **2**(2), 363–366 (2013)
7. R. Hegde, R.R. Sali, M.S. Indira, RFID and GPS based automatic lane clearance system for ambulance. Int. J. Adv. Electr. Electron. Eng. **2**(3), 102–107 (2013)
8. K. Khaled, S. Smys, A. Bashar, Tenancy status identification of parking slots using mobile net binary classifier. J. Artif. Intell. **2**(03), 146–154 (2020)
9. S. Shakya, Collaboration of smart city services with appropriate resource management and privacy protection. J. Ubiquitous Comput. Commun. Technol. (UCCT) **3**(01), 43–51 (2021)
10. R. Bestak, Intelligent traffic control device model using Ad Hoc network. J. Inf. Technol. **1**(02), 68–76 (2019)

11. M. Abdoos, N. Mozayani, A.L.C. Bazzan, Traffic light control in non-stationary environments based on multi agent Q-learning. in *Proceedings IEEE Conference on Intelligent Transportation Systems*, (2011), pp. 580–1585
12. K. Mandal, A. Sen, A. Chakraborty, S. Roy, Road traffic congestion monitoring and measurement using active RFID and GSM technology. in *IEEE | Annual Conference on Intelligent Transportation Systems* (2011)
13. V. Dangi, A. Parab, K. Pawar, S.S. Rathod, Image processing based intelligent traffic controller. Undergrad. Acad. Res. J. (UARJ) **1**(1), (2012) ISSN 2278–1129
14. B. Prashanth Kumar, B. Karthik, Microcontroller based traffic light controller. (Department of Electrical and Electronics Engineering Gokaraju Rangaraju Institute of Engineering and Technology, 2011)
15. S. Kumar, P.G. Abhilash, D.G. Jyothi, G. Varaprasad, Violation detection method for vehicular Ad Hoc networking. ACM/Wiley Security and Communication Networks (2014)https://doi.org/10.1002/sec.427