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Intelligent Traffic Control System Using ARM7 Controller and Image Processing Techniques

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Abstract

The urban traffic congestion is being increased day by day due to large number of vehicles are used by dense people in cities. In the current model of the Traffic Control System, the time delay of each signal light is static which leads to lot of waiting time and was tage of fuel. To overcome this problem, intelligent traffic management system of controlling the traffic lights using the ARM 7 controller and camera sensor is proposed. The camera which is installed along the pavement captures the real time video of the road. The video is then processed indifferent stages to find the number of vehicles in that particular lane using Convex hull technique and accordingly the time delay of the traffic signals has been changed dynamically. Incase, if an emergency vehicle like ambulance is detected by RF434 in a particular lane then automatically this lane will be given the highest priority to clear the traffic. Another feature is if any vehicle violates the traffic line that can also be identified by the RFID reader and automatically and an alert message will be sent to registered mobile number through GSM module which is interfaced with LPC2148.

Key-words: Traffic Lights, ARM7 Controller, Image Processing, RF434, RFID Reader, GSM.

1. Introduction

With each passing day, technology in almost every sector emerges and vanishes. One of the major factors driving the country's economic growth is the rapid increase in vehicle ownership. With a total length of 5.6 million kilometers, India has one of the world's largest road networks. The indirect impact of car ownership, on the other hand, causes traffic congestion. Congestion on roads results in slow-moving traffic which increases the travel time as well as fuel consumption and noise.

The congestion could even lead to road accidents. The goal of each one is to reach the destination within short time &without wastage of fuel. But resources provided by the current traffic base are limited. So, the traffic management on the road is difficult to reduce waiting & traveling times, to save fuel & money.

The emergency vehicles like ambulances, fire engines, VIP vehicles, etc. will face immense trouble during heavy traffic because the emergency vehicles get stuck in the traffic which may leads to loss of life and time.

The heavy congestion leads to an increase in the number of traffic violation cases. As a result, traffic management and control has become challenge. To make people to follow the traffic rules, it is necessary to send an alert message for the traffic violations done by them. These quick actions can help control the traffic rules. The principal objective of the Intelligent Traffic control system is to achieve safety improvement, less time delay as per the less density. The dynamic control system uses image processing techniques at different stages to calculate the density of traffic and controls the traffic lights dynamically. The system use sanRF434trans-receiver module to provide automatic clearance for emergency vehicles. The EM18 (RFID Reader) is used to detect the violated vehicles and an alert message will be sent through GSM.

2. Literature Survey

The number of vehicles on the road is growing every day. As a result, traffic management issues have become increasingly prevalent in recent years, and current traffic light controllers are limited due to the usage of antiquated hardware.

To improve the efficiency of the traffic light controller, Varsha Sahadev Nagmode et al., 2017 [1] have been proposed a model based on IoT which gives priority to different lanes by the density of traffic. The density of each is calculated by using array of Ultrasonic sensors embedded along the lane. The disadvantage of this model is ultrasonic sensors are affected by temperature fluctuations which leads to inaccurate results. Jadav Shruthi et al., 2018 [2] have been proposed a system that uses IR sensors but the disadvantage is data transfer speed is limited and the infrared frequencies are affected by dividers. Arjun Dutta et al., 2019. [3] have been introduced a technique that uses RFID tags attached to vehicles gives the vehicle count to make the system more dynamic as well as the RFID tags used to recover the stolen vehicle and provide clearance to emergency vehicle. The limitation of this method is the range of RFID is limited. Bhaskar M S et al., 2020 [4] proposed a

system based on the LPC2148board which uses Mail-C52, an ARM-based video processor. This video processor is used to capture the region of road. The image sequences are then processed using MATLAB which uses Canny edge detection technique in order to find the density and allocate different time delays for each lane. But canny edge detection may give distorted edges for noisy images which may results inaccurate count of vehicles in a particular lane. Shreya Asoba et al., 2020 [5] have mainly concentrated on traffic violations. The violated vehicle is detected by RFID technology and the violated vehicle number plate is identified by Image Segmentation technique. The alert message can be sent through the GSM.

3. Proposed Model

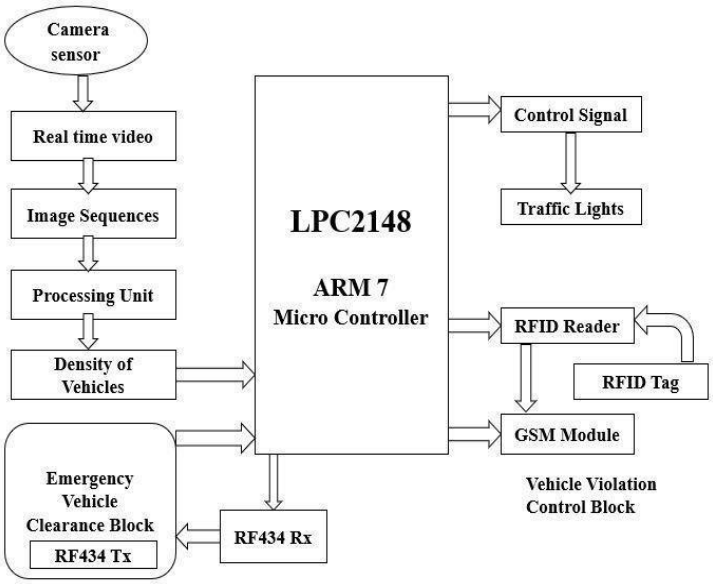
It is sometimes impossible for an ambulance to move through a congested lane, and the patient suffers greatly as a result. There has been an increase in traffic offenses, which could lead to accidents. There is a pressing need to replace present traffic technology with new technology that not only clears the roads but also automates and smartens the entire system so on as reasonably possible. Massive traffic jams cause unwanted delays, which increases time consumption and makes working conditions dull and repetitive.

Taking into account all of the current issues and the potential for future improvements, the proposed system provides a concrete and smart solution to all of them by (i) using image processing technique for density of vehicles calculation which overcomes the drawbacks of [1,2,3], (ii) using Convex hull technique that improves the accuracy of finding the density of vehicles in a specific direction [4], (iii) adapting the RFID technology for violated vehicle indication from [5]. The prototype which is based on LPC2148 implements a functioning system shown in Fig.1 that will achieve the following results.

- Dynamic controlling of traffic lights using Image Processing techniques.
- Priority to the emergency vehicles.
- Traffic violated vehicle detection and sending an alert message to the vehicle’s owner.

The detailed block diagram is as shown in Fig.1.

Fig. 1 - Detailed Block Diagram



1. Traffic Density Monitoring & Controlling Block through Image Processing Techniques

Camera sensors at the traffic junction cover all four lanes namely North, South, East, and West directions. Image sequences are captured from the real-time video. The image processing stages are processed using Python and the control signal then passed from LPC2148 for controlling time delay as shown in the Fig. 2. The version used in this model is Python 3.6.7. As per the Fig.3 these image sequences are first resized and then converted to a Gray scale, followed by background subtraction. The shape of the objects is called as blobs. The blobs are identified by Convex Hull technique.

A binary image's convex hull is the set of pixels included in the smallest convex polygon that surrounds all white pixels in the input. The algorithm for finding convex hull consists of

- Binarize the input image includes RGB to Gray conversion followed by thresholding.
- In Opencv, find Contour function is used to find the contours. Contours are nothing but boundary points around the blob.
- Convex Hull is drawn using those boundary points.

According to the shape of the blob, the number of objects is calculated which indicates the density of traffic in a specific lane. Similarly, remaining all directions are calculated. The order of the priority shifted with increase in density of the vehicles in each lane. The traffic is categorized into heavy traffic, moderate traffic, and low traffic. According to the category, the time delay will be allocated.

Fig. 2 – Image Processing Block

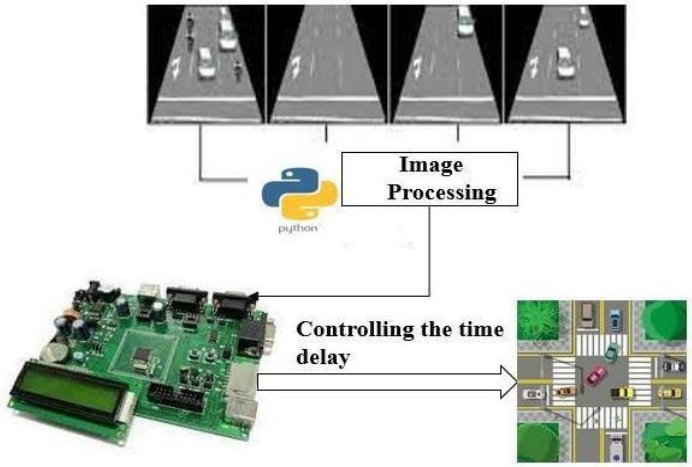
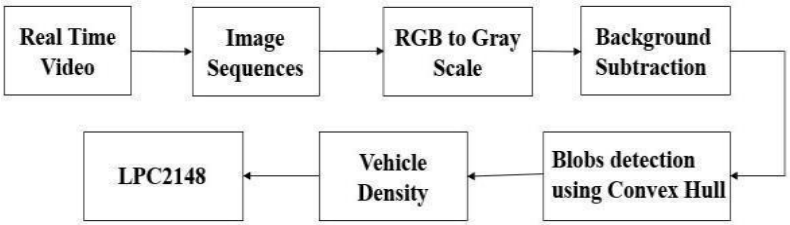


Fig. 3 - Steps involved in Image Processing



2. Clearance for Emergency Vehicles

Fig. 4 – Changing the Red Signal to Green

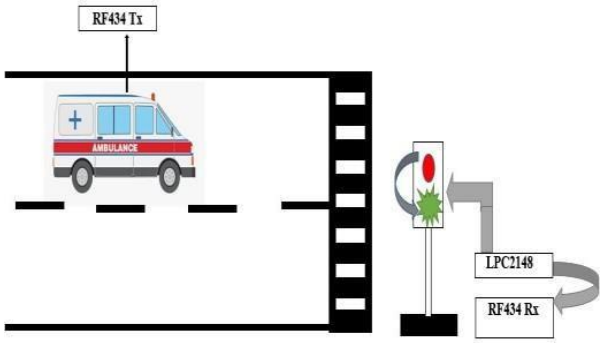
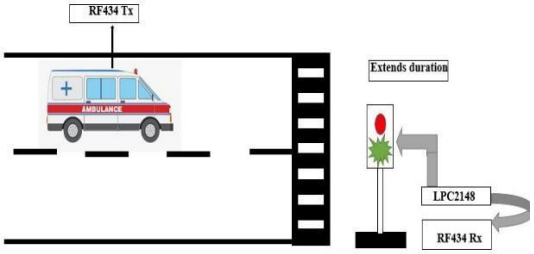


Fig. 5 – Extending the Green Light Time Delay



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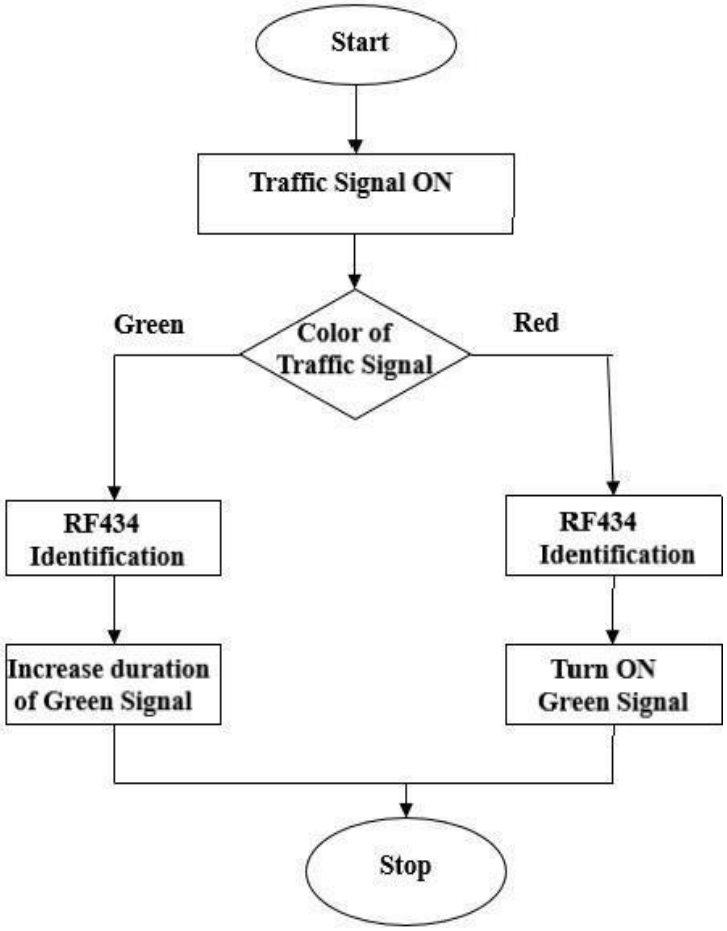
FlowChart

Fig. 6 - Flow Chart of the Emergency Vehicle Clearance



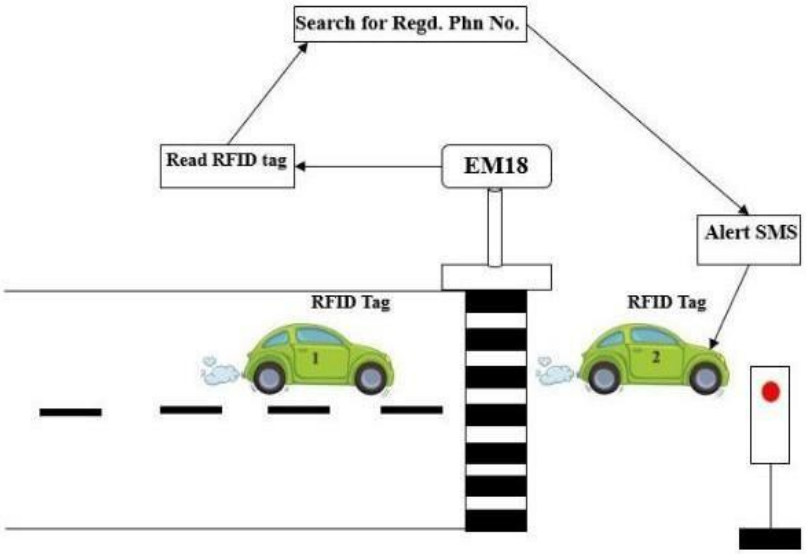
Every emergency vehicle is attached with an RF434 transmitter module (Radio Frequency module). RF434 receiver module is interfaced with LPC2148 is placed at the traffic junction. Essentially, the problem with the emergency vehicle is that it requires its road and path to be cleared so that it can reach its designated location on time and avoid any loss of life or property. The priority can be given by when an emergency vehicle approaches an intersection, the green light can be set too high.

As shown in the flow chart Fig.6, whenever the Emergency vehicle approaching an incoming junction with a red signal as shown in Fig.4, with the help of the RF transreceiver module, the emergency vehicle will be detected and the red light turns ON to green. In case, the signal at this junction is green as shown inFig.5 then the duration of that signal will be extended until the emergency vehicle crosses the junction.

3. Traffic Violation Control Block

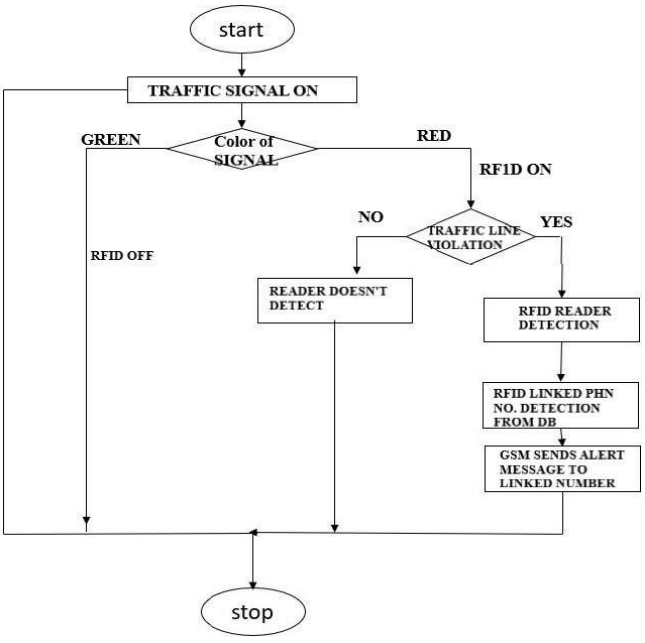
For traffic violation control, each vehicle is preinstalled with RFID tags at safest place in a vehicle that have unique id information. The RFID reader is placed near the junction. The RFID reader reads the unique id information of RFID tags whenever the tags come near to its coverage area (shown in Fig.7).

Fig. 7 - Vehicle Violation Control Block



Flow Chart

Fig. 8 - Flowchart of the Vehicle Violation Control Block



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According to Fig. 8, when the signal light is Red if any vehicle jumps the signal, the RFID tag attached to the vehicle is read by the RFID reader. The mobile number which is linked with the unique RFID tag is retrieved and an alert message is sent through the GSM module.

4. Results

Fig. 9 - Image Processing Result and Time Delay is Allocated According to the Type of the Traffic

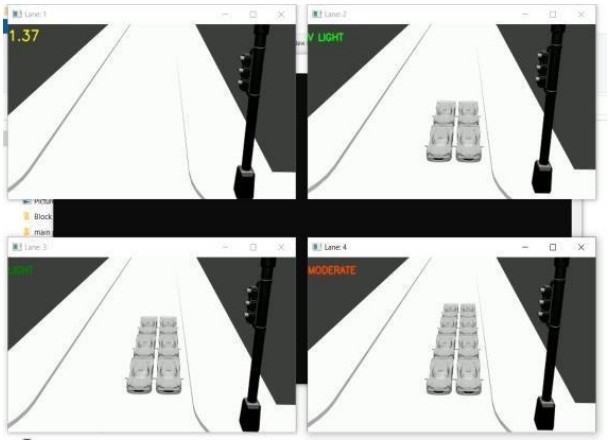

Fig. 10 – Hardware setup of the Prototype

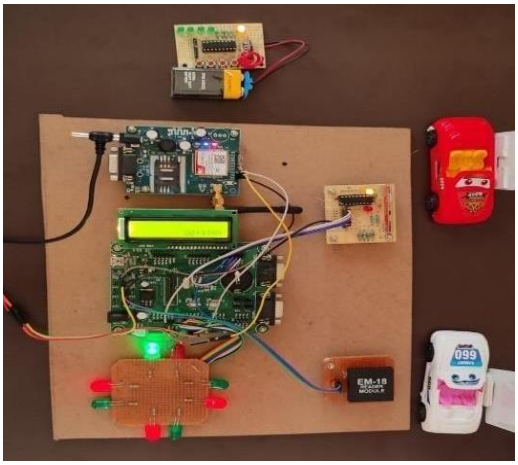

Fig. 11 - RF434 Transmitter Module with Push Buttons Indicating Priority for 4 Directions

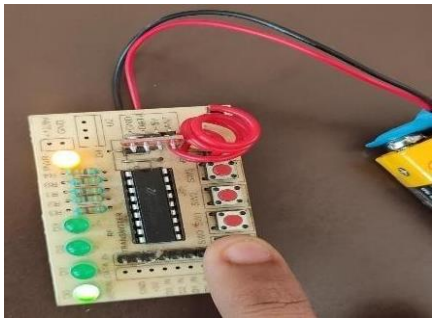

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Fig. 12 – Alert Message Sent through GSM when a Vehicle Jumps the Signal

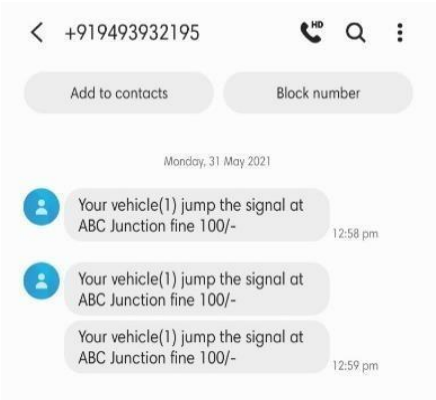

Fig. 13 - Indication of SJUMP on LCD

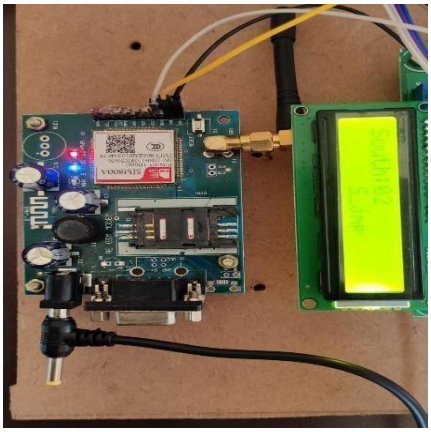

Fig. 10 depicts the whole hardware setup of the proposed system. The simulation part for density calculation is implemented using Python software which helps for assigning different time delays according to the vehicle count to each lane as shown in the Fig.9. The RF transmitter module shown in Fig.11 has four push buttons which are used for priority indication for 4 different directions to clear the traffic in that specific direction. Whenever the vehicle jumps the signal then automatically the vehicle will be detected by EM18 module and an alert message sent through the GSM module as shown in Fig.12 and the same message will be displayed on LCD (Fig.13).

5. Conclusion

The intelligent traffic management system is successfully designed that processes image sequences using Python software and creates an output that is interfaced with an ARM-based controller LPC 2148 to provide the desired output. This technology allows us to monitor traffic flow in real-time, significantly reducing traffic congestion and delays. Automatic clearance for emergency

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vehicles is provided by the RF trans-receiver module that is interfaced with LPC2148 and the vehicle violation control is done by RFID technology and an alert message is sent through the GSM module.

Future Scope

The intelligent traffic control system can be further improved by incorporating (i) Stolen vehicle recovery, (ii) in case accident occurs near the junction providing information to the nearby hospital to take the necessary actions (iii) Suggesting the shortest path to the emergency vehicle.

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