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# Intelligent and Smart Traffic and Transportation System for Modernisation of Cities

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**ABSTRACT:**Today in a country like India where vehicular traffic is more, the management becomes a challenging task for the policemen. Several accidents take place in day to day life which results in traffic congestion due to which vehicles remain on due to which pollution is generated and these results in danger to our lives. The accidents may be caused to due to several reasons on the roads, railway crossing, etc. Today many of the cars have built-in reverse parking sensors but sometimes for the small cars this feature is not built in thus the project suggest a cost effective solution for reverse parking using ultrasonic sensor. In metropolitan areas finding empty parking slot is becoming a difficult task thus a system needs to be present that could detect empty parking space and use the same to intimate the drivers if they wish to park their vehicle in the given parking space. The project aims in providing solution to some extent to get rid of the traffic management problem. The project helps finding empty parking space in a given area using MATLAB with help of the camera. The project uses various devices such as Raspberry Pi, sensors and Internet of Things. This project provides a cost effective solution for reverse parking using ultrasonic sensor and the LED to indicate the distance from the wall or vehicle. The system proves to be efficient and effective in nature. The merger of Raspberry pi and MATLAB forms a major challenge.

**KEYWORDS:** MATLAB, Traffic Management, Sensors, LED, Raspberry pi, Bluetooth, Traffic Intensity

## I. INTRODUCTION

A smart city is an urban development vision to integrate multiple information and communication technology and Internet of Things (IoT) solutions in a secure fashion to manage a city's asset. The goal of smart city is to improve quality of life by using urban informatics and technology to improve the efficiency of services and meet resident's needs. The emerging trend of IoT has made the work of day to day life much simpler and better. That the inadequate infrastructure cannot handle the issue of traffic is also a decisive reason. Besides, the highway and roads are incapable of meeting the requirement of increasing number of vehicle. With the available infrastructure if the proposed system is implemented then the issue of traffic and associated problems can be contained. This system provides system for finding empty parking space in a given area, measuring traffic intensity on the roads, making railway crossing more secure and making street light Eco-friendly. The central system also called as the brain of the system is Raspberry Pi and MATLAB. The system is an integration of sensor hardware and software programming. The system is capable of sending SMS, email using SMTP protocol which could be further used for triggering other actions as required. In actual implementation a database needs to be created where in only those user who have opted should be able to receive the notification else the notification may become irritating for the user. The trigger sent will be used to activate the database. The system uses Internet to activate and send services.

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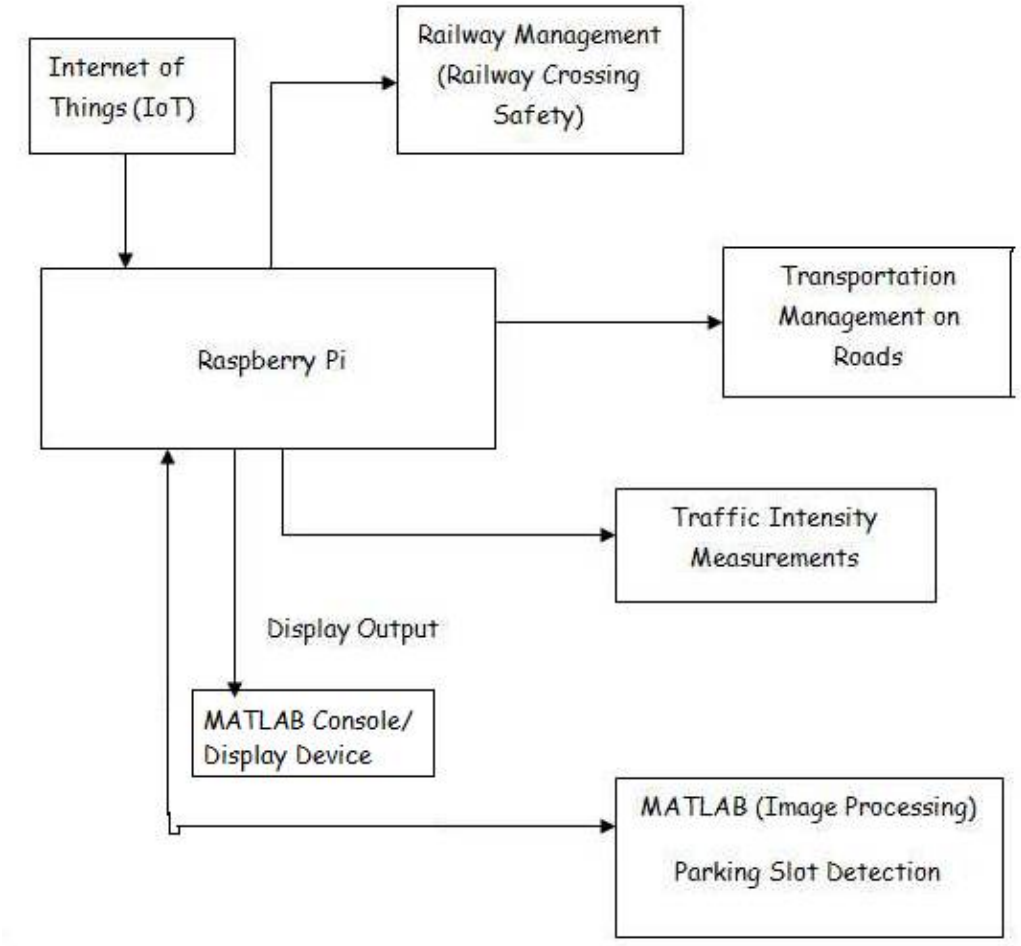


Fig. 1 System Overview

In the fig. 1 we see that we need to employ wireless communication, Bluetooth, Image processing software using MATLAB, integration of hardware and lastly all of this with minimal cost.
The system can find its application in hotels, offices where parking areas are present. The reverse parking can be used for parking and also for the people to know how close or how far they are from the vehicles moving in front of them. The system could also be used for conserving energy and shutting off the street lights are the correct time and place without any interference.The control server for the project is the computer which can connect and help in controlling the entire system operation. This system operation server can be connected to the Raspberry Pi via Ethernet cable orWi-Fi (wireless connection). The installation of MATLAB 2012 was done on raspberry pi which made the microcomputer heavy and hence employment of 2 Raspberry with Bluetooth connectivity.

## II. RELATED WORK

There are various ideas have been proposed using hardware and software for controlling street light. In a paper published by Mustafa Saad, Abdalhalimfarij, Ahamed Salah and AbdalroofAbdaljalil [1] under the title of Automatic street light control using microcontroller have pro- posed that with the use of photoelectric sensors and LDR providing the features of Automatic control and automated guidance but the problem in system totally depends on photoelectric sensor. The paper being discussed here also just one LDR for one street light but here an effort is being made to control

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one or more street light by a single LDR by taking into account the various distributions of current and voltages. Also, the use of micro-controller makes it difficult for coding for the user who are not efficient with the programming languages such as Embedded C, C language, etc. hence the use of microcomputer i.e. Raspberry Pi which makes use of the python coding.Also in the paper by Hilal Al-Kharusi, Ibrahim Al-Bahadly [2] used a software based method in determining the empty slots for car parking by it has several complexity in the processing part also it did not account for the various weather conditions in the environment. Several projects on car parking have been done using an open source software example OpenCV but it takes into account the color of the cars which could lead into mistake if any color comes in place of the car can be identified as car. And also in a paper Design and Im- plementation of Intelligent Parking Management System using Image by B.Karunamoorthy, R.SureshKumar, N.JayaSudha [3] a system composed of hardware and software was imple- mented but again the use of hardware makes its maintance cost high and also the system might weaken due to aging. Therefore a solution of using some of the simple techniques and MAT- LAB we determine the slots. MATLAB though being a licensed software but is a efficient investment as it one of the diverse and most flexible and efficient software for any type of requirement. Krishna, Shashi Yadav and Nidhi [4] presented a paper which dealt with automation of railway gate closing and opening by placing the sensors at a certain distance from the gate detecting the approaching train and accordingly controlling the operation of the gate. Also an indicator light had been provided to alert the motorists about the approaching train. Lim- itation of this project lies in the use of microcontroller 8952. Karthik Krishnamurthi Monica Bobby, Vidya V., Edwin Baby [5] presented system based on the arduino and IR sensor for au- tomatic control of railway gates. The paper presented by Ahmed Salih Mahdi. Al-Zuhairi [11] describes a system based on microcontroller for controlling railway gate and crossing. They found that the time for operation of railway gates is less as compared to manually operated gates and also reduces the human labour. J. Banuchandar , V. Kaliraj , P. Balasubramanian , S. Deepa , N. Thamilarasi [12] presented a paper which firstly deals with the reduction of time for which the gate is being kept closed and secondly, provides safety to the road users by reducing the accidents. By employing the automatic railway gate control at the level crossing the arrival of the train is detected by the sensors placed near to the gate. Hence, the time for which it is closed is less compared to the manually operated gates. The operation is automatic; error due to manual operation is prevented. Automatic railway gate control is highly microcontroller based arrangements, designed for use in almost all the unmanned level crossing in the train. In previous years various method have been proposed such as the idea of using analog circuits such as potentiometers to control the LED which indicates the distance between the object and the car but it was seen with a small change in the values of the resistor the entire system can get disturbed and the calibration of the potentiometer is very difficult [6]. The circuit was further improved using timer IC 555 [7] but the circuit still remained analog and the problem of adjustment of potentiometer still persists. There are many works which discuss the T&T reverse parking problem. In [8] and [9] the authors present a partially fuzzy approach and its analysis of stability. It is true that this approach is very efficient, but what about the cases when we do not have the luxury of exact knowledge that is required for the non-fuzzy part of the controller. In [10] authors have used a T & T model to present procedures for escaping from the jack knife situation that are based on a hierarchy of two fuzzy controllers. One is used for reverse and one for forward drive control.

## III. HARDWARE REQUIREMENTS

i. Raspberry Pi:

The Raspberry Pi which is a microcomputer has extensive features at a lower cost. It has 17 GPIO (General Purpose Input Output) pins which give out 3.3V. The device uses the ARM processor which does most of the hard work in order to run the Raspberry Pi. ARM processors can be thought of as the brains of the device. The Raspberry Pi is connected to PC via software called PUTTY. The PUTTY establishes the connection and helps to enter into the Kernel Shell and program the Raspberry pi. The coding of Raspberry Pi is done using Python programming language. PuTTY allows you to communicate to Raspberry Pi directly.

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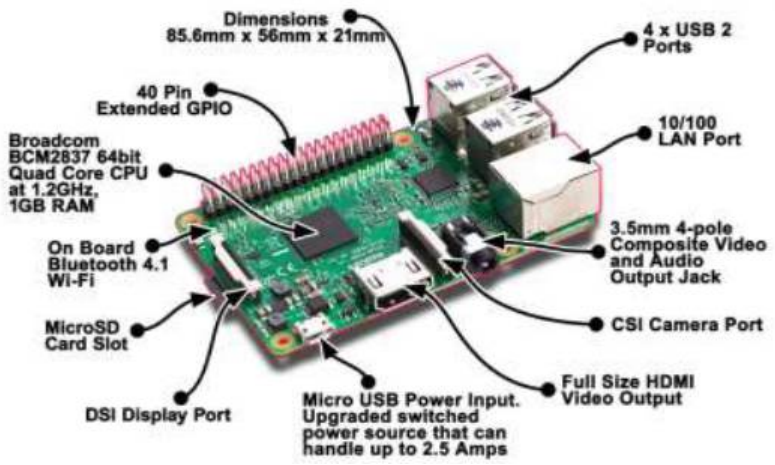


Fig. 2 Raspberry Pi 3 Board Parts

ii. IR Sensor:

Infrared technology addresses a wide variety of wireless applications. The main areas are sensing and remote controls. In the electromagnetic spectrum, the infrared portion is divided into three regions: near infrared region, mid infrared region and far infrared region. The frequency range of infrared is higher than microwave and lesser than visible light. An infrared sensor emits and/or detects infrared radiation to sense its surroundings. The working of any Infrared sensor is governed by three laws: Planck's Radiation law, Stephen – Boltzmann law and Wien's Displacement law. The basic principle of working of this sensor is shown in fig 3.

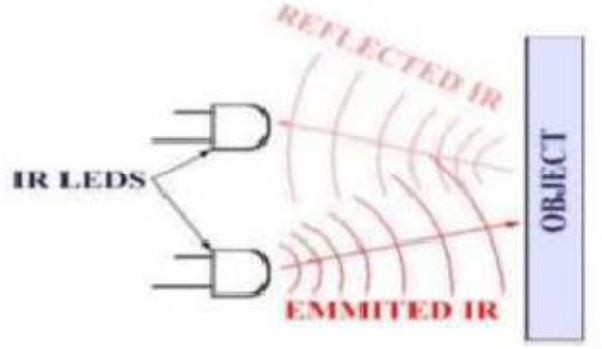


Fig 3. Working of IR Sensor

iii. Ultrasonic Sensor:

The sensor used for reverse parking is ultrasonic sensor. The Fig. 4 shows the description of ultrasonic sensor and the principle of working of ultrasonic sensor. It has 4 pins called as VCC, Trigger, Echo and ground respectively. When ultrasonic waves are incident on the object, diffused reflection of the energy takes place over a wide solid angle which might be as high as 180 degrees. Thus some fraction of the incident energy is reflected back to the transducer in the form of echoes and is detected. The distance to the object (L) can then be calculated through the speed of ultrasonic waves (v) in the medium by the relation, where't' is the time taken by the wave to reach back to the sensor and 'Ø' is the angle between the horizontal and the path taken.

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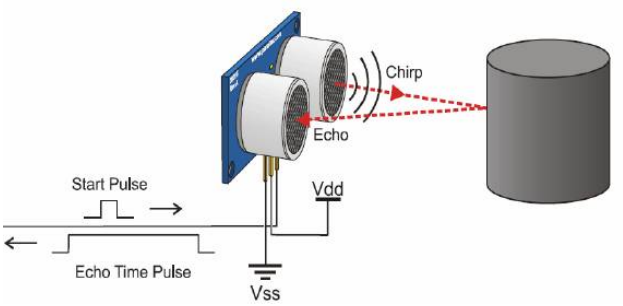


Fig. 4 Principle of Ultrasonic Sensor

iv. LDR (Light Dependent Resistor)

The theoretical concept of the light sensor lies behind, which is used in this circuit as a darkness detector. When the LDR detect light its resistance will get decreased, thus if it detects darkness its resistance will increase. The LDR is a resistor as shown in Fig. 5. When light falls i.e. when the photons fall on the device, the electrons in the valence band of the semiconductor material are excited to the conduction band. These photons in the incident light should have energy greater than the band gap of the semiconductor material to make the electrons jump from the valence band to the conduction band. Hence when light having enough energy strikes on the device, more and more electrons are excited to the conduction band which results in large number of charge carriers. The result of this process is more and more current starts flowing through the device when the circuit is closed and hence it is said that the resistance of the device has been decreased.

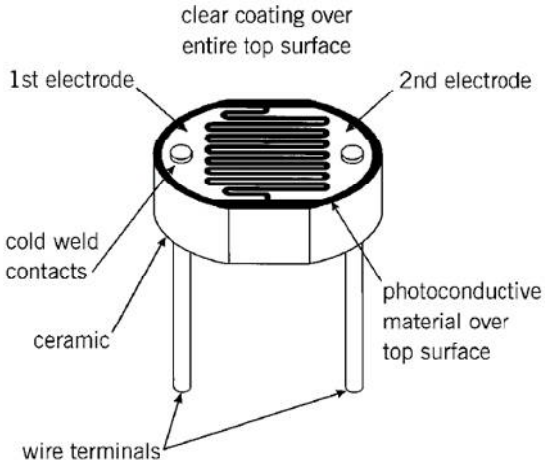


Fig. 5 Construction of LDR

LDR's are light dependent devices whose resistance is decreased when light falls on them and that is increased in the dark. When a light dependent resistor is kept in dark, its resistance is very high. This resistance is called as dark resistance. Figure below shows resistance vs. illumination curve for a particular LDR. Photocells or LDR's are non linear devices.

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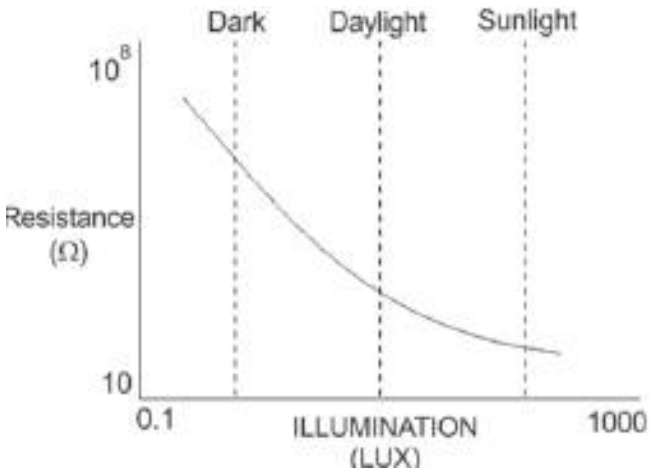


Fig. 6 Illumination during various times

v. PIR (Passive Infrared Resistor):

This motion sensor consists of a Fresnel lens, an infrared detector, and supporting detection circuitry. The lens on the sensor focuses any infrared radiation present around it toward the infrared detector. Our bodies generate infrared heat, and as a result, this heat is picked up by the motion sensor. The sensor outputs a 5V signal for a period of one minute as soon as it detects the presence of a person. It offers a tentative range of detection of about 6-7 meters and is highly sensitive. The sensor converts the resulting change in the incoming infrared radiation into a change in the output voltage, and this triggers the detection. Objects of similar temperature but different surface characteristics may also have a different infrared emission pattern, and thus moving them with respect to the background may trigger the detector as well. Fig. 7 shows the working of the sensor.

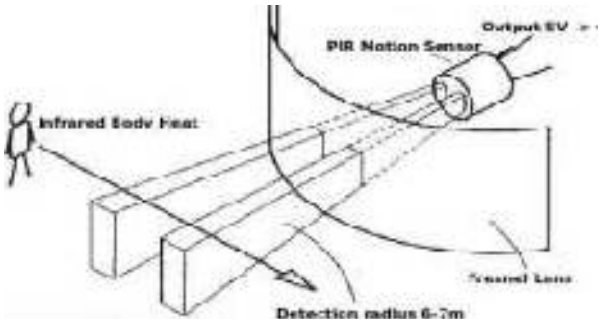


Fig. 7 Working of Motion Sensor

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## IV. CIRCUIT DESIGN AND FLOW CHARTS

1. Street Light Controls

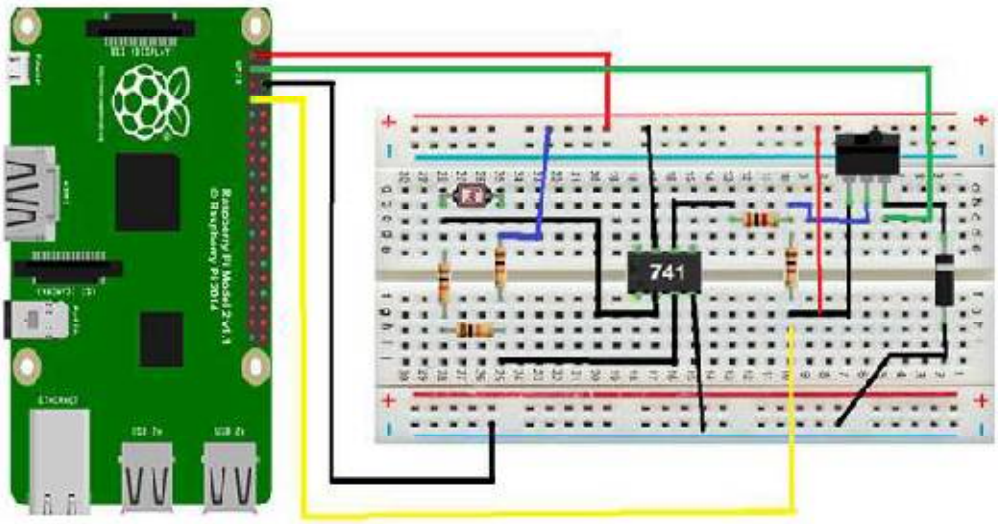


Fig. 8 Circuit for Street Light Control

2. Reverse Parking:

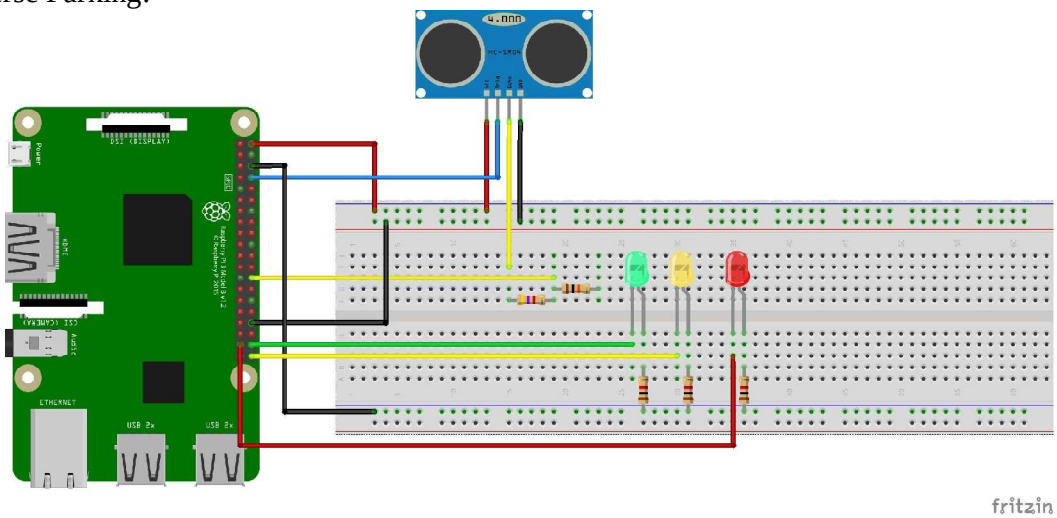


Fig. 9 Connection for Ultrasonic Sensor

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3. Traffic Intensity Management:

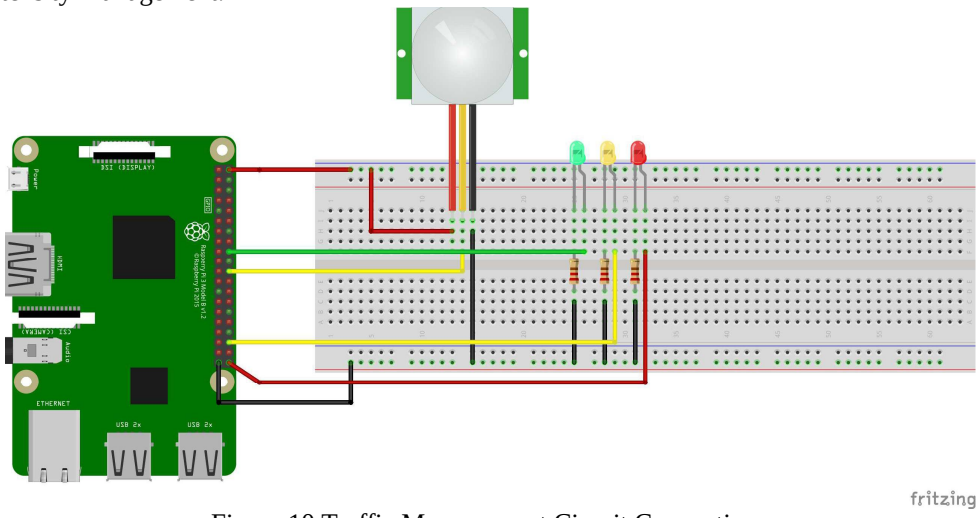


Figure 10 Traffic Measurement Circuit Connections

4. Railway Guarding

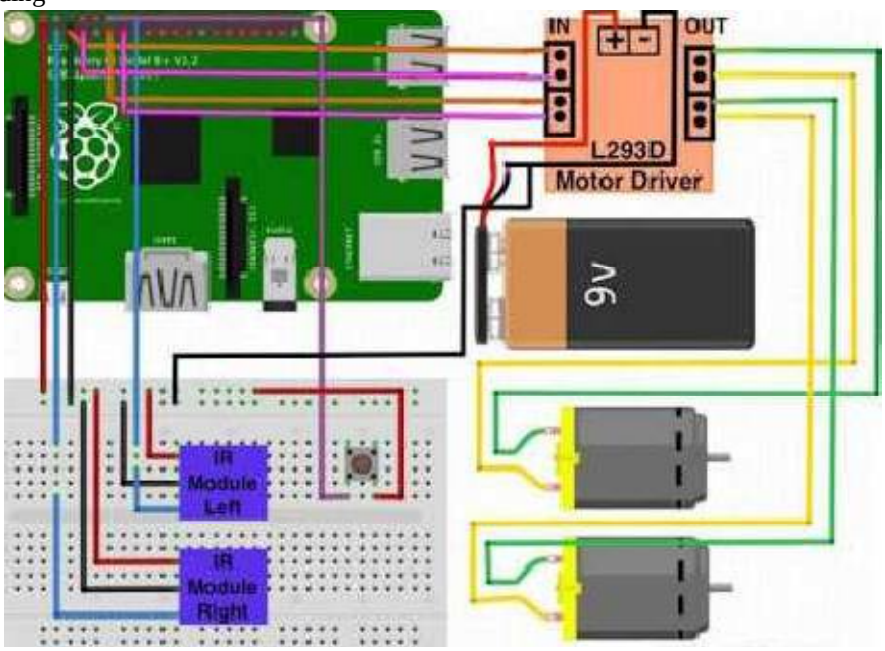


Fig. 11 Railway Guarding Safety Connection

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Vol. 6, Issue 3, March 2018

5. Parking Space Detection:

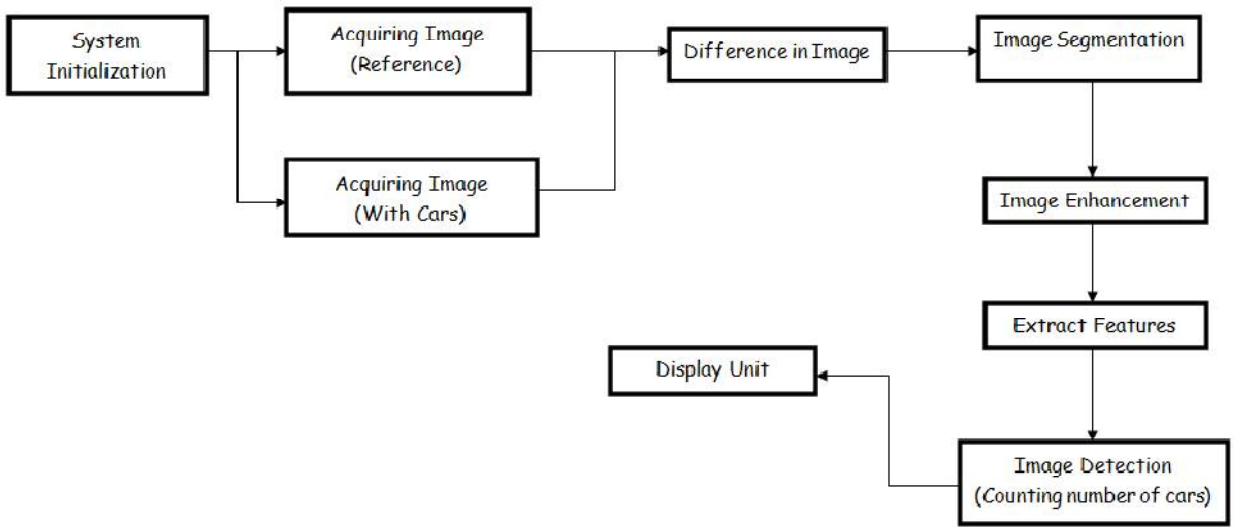


Fig 12: Image Processing Blocks

## V. EXPERIMENTAL RESULTS

In the reverse parking when the cars approach the wall and the distance keeps on decreasing between the wall and the car then appropriate LED goes on for the car that enters in the danger zone and buzzer turns on to indicate that car is almost near the wall. The ultrasonic sensor measures the distance with an average error percentage of 0.05%. The system provides an efficient way to measure the distance between any two cars while the car is driving. Here the Green LED glowing indicated that the car can be parked easily as the distance between the car and the wall is not so much that may cause accidents.

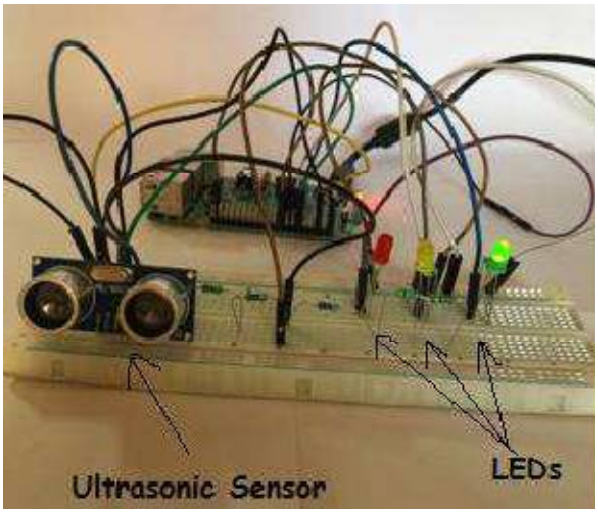


Fig. 12 Reverse Parking Implementation

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Vol. 6, Issue 3, March 2018

The LDR circuit for smart street lights is connected and the observation was made when the LED turned on. In this study we have employed LDR and IR sensor to detected object. The system also need not have a specific time when the light should turn ON, all happens with the help of the sunlight intensity falling on the LDR. A single LDR signal can help to control more than one street light. With commands from the Raspberry Pi the lights will be ON in the places of the movement when it is dark. Figure 7.1 shows the actual implementation of the circuit and table 7.2 shows the observation that was been made in various conditions.

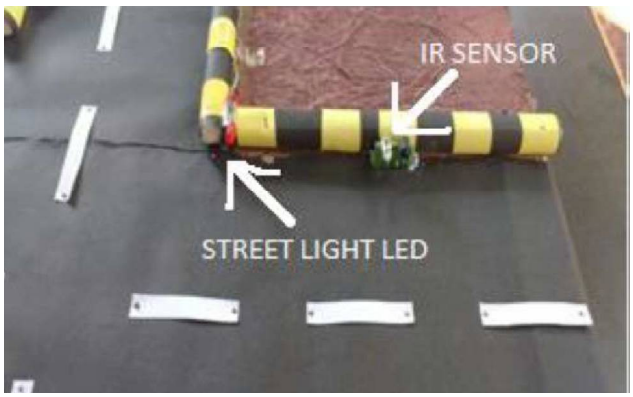


Fig. 13 Street Light Actual Implementation Prototype

In parking slot detection using image processing techniques were employed and the images were fed which acted as the reference image and further the images were taken where the cars are parked and the output of the same was displayed on the MATLAB work space. The reference image, image with presence of cars and the image outputs that were being obtained due to the image processing techniques. This project proposes the idea of parking slot detection system based on image processing was designed and tested. It is an efficient way of comparing the reference image and the captured image which simplifies the system. The conceptualization of this part of the project is based on software instead of hardware which makes the system cheap to maintain and implement. This system also makes the system free from wire hassles.

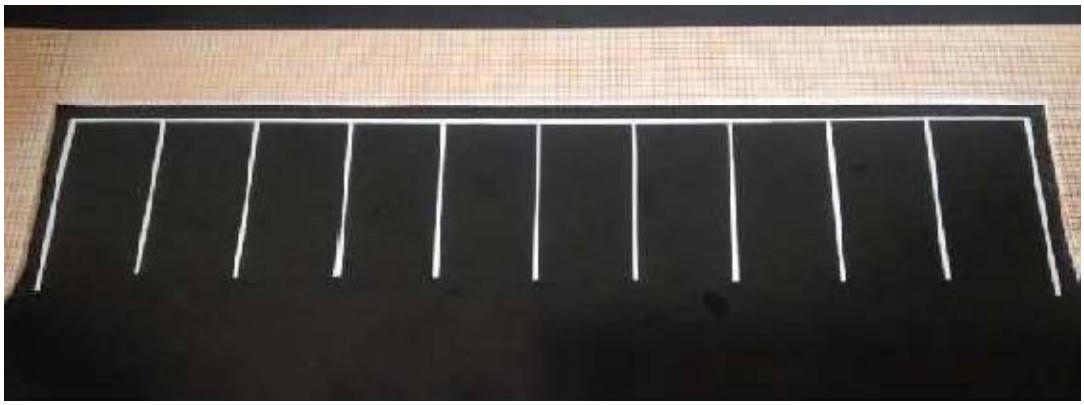

Fig. 14 Reference Image

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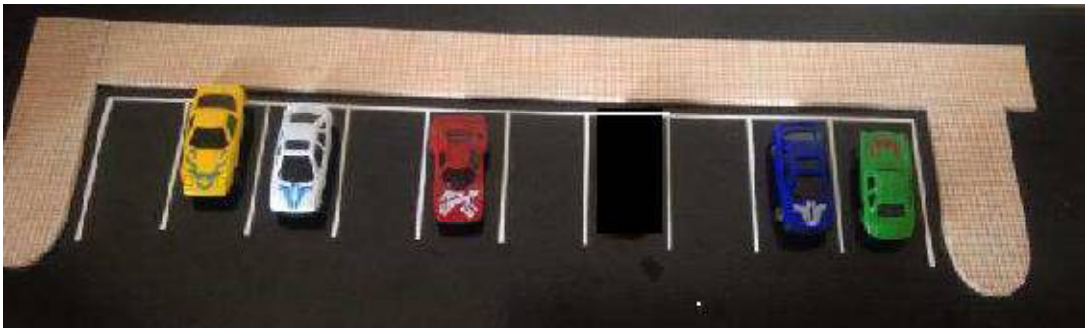

Fig. 15 Image of Parking slot at time t

The camera connected to Raspberry Pi captures the images of the parking slot and send for further processing to raspberry pi the image get overwritten again after every instance k. Color digital images are made of pixels, and pixels are made of combinations of primary colors represented by a series of code. A channel in this context is the greyscale image of the same size as a color image, made of just one of these primary colors. For instance, an image from a standard digital camera will have a red, green and blue channel. A greyscale image has just one channel."Channel" is a conventional term used to refer to a certain component of an image. In reality, any image format can use any algorithm internally to store images. For in- stance, GIF images actually refer to the color in each pixel by an index number, which refers to a table where three color components are stored. However, regardless of how a specific format stores the images, discrete color channels can always be determined, as long as a final color image can be rendered. Three main channel types (or color models) exist, and have respective strengths and weaknesses. Similarly adopting this concept the RGB Image is separated into different channel components.


Fig. 16 Separation into RGB Channels

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**Vol. 6, Issue 3, March 2018**


Fig. 17 Conversion of RGB Channel into Binary Channel (threshold)

An RGB image has three channels: red, green, and blue. RGB channels roughly follow the color receptors in the human eye, and are used in computer displays and image scanners.If the RGB image is 24-bit (the industry standard as of 2005), each channel has 8 bits, for red, green, and blue—in other words, the image is composed of three images (one for each channel), where each image can store discrete pixels with conventional brightness intensities between 0 and 255. If the RGB image is 48-bit (very high color-depth), each channel is made of 16-bit images.

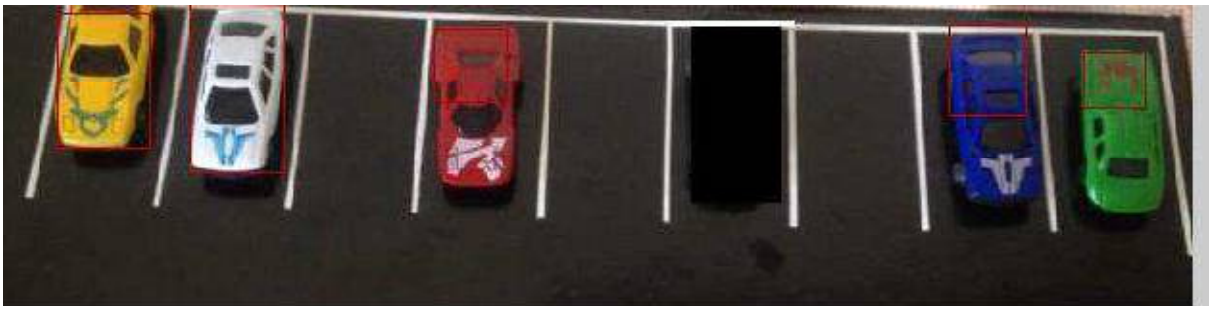

Fig. 18 Cars Parked getting detected

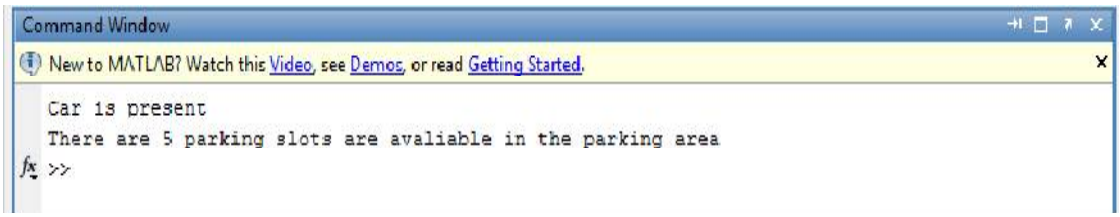


Fig. 19 Output on MATLAB Console

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The Fig 19 output is again passed into the python code and using IFTTT App a notification is send on the user phone who has registered himself with the parking area management committee. This will help him find easily the space available for which area and hence can save his time.

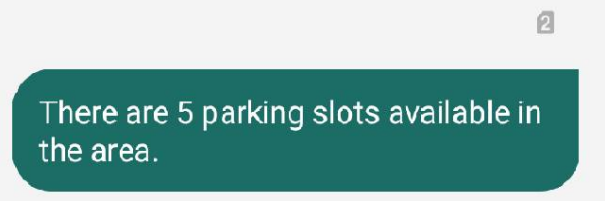


Figure 20 Notification Service for parking space

In the study for traffic intensity measurement, the cars were counted passing in front of the sensor and the respective action were done as per the program. The notification of the traffic is shown in figure 21.

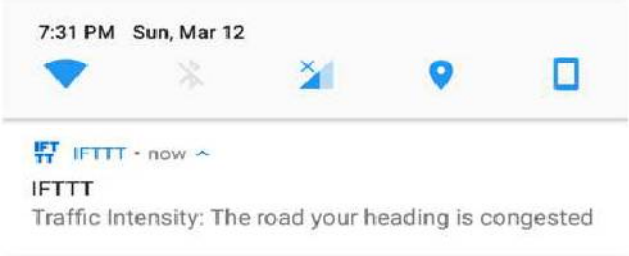


Fig. 21 Traffic Status on the road the person is travelling

The circuit for railway crossing was implemented and the gates closed when the train reaches the first IR sensor pair and they remained closed till it departed from the second sensor. While making the observation we had placed the IR sensor 1 on the left side of the gate and assumed that train would first cross sensor 1 that is train would come from left side. The sensor value high means that there is an obstacle which is the train and the gates will close and they will remain closed until the sensor value at the second IR pair is low. After 30 seconds, Raspberry Pi issues a command to close the gates by rotating servo motor. When the train is completely passed, it is to be sensed by the second IR sensor which is located the second end of railway gate based upon which the gates will get opened. Once the second IR pair is low then Raspberry Pi command the complete opening of the gate.

## VI.CONCLUSION

The aim of the project is to design features which have the advantages of low cost, portability, small size and easy expansibility. This is the reason we have integrated 5 features in one project. The platform of the system is Raspberry Pi which is now used widely worldwide. The project helps in reducing the number of accidents and also helps in maintaining the traffic congestion and also makes the street lights smart and efficient and helps in the conserving the energy because it has no human intervention. This system has software implementation which makes the cost cheap though camera required would be high sensitivity and hence this would raise the cost but that is for one time only. The notification service provided can help the drivers to reach to their destination taking different route available in case there is traffic on the road they are travelling thus reducing traffic congestion as well. The system providing safety railway crossing feature enables in reducing the accidents that take place unguarded railway system and also reduces the man power. To avoid the cars that collide with each other or to the wall then a prototype with Raspberry Pi was developed. When the cars approach the wall and the distance keeps on decreasing between the wall and the car then appropriate LED goes on and for the car that enters in the danger zone that the car is almost near the wall then a buzzer

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Vol. 6, Issue 3, March 2018

goes on for this condition. The ultrasonic sensor measures the distance with an average error percentage of 0.05%. Circuit works properly to turn street lamp ON/OFF. After designing the circuit which controls the light of the street as illustrated in the previous sections. LDR sensor and the IR sensors are the two main conditions in working the circuit.
The same reverse parking can be used to indicate the drivers to find the distance between the two vehicles on the same road. They also can be used to indicate if a accident has taken place by intimating the vehicles behind on the same route so that they can take an alternate route if available. Also this sensor can be used to see that the car is properly parked in the given area. Further the project can be used in complement with proper car space alignment. It could also be used in cars with cruise control system for reverse parking. If used for parking where no car is present and the system is fitted with this system then it can be use for detecting a collision with hostile vehicle in any direction thus reducing accidents caused due to other vehicles The working of IR sensor can be major challenge for this system since it can be affected by the animal or any other environmental obstacle. This can be overcome by use of image processing technique for the implementation of this system. The way to determine the traffic intensity can be improved by inserting a magnetic sensor instead of PIR sensor as they can even count the humans as object as the body also radiates energy which gets absorbed and causes interference in proper counting. The railway crossing system can further be complemented to provide recording of time when the train arrived at the railway crossing and departed from the railway crossing so that accurate time of arrival can be predicted. Also the system can be further implemented by intimating the user that the train is arriving and the gates shall close so the driver can choose to divert his path in order to avoid traffic at that point.

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