IoT Based Traffic Congestion and Warning System

Submitted

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For the partial fulfillment of the degree of

Bachelor of Technology in

Computer Science and Engineering

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Certificate

This is to certify that the project entitled *"IoT Based Traffic Congestion and Warning System"* being submitted by Akarsh Somani and Gaurav Misra, undergraduate student, Reg No. 0000162 and 0000172, Roll No. 39/CSE/16005 and 39/CSE/16015, respectively, in the Department of Computer Science and Engineering, Indian Institute of Information Technology Kalyani, West Bengal 741235, India, for the award of Bachelors of Technology in Computer Science and Engineering is an original research work carried by him under my supervision and guidance. The project has fulfilled all the requirements as per the regulations of Indian Institute of Information Technology Kalyani and in my opinion, has reached the standards needed for submission. The work, techniques and the results presented have not been submitted to any other University or Institute for the award of any other degree or diploma.

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Declaration

I hereby declare that the work being presented in this project report entitled, "**IoT Based Traffic Congestion and Warning System**", submitted to Indian Institute of Information Technology Kalyani in partial fulfilment for the award of the degree of Bachelor of Technology in Computer Science and Engineering during the period from July, 2018 to May, 2019 under the supervision of **Dr. Dalia Nandi**, Department of Electronics and Communication Engineering, Indian Institute of Information Technology Kalyani, West Bengal 741235, India, does not contain any classified information.

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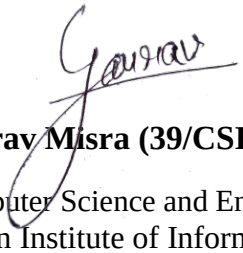

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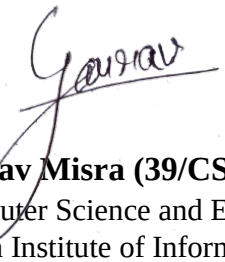

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ABSTRACT

Traffic nowadays, especially in modern cities, is proving to be a major concern for the public and Administration system. Incidents such as jams, accidents have become quite common because of exponential growth in vehicles on road. While human errors are one of the prime reasons for these problems, the lack of proper measures and adaptive traffic control system is another reason. Security of vehicles is also important.

As technology has become more and more advance with the time, many projects got developed. There has been various research work carried out in Traffic Signal Automation and Management by using image processing, Infrared Sensor and prioritizing emergency vehicles using fuzzy logic.

One of the cons of all these systems lies in the expensiveness while deploying camera for capturing the traffic for controlling the traffic lights. One more thing is that Infrared Sensor requires vehicle to be very close while calculating the traffic density.

This project report investigates regarding traffic problems in day to day life provide a solution for handling problems such as traffic congestion, emergency ambulance and fire brigades passing, etc. with the help of IoT. People tend to use their own vehicles for transportation purpose nowadays for their own comfort rather than standing in queue waiting for a public transport. And considering India's population density, it leads to high number of vehicles. This leads to Traffic Congestion and Jam, Slower traffic speed, longer trip time and vehicular queuing. In India, traffic signals are still manually operated many where. It is to be noted that we don't see traffic police at every junction which leads to traffic jam.

Due to this jam, many emergency needing vehicles are not able to pass immediately and thus leading to fatal result. Our main two emergency vehicles are ambulances and fire brigades. Looking into consideration these two emergency vehicles our thought was to handle this situation in a more efficient manner.

To make a cost friendly Traffic Management System, we propose this project named "Traffic and Congestion and Warning System based on IoT". This would include smart traffic light management, handling emergency cases such as fire brigade and ambulance and pre-warning before jams. We have used Raspberry Pi3, LEDs, and bread board, Ultrasonic Sensors, GSM Technology and M2M Communication.

Many Solutions has been made for the traffic management using image processing and infrared sensors. But it is very costly, and proximity of infrared is very low. These devices also don't interact. So, a better idea would be to use Machine to Machine communications, where devices can share data and use it for traffic light controlling. Our project is just based on that.

1. Need of Proper Traffic Management

We need proper traffic management due to following reasons-

- Traffic jams which takes hours to be unjammed.
- Wastage of time when a lane is open which has no traffic or vehicle to pass.
- Emergency vehicles such as ambulance and fire brigades are not able to pass in affordable time.
- Delay in such emergency case can lead to fatal results.
- To ensure that traffic is routed conveniently and with minimum inconvenience around.
- To ensure safety of all road users - pedestrians, cyclists, motorcyclists and motorists using the adjacent roads.
- Improper management of traffic can cause road accidents which can cause fatal deaths.

2. Literature Survey

In the field of IOT based Traffic Congestion and Warning System, many of the papers has been published while the concepts and ideas kept developing with the time. This section is all about different methods of Traffic Monitoring and control. Many methods and approaches have been offered.

Findler and Stapp gave an expert system based on connected roads and traffic light management. These systems decide their action based on a specific set of rules. These rules are analyzed by optimizing set of rules that apply to them and based on the frequency at which these rules work [1]. They said they can improve efficiency by making slight modifications and some simple assumptions.

To overcome these fluctuations, Liu demonstrated some methods by fitting traffic detectors at both sides of a junction. He also used vehicle identification to measure average delay at a junction [2].

In a research, PIC Microcontroller has been used towards density based Intelligent Traffic Management System [3]. This system records total number of vehicles in real time and send this data to computer, where the administrator can access traffic conditions pertaining to any accessible traffic lights and nearby roads reducing traffic congestion.

Another research on Density Based Traffic Signal System [4] is based on image processing methods like edge detection to find the traffic density that regulates the traffic signals. Its advantage is that it reduces congestion, operational costs; provide alternate routes to travelers and increases capacity of infrastructure.

Density based Intelligent Traffic Control system [5] has been calculated using IR sensor. Sensors are placed on the side of the roads to detect presence of vehicle and send this information to microcontroller. Then Microcontroller makes decision based on vehicle density about glowing time of Green and Red light.

Intelligent Traffic Signal Control system [6] was developed using AVR 32-bit microcontroller with programmable flash memory, built in 8 channels Analog to Digital Converter and IR sensor. These sensors detect the presence of emergency vehicles and accordingly microcontroller allots green signal to the one with emergency vehicle.

Wireless Sensor Networks [7] was presented in the Priority Based Traffic Light Controller where the direction of any emergency vehicle uses a fuzzy logic and by collecting all the information, the central monitoring system gives the corresponding appropriate response.

3. Our Methodology

Looking at all the above models we thought to design a system which can automatically detect

1.) The lane traffic and allows the passage of the lanes according to that. So, if a lane has more traffic than the passing time of the lane will be more.
2.) Emergency vehicle needing an immediate passage and thus open the required gate for the passage.
3.) If there is an emergency/accident, a reporting channel is made through which a mail will be sent to hospital for the ambulance purpose.

3.1 Ultrasonic Sensor and its Implementation

We used a raspberry pi (The cheap and best minicomputer). All the connection is properly made and checked if all lanes are working fine. The basic sensors we used is ultrasonic sensor, sound sensor, etc. For checking the lane crowd, we used ultrasonic sensor. Ultrasonic sensor will send some signal and will wait for the signal to return after colliding to the object and thus return us the distance at which the vehicle is present. We will fix a threshold distance and according to that threshold distance, the result will be “traffic” or “no traffic”.

$D > D_{threshold}$ → No Traffic
$D < D_{threshold}$ → Traffic

If a lane is open and there is no vehicle passing or “no traffic” situation for 5 continuous second than automatically the lane will be closed, and next lane will be open. This way an efficient way of handing the traffic can be done.

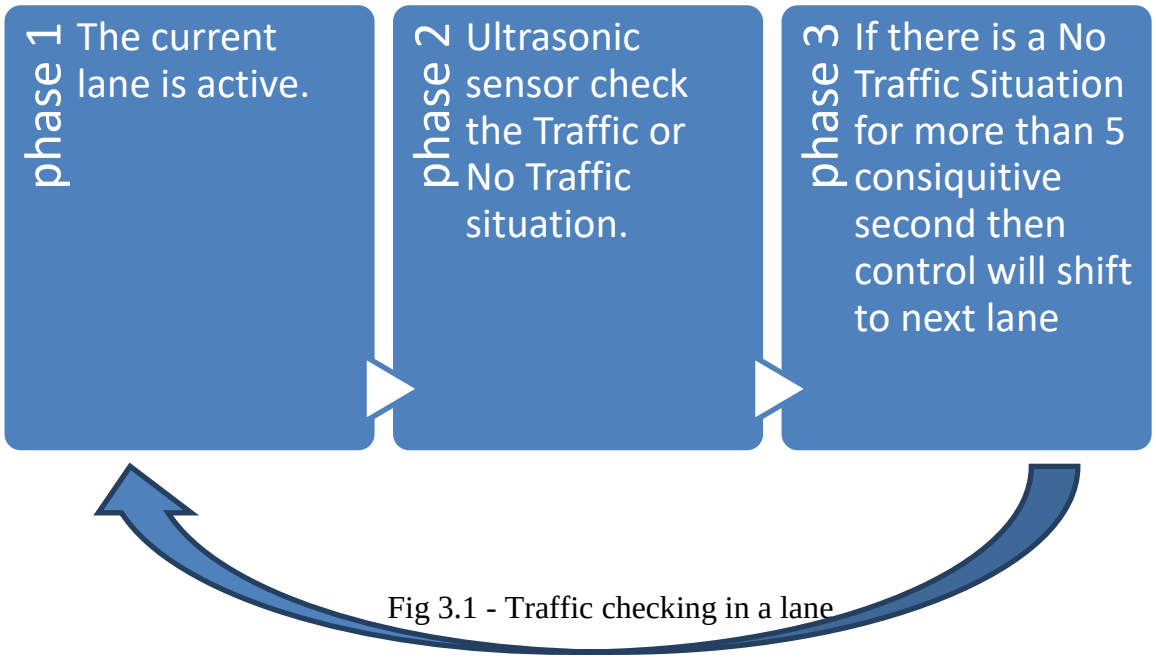


Fig 3.1 - Traffic checking in a lane

3.2 Sound Sensor and its Implementation

For detecting the emergency vehicle, we have used sound sensor. The frequency of the sound sensor is set in such a way that it will only detect the frequency of the ambulance and fire brigades.

$F_{\text{Sensor received}} = F_{\text{Emergency vehicle}}$ → then it is an emergency alarm from emergency vehicle

On receiving an emergency signal our current ongoing process will check if the emergency vehicle is pointing to the current open lane then there will be no swapping of lane and the emergency needing vehicle can pass. If the vehicle is from another lane than immediately the lane will be swapped and thus the emergency needing vehicle can pass.

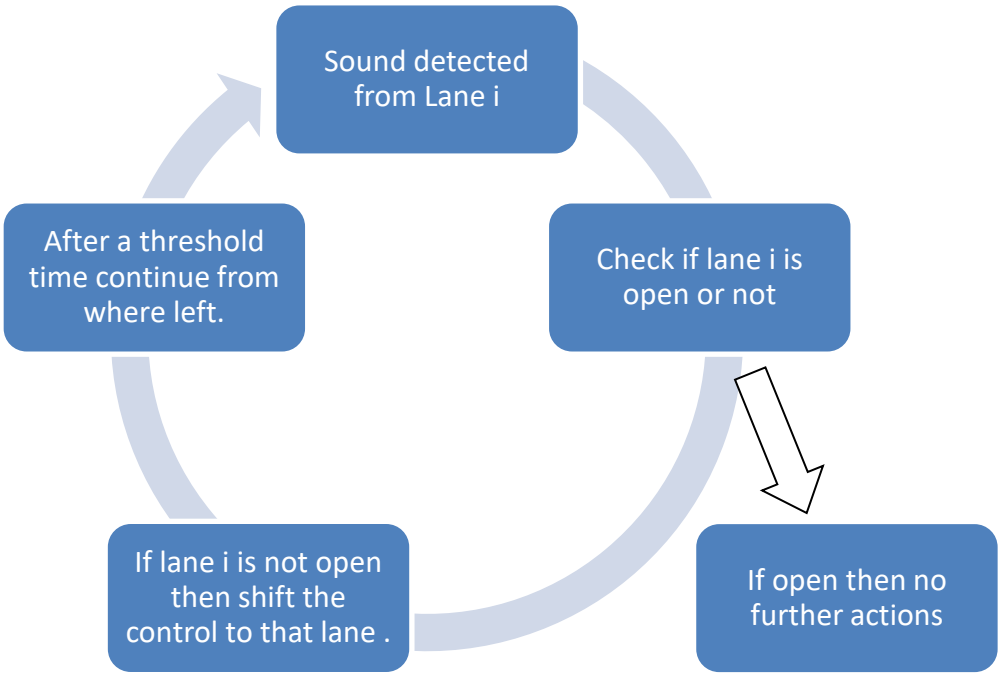


Fig 3.2 - Checking and flow for emergency vehicle passage

3.3 Emergency Button Implementation

We have set up a button, which on being pressed sends an emergency email to the hospital for ambulance service in case of road accidents and such situations. The traffic police have not to write any message or an email manually, just need to press a button and email will be sent. We have carried out the email automation using python inbuilt package 'SMTP' which provides this functionality of sending an email. This system involves an important role of IoT where the sensor (here button) senses the press and emergency message instantly send to a hospital connected to it.

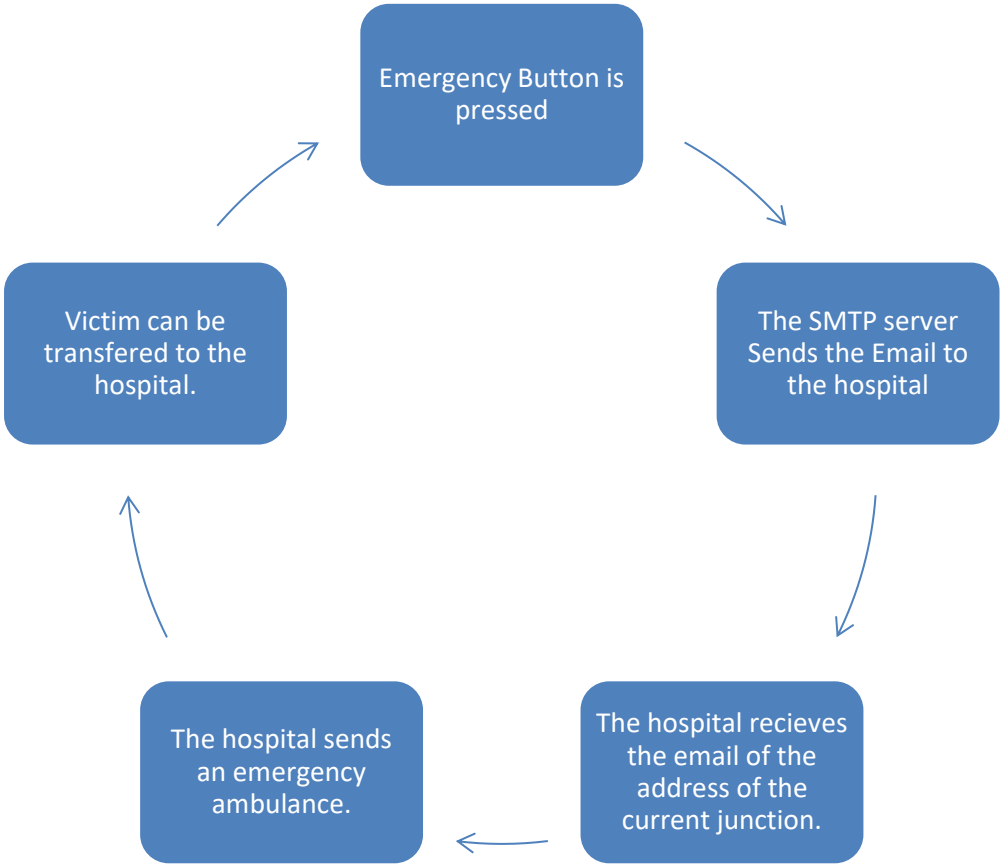


Fig 3.3 - Emergency Handling

Here is how this SMTP package in Python works

- Set up the SMTP server and log into your account.
- Create a message object and load it with appropriate values.
- Add the message body
- Send the mail using the SMTP server

3.4 SMTP Protocol

A basic look of how SMTP works

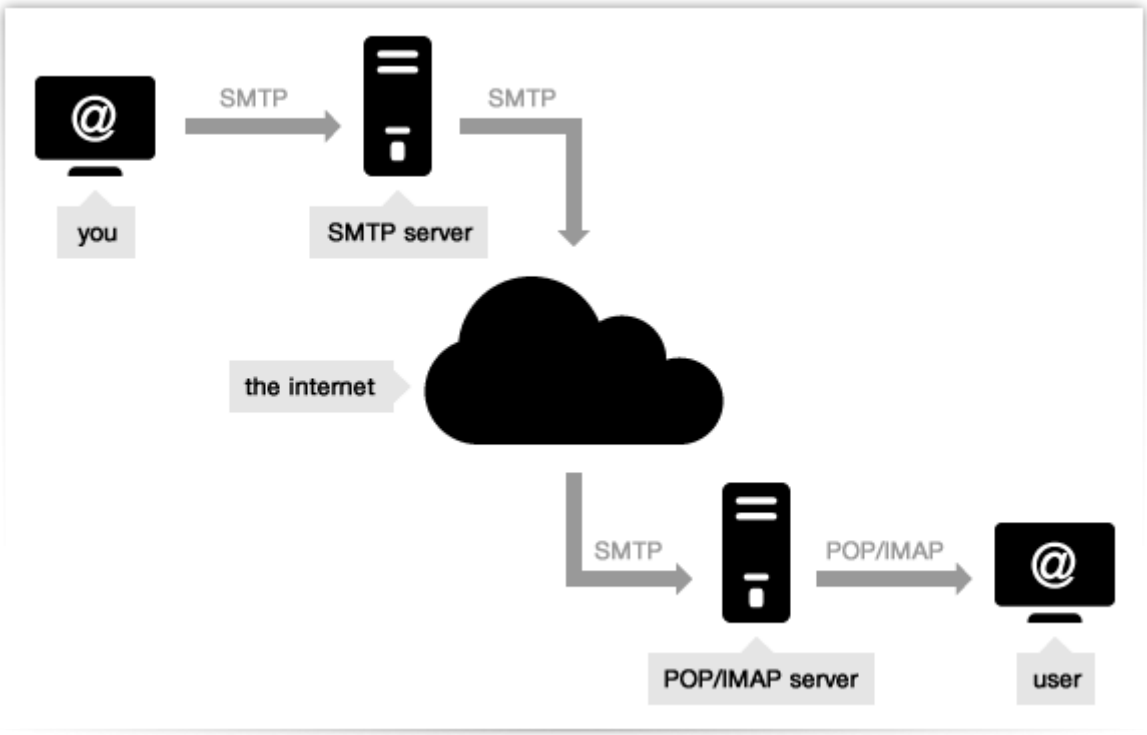


Fig 3.4 - Simple Mail Transfer Protocol [8]

We designed an algorithm which will do all these functions together in the system i.e. Lane crowd checking, emergency vehicle detection and correct passage and sending email for the emergency. The hardware and the sensor which we used as total are raspberry pi, LEDs, ultrasonic sensor, sound sensor with breadboards, some connecting wires and a button.

We have implemented this whole model for the four-lane model, and this is connected to the internet thus is the implementation of the IoT. A wide Use of IoT is there which can make the life very easier for traffic handling and management. The collection of data from the sensor and sending the information across email is very effective.

4. Algorithm

- Setup the board as GPIO.BOARD to use GPIO pin numbers as normal numbers on the Raspberry Pi board (Assigning by counting).
- Declare all the related pins as variables for the ease of other steps. Setup all the related GPIO Pins according to the connection between Raspberry Pi and Sensors.
- These pins include trig, echo pins for ultra-sonic sensor; Input from sound sensor and LED output pins apart from corresponding VCC and Ground pins.
- At first, we will assign any one lane to be functional/ active at that time.
- At this instant, other lanes will be inactive (Except Sound Sensors of that lane).
- Set the Green Light of the active lane to on state and other lights i.e. Red light to off state.
- Set the Red lights to on state for all the other lanes and Green lights to off state for all of them.
- Iterate 240 times
- Each iteration will take 0.1 seconds
- Hence maximum time span for which a lane can be active is limited by 24 seconds in our case.
- This will also insure even if one lane is crowded all the time the other lane will get active after maximum of 24 seconds.
- Every iteration, we find the distance of the object in front of each ultrasonic sensor of that lane.
- We can calculate the traffic density from this data.
- We can assume the greater number of backward sensors sense the object, the more traffic density.
- **In case of Sound,** we will simply activate that lane ignoring the other lanes at that moment, for a limited time span; so that the specified emergency vehicle can get time to pass. The ultrasonic sensor will be put to rest while this lane will be active.
- After that the iterations will start from where it left just before the sound came.
- To achieve the specificity of noisy lane, we have used lock concept. According to lock concept, noisy lane will acquire lock when sound occurs, finish its iterations and release the lock to take over for normal iterations.
- There is one additional interesting concept of switch, where pressing it will send mail to relevant authority immediately referencing the situation.

4.1 Flow Chart

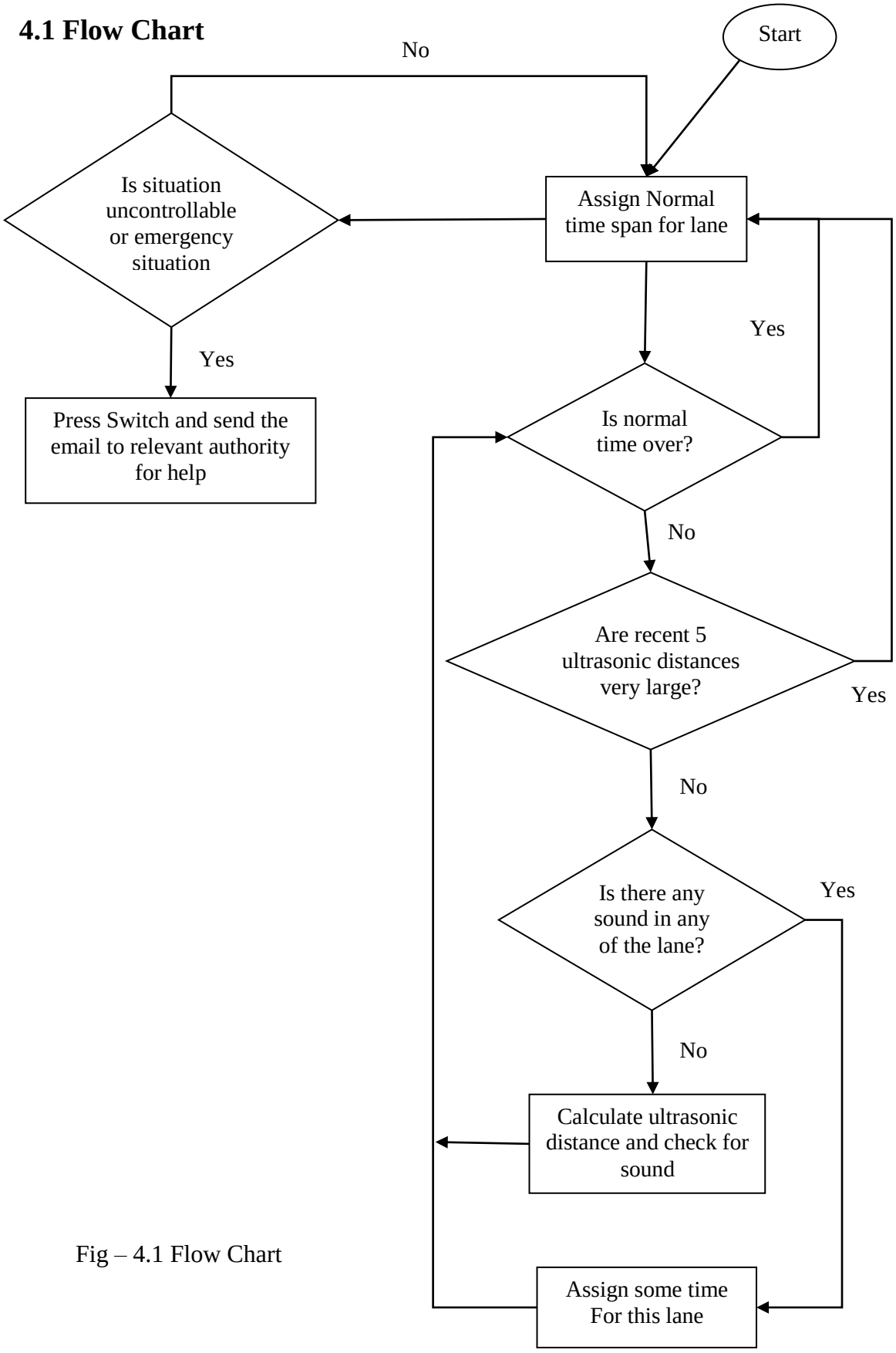
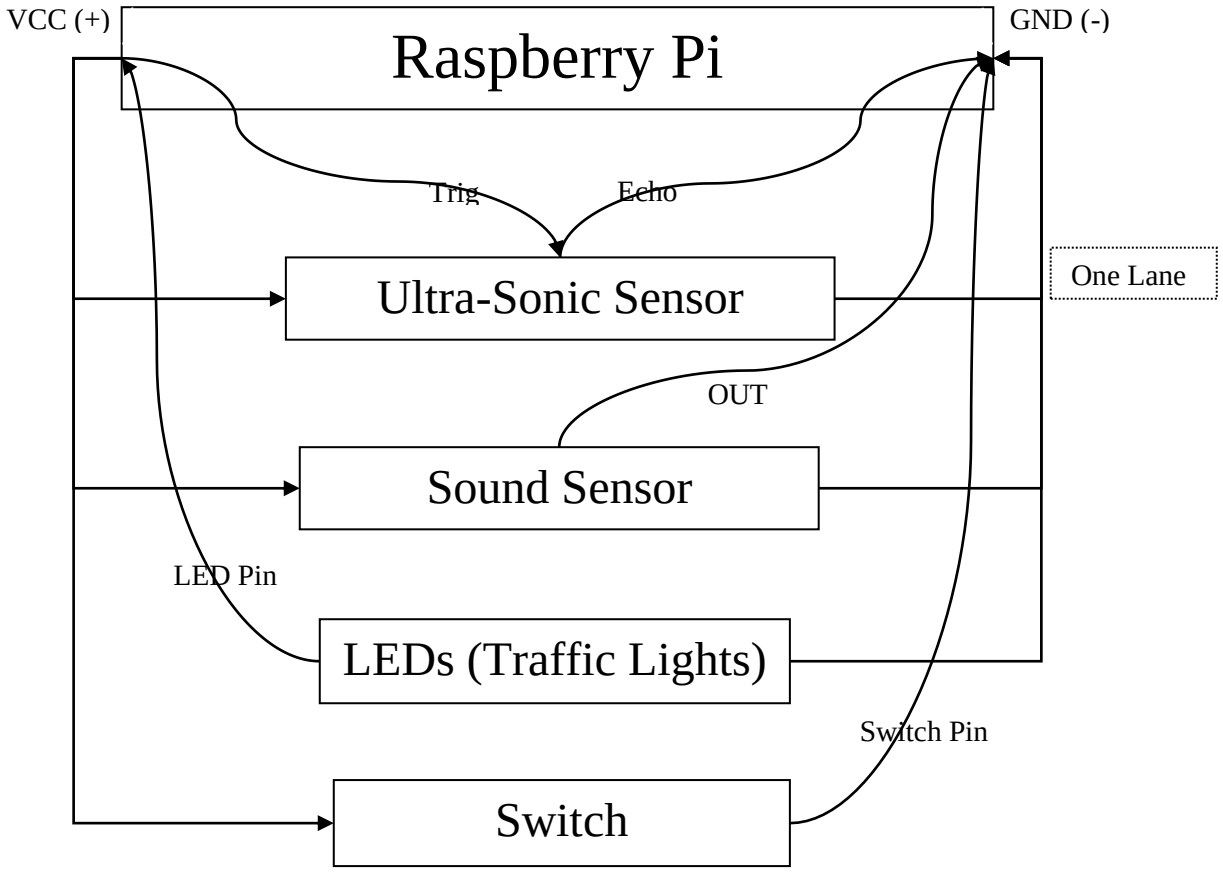


Fig – 4.1 Flow Chart

4.2 Circuit Diagram



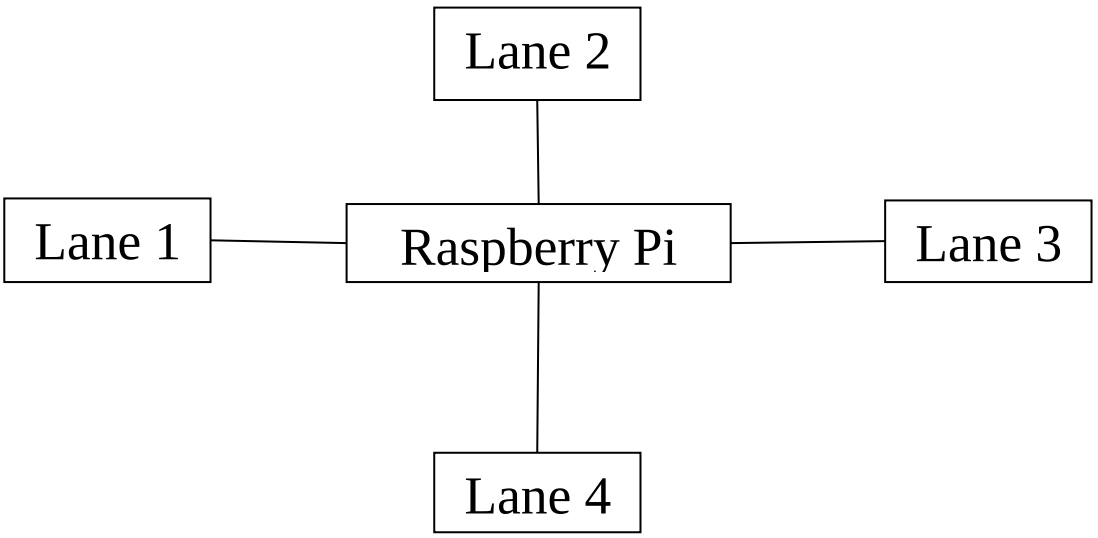


Fig – 4.2 Circuit Diagram

4.3 Circuit Implementation

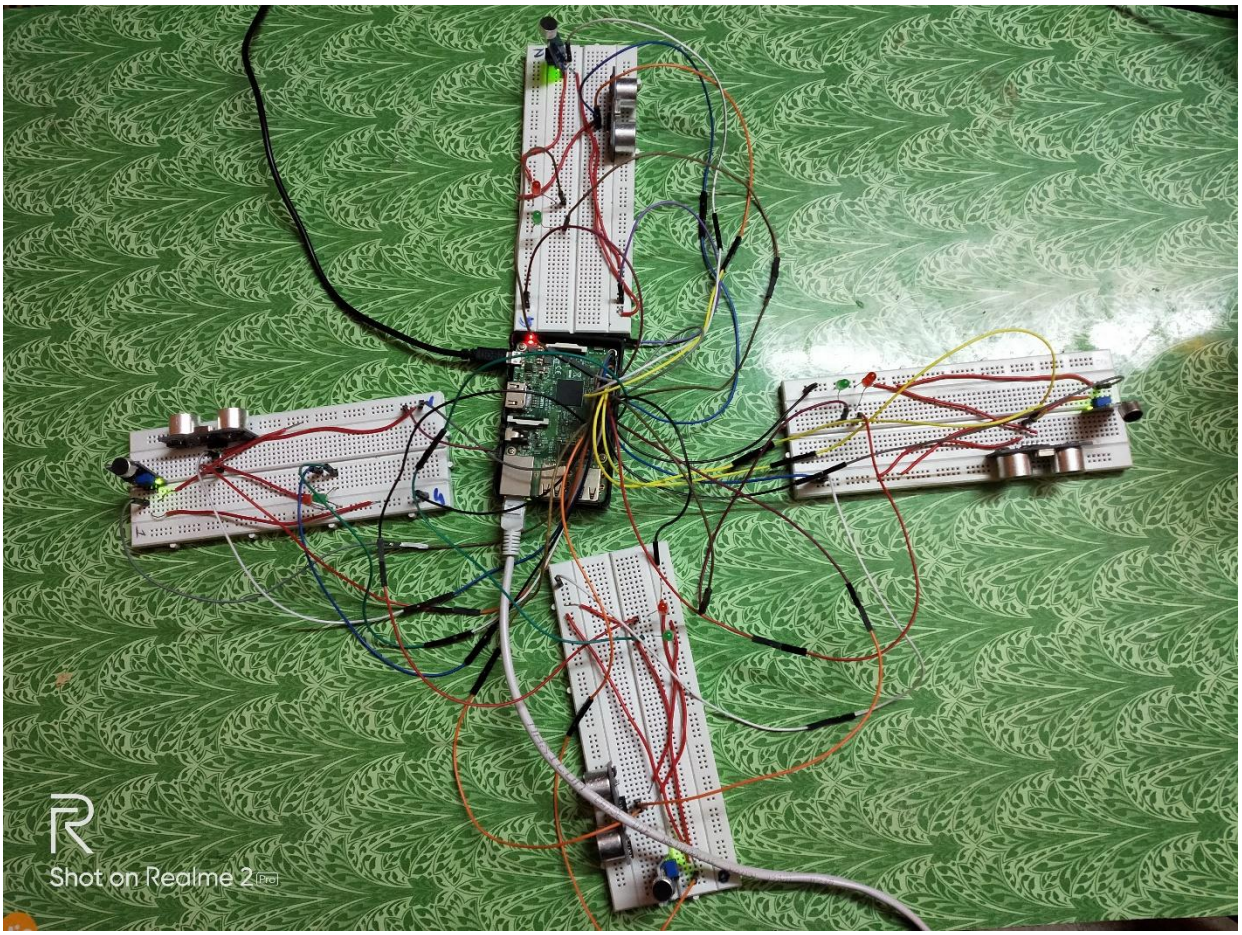


Fig – 4.3 Circuit Implementation

5. Equipment Used

5.1 Raspberry Pi

It is credit card sized computer mainly running on Linux like is such as Raspbian. It is not that much powerful. It has 1 GB of RAM, Wi-Fi, Bluetooth, 4 USB ports, 1 Ethernet port, HDMI, Camera port and 40 GPIO pins for external sensor or any electronics connection. Just add a keyboard, mouse, display, power supply, micro SD card with installed Linux Distribution and you'll have a fully-fledged computer that can run applications from word processors and spreadsheets to games.

Now it is mainly used in robotics, embedded systems and IoT.

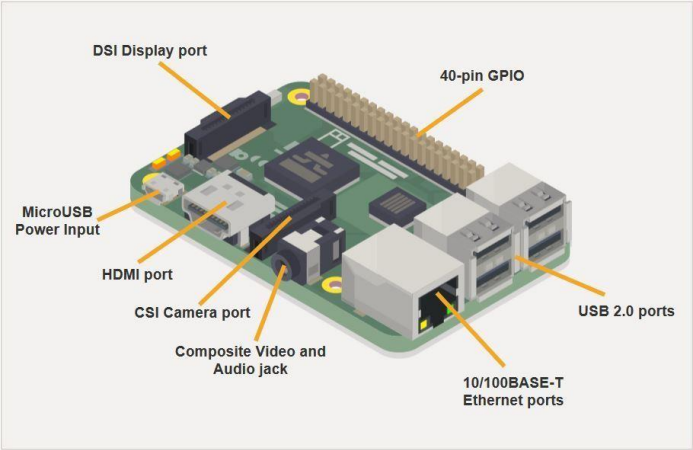


Fig – 5.1 Raspberry pi [9]

5.2 Ultrasonic Sensor

The HC-SR04 is an inexpensive ultrasonic distance sensor that works out of the box with an Arduino. Specifications: Power Supply: 5V DC quiescent current: <2mA effectual angle: <15° ranging distance: 2cm – 500 cm resolution: 0.3 cm Works with Arduino
It basically has four pins -

- VCC
- Echo
- Trig
- Ground

Each has their respective functionalities.

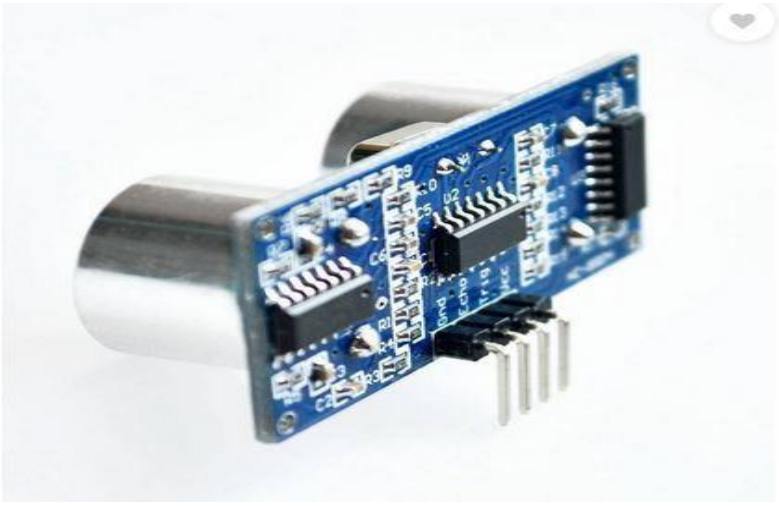


Fig – 5.2 Ultrasonic Sensors [10]

5.3 Sound Sensor

It has three pins

- VCC
- Ground
- Output

The range of sound can be modified manually and not digitally

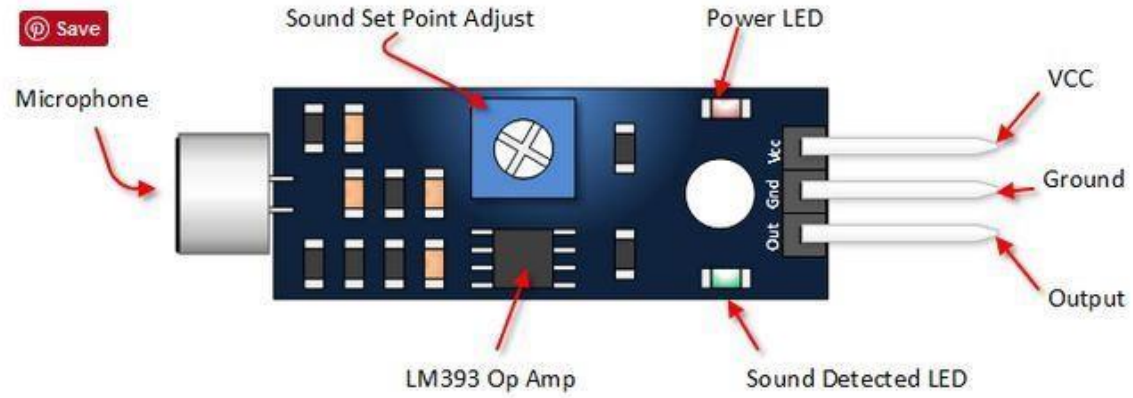


Fig – 5.3 Sound Sensor [11]

Other Equipments used are LEDs, Bread Boards, and connecting wires.

6. Software Used

We have worked on raspberry pi with Raspbian which is Linux based Operating System.

6.1 Raspbian

Raspbian is a free operating system based on Debian optimized for the Raspberry Pi hardware. An operating system is the set of basic programs and utilities that make your Raspberry Pi run. However, Raspbian provides more than a pure OS: it comes with over 35,000 packages; pre-compiled software bundled in a nice format for easy installation on your Raspberry Pi.

6.2 Python

The programming language used to code the above shown algorithm is Python which is very popular now days and provides tremendous support of the inbuilt libraries and packages present freely as open source.

- Interactive
- Interpreted
- Modular
- Dynamic
- Object-oriented
- Portable
- High level
- Extensible in C++ & C

6.3 Python Packages Used

- RPi.GPIO – to use the pins of the raspberry pi
- smtplib – for implementing SMTP protocol
- email – for configuring E-Mail
- getpass
- time

7. Conclusion and Future Works

Our model will bring a change to traffic monitoring system. It is a fully working model with proper handling of congestion.

7.1 Results/Highlights of our Model

- Automatic switching of lane in case of no traffic
- Automatic detecting emergency vehicles and opening the lane for them.
- Proper traffic light configuration.
- Cheap in cost
- Portable
- If sensor is damaged, then we only need to replace the sensor and not the whole system.
- Email Automation for emergency/accidents.

7.2 Future Works

- Connecting the system to cloud for better monitoring
- Even though the button is pressed, any confirmation is not informed to the traffic police. This can be improved using a display screen.
- Camera sensors can be used to capture the photos of the person or vehicle who breaks the traffic rules. Depending on the situation the vehicle number or the person can be charged with fines according to traffic rules.
- The use of IoT can be very useful and this could be helpful in rural areas or emergency situations. The use of IoT can further be extended to smart ambulance which contains the basic health sensors. Such sensors can be Body temperature sensor, Pulse and oxygen in blood sensor, Patient position sensor, Airflow sensor, Electrocardiogram (ECG), Galvanic skin response sensor, etc. The sensors then can be connected to the patient body in the ambulance and thus the body health parameter can be sent to the hospital and depending on the sensor's result the hospital can be ready with the procedures.
- Speed measuring sensor to capture the speed of the vehicle and if it exceeds the speed limit then some security action can be taken.
- If a junction detects an emergency vehicle then the next junction can be aware that the emergency vehicle is coming in the direction of its travel.

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