INTELLIGENT TRAFFIC SIGNAL
CONTROL SYSTEM FOR EMERGENCY VEHICLES

A MINI PROJECT REPORT

Submitted by

A. ABHISHEK SHIVRAM	**(1803002)**
I. N. LALETH	**(1803031)**
SHAIK AZAMATHULLA	**(1803055)**
S. R. SIVNANDHINI	**(1803056)**

in partial fulfillment for the award of the degree

of

BACHELOR OF ENGINEERING

in

ELECTRICAL AND ELECTRONICS ENGINEERING

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution)

COIMBATORE – 641 014

ANNA UNIVERSITY: CHENNAI 600 025

MAY 2021

INTELLIGENT TRAFFIC SIGNAL CONTROL SYSTEM FOR EMERGENCY VEHICLES

A MINI PROJECT REPORT

Submitted by

A. ABHISHEK SHIVRAM	**(1803002)**
I. N. LALETH	**(1803031)**
SHAIK AZAMATHULLA	**(1803055)**
S. R. SIVNANDHINI	**(1803056)**

Under the guidance of

Dr S VASANTHARATHNA, M.E., Ph.D.

Professor & Head

Department of Electrical and Electronics Engineering

in partial fulfillment for the award of the degree

of

BACHELOR OF ENGINEERING

in

ELECTRICAL AND ELECTRONICS ENGINEERING

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution)

COIMBATORE – 641 014

ANNA UNIVERSITY: CHENNAI 600 025

MAY 2021

COIMBATORE INSTITUTE OF TECHNOLOGY

(Government Aided Autonomous Institution)

COIMBATORE – 641 014

ANNA UNIVERSITY: CHENNAI 600 025

BONAFIDE CERTIFICATE

Certified that this project report "**INTELLIGENT TRAFFIC SIGNAL CONTROL SYSTEM FOR EMERGENCY VEHICLES"** is the bonafide work of "**ABHISHEK SHIVRAM A (1803002), LALETH I N (1803031), SHAIK AZAMATHULLA (1803055), SIVNANDHINI S R (1803056)"** who carried out the project work under my supervision.

SIGNATURE	SIGNATURE
Dr. S. VASANTHARATHNA, M.E., Ph.D.	**Dr. S. VASANTHARATHNA, M.E., Ph.D.**
PROJECT GUIDE	**PROFESSOR & HEAD**
PROFESSOR & HEAD	

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COIMBATORE INSTITUTE OF TECHNOLOGY

COIMBATORE – 641 014

Place:

Date:

CERTIFICATE OF EVALUATION

College Name : Coimbatore Institute of Technology

Branch : Electrical and Electronics Engineering

Semester : VI Semester

Name of the Student who has done this project	Title of the Project	Name of the Supervisor with designation
ABHISHEK SHIVRAM A LALETH I N SHAIK AZAMATHULLA SIVNANDHINI S R	**INTELLIGENT TRAFFIC SIGNAL CONTROL SYSTEM FOR EMERGENCY VEHICLES**	**Dr. S. VASANTHARATHNA, M.E., Ph.D.** PROFESSOR & HEAD **Department of Electrical and Electronics Engineering**

The report of the project work submitted by the above students in partial fulfillment for the award of **Bachelor of Engineering** degree in **Electrical and Electronics Engineering** of Anna University, Chennai is evaluated and conformed to be report of the work done by the above students.

Certified that the candidates have been examined in the project work viva-voce examination held on ____________

EXAMINER I **EXAMINER II**

ANNA UNIVERSITY

CHENNAI-600 025

CERTIFICATE

The mini project entitled "**INTELLIGENT TRAFFIC SIGNAL CONTROL SYSTEM FOR EMERGENCY VEHICLES**" has been carried out in the **ELECTRICAL AND ELECTRONICS ENGINEERING, COIMBATORE INSTITUTE OF TECHNOLOGY, COIMBATORE.** The work reported herein is original and does not form part of any other work.

I understand the University's policy on plagiarism and declare that the mini project is my own work, except where specifically acknowledged and has not been copied from other sources.

A. ABHISHEK SHIVRAM | I. N. LALETH

SHAIK AZAMATHULLA | S. R. SIVNANDHINI

Dr S VASANTHARATHNA, M.E., Ph.D.
PROFESSOR & HEAD

ACKNOWLEDGEMENT

I wholeheartedly thank and express my heartiest gratitude to our project guide, **Dr.S.Vasantharathna M.E., Ph.D.** for encouraging us throughout the year. Her constructive and encouraging comments and suggestions proved to be indispensable for this project.

I express our gratefulness to the Professor and Head of the Department, **Dr.S.Vasantharathna M.E., Ph.D.,** for her inspiring motivation and encouragement, without which this project could not have been completed.

I thank the members of the Project Evaluation Committee **Dr.V.Manikandan M.E., Ph.D., Ms.D.Prema M.E., Ms.S.Rathnapriya M.E.,** who reviewed our project and guided us in a successful way.

I thank the members of the Project Steering Committee **Ms.S.Rathnapriya M.E., Dr.K.Suresh M.E., Ph.D. Ms.E.Suganya M.E.,** who reviewed the weekly progress of this project.

I would like to thank the Principal **Dr.V.Selladurai M.E., Ph.D.** for his support and for providing us with lot of facilities to do this project**.**

I would like to express my gratitude to the Secretary **Dr.R.Prabhakar B.Tech (IITM), M.S.(OSU,USA), Ph.D.,(Purdue,USA)** for his continued support in providing the infrastructure for doing this project.

I express our gratefulness to Director **Mr.Rajiv S Rangasami** for his continued support in providing the infrastructure for doing this project.

I thank our correspondent **Dr.S.R.K.PrasadD.Sc,** for his support in providing infrastructure to successfully complete the project.

CONTENTS

CHAPTER	TITLE	PAGE No.
	ABSTRACT	**I**
	LIST OF ABBREVIATIONS	**II**
	LIST OF TABLES	**III**
	LIST OF FIGURES	**IV**
1	**INTRODUCTION**	
	1.1 Introduction	**1**
	1.2 Need for traffic control system	**1**
	1.3 Objectives	**2**
2	**LITERATURE REVIEW**	
	2.1 Introduction	**3**
	2.2 Literature Review	**3**
	2.3 Conclusion	**5**
3	**BLOCK DIAGRAM AND DESCRIPTION**	
	3.1 Introduction	**6**
	3.2 Block Diagram	**6**
	3.3 Flow Chart	**7**
	3.4 Hardware Description	**8**
	3.5 Software Description	**13**

	3.6 Mathematical Calculation	**19**
	3.7 Conclusion	**20**
4	**PROGRAMMING AND RESULTS**	
	4.1 Introduction	**21**
	4.2 Algorithm	**22**
	4.3 User Interface	**25**
	4.4 Conclusion	**27**
5	**HARDWARE SOLUTION**	
	5.1 Introduction	**28**
	5.2 Hardware Solution	**28**
	5.3 Conclusion	**28**
6	**CONCLUSION**	**29**
	6.1 Future scope	**29**
	6.2 Socio-Economic Impact	**29**
	6.3 Project Conclusion	**29**

ABSTRACT

India is the second most populated country in the world and is one of the fastest growing economies and has the second largest road network. Over the years, traffic congestion is posing a significantly huge number. According to **TIMES OF INDIA** about 30 percent of deaths are caused due to delayed ambulance and many loses happens due to late arrival of other emergency vehicles such as fire trucks. To clear the pathway and provide a green corridor for the vehicle to reach the destination without any delay we have come up with an **Intelligent Traffic Signal Control System for Emergency Vehicles.** The proposed system uses radio communication to create a network between vehicle and the traffic signals. The idea behind the system is that, a path is planned for the vehicle to reach the destination and when the vehicle is at a certain range from the signal the traffic signal is made green to clear any traffic congestion. After the vehicle passes, the traffic signal regains its original flow. If the system is fully automated, the system identifies the vehicle position, controls the signal without affecting the normal traffic so much. Since this system does not depend internet or sensors, there will be no interruption in the flow of the system making it fool proof. This system controls the traffic lights and save the time in emergency periods. Hence it acts as a life saver project.

LIST OF ABBREVIATIONS

CAG	Comptroller Auditor General
GoMP	Government of Madhya Pradesh
GPS	Global Positioning System
IEEE	Institute of Electrical and Electronics Engineers
EVP-STC	Emergency Vehicle Priority and Self-organised Traffic Control
AARS	Automatic Ambulance Rescue System
RFID	Radio-Frequency Identification
MAC	Media Access Control
P - MAC	Parallelizable Media Access Control
TMC	Traffic Message Channel
VANET	Vehicular Ad hoc Network
UTMS	Urban Transportation Modeling System
NS	Network Simulator
EPR	Emergency Periodic Request
SPI	Serial Peripheral Interface
RF	Radio Frequency
PRX	Primary Transmitter
PTX	Primary Receiver
hav	Haversine
UI	User Interface

LIST OF TABLES

TABLE No	TABLE NAME	PAGE No
3.1	nRF24L01 Specifications	9
3.2	nRF24L01 Pin Configuration	10
3.3	GPS Module Specifications	12
3.4	Arduino Specification	14
3.5	Arduino Pin Description	16
3.6	Raspberry Pi Specificatons	18

LIST OF FIGURES

FIGURE No	FIGURE NAME	PAGE No
3.1 (a)	Block Diagram	6
3.1 (b)	Flow Chart	7
3.2	nRF24L01	8
3.3	nRF24L01 Pin Diagram	10
3.4	Multiceiver	11
3.5 (a)	NEO 6m	11
3.5 (b)	Antenna	11
3.6	Arduino UNO	13
3.7	Pin diagram of Arduino UNO	15
3.8	Raspverry Pi Model B+	17
3.9(a)	Spherical Coordinates	19
3.9(b)	Arc length	20
4.1	Distance and Time	24

4.2 (a)	User Interface	25
4.2 (b)	Adding Junctions	25
4.2 (c)	View Junctions	26
4.2 (d)	Details of Traffic Signal	26
4.3 (a)	Junction OFF in UI	27
4.3(b)	Junction ON in UI	27
5.1 (a)	Normal Traffic Signal Sequence	28
5.1 (b)	Traffic Signal Sequence Intruppted	29

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

It is well known that easy and timely availability of ambulances and other emergency vehicles can save lots of lives, especially in case of emergencies. The state of emergency vehicle transport is a vast issue. Delayed services may also result in loss of service for others. The 108-ambulance service has been regarded as a successful public private partnership project for handling medical emergencies. However, the service is marred with irregularities and frequent disruptions. The standard norm for reaching every urban call is within 20 minutes, every rural call within 40 minutes, and to shift the patient to the nearest hospital within 20 minutes after reaching the patient. However, non-adherence to stipulated response time in delivery of the emergency service has been observed across several states. The mean time was between 41 to 47 minutes, as per the Comptroller Auditor General (CAG) report from Madhya Pradesh (GoMP 2017). To overcome this our team has made a traffic control system in which the path is planned for the emergency vehicle to reach the destination ensuring that they reach in time the destination.

1.2 NEED FOR TRAFFIC CONTROL SYSTEM

Every year, around 33% road accidents and 99% of cardiac arrests victims do not survive in India. One of the main reasons for this disruption is traffic congestion. India's road network (including national highway) has grown by just about a third in the last decade whereas vehicle registrations have increased by almost three times. Thus, vehicle density is increasing at a much faster pace than road length - obviously, congestion will be higher. The objective of this project is to provide a green corridor for the emergency vehicles ensuring that they reach in time at the destination and will also reduce the fuel consumption. The green corridor will help to reduce the response time and priorities the emergency vehicles. The traffic signal will be operated through radio communication to the upcoming signal with the help of GPS (**Global Positioning System**) and it will turn green if it is red. The suggested system will uniquely identify the vehicle, track its real time position and provides way for the vehicle before it reaches the signal. The existing and propped systems for intelligent traffic control systems include the need of internet, cloud computation, camera or other sensors. These systems require monitoring the condition of sensor and adds complexity to the system. And these systems may fail if one component like internet or the sensor fails. Since emergency vehicles are fully utilized in disaster periods these systems may not work. The proposed system has its own network communication via radio signals and the system does not depend on internet or sensors. Hence it has less chance of failing and does not require large maintenance.

1.3 OBJECTIVE

- The main objective is to provide a 'green corridor' for emergency vehicle.
- To make sure that emergency vehicles reach the destination in time.
- To reduce response time and fuel consumption.
- To reduce the lives and property losses.
- To provide a route for emergency vehicles without affecting the normal traffic flow.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter discusses the various literature and IEEE papers referred to provide path for the emergency vehicles without affecting the normal traffic ensuring that they reach in time at the destination.

.

2.2 LITERATURE REVIEW

2.2.1 EVP-STC: Emergency Vehicle Priority and Self-Organizing Traffic Control at Intersections Using Internet-of-Things Platform

- By Ajmal Khan1, Farman Ullah1, Zeeshan Kaleem 2, Shams Ur Rahman3,
Hafeez Anwar1, And You-Ze Cho. Year of Publication Nov 5 2018

This paper presents an Internet-of-Things-based platform for emergency vehicle priority and self-organised traffic control (EVP-STC) management at intersections. EVP-STC contains three main systems. The first system, called the intersection controller, is installed at traffic lights and collects emergency vehicle position information and vehicle density data at each road segment approaching an intersection. The intersection controller then adjusts the timings of traffic lights based on detected real-time traffic. The second system is installed at each road segment and contains force resistive sensors to detect vehicles. It transmits the detected information to the intersection controller via ZigBee. The third system is installed in emergency vehicles and provides GPS coordinates to the intersection controller to avoid any waiting time for emergency vehicles at intersections.

2.2.2 An A Rescue System of an Advanced Ambulance Using Prioritized Traffic Switching.

- By Tandrima Chowdhury, Smriti Singh, Dr.S.Maflin Shaby, Year Of Publication:- 2016

Automatic Ambulance Rescue System (AARS), the main idea behind this scheme is ambulance can reach smoothly to hospital in time, by mechanically controlling traffic lights in path. The ambulance is controlled by control unit which gives the shortest path for reaching hospital and controls traffic lights. The sensor senses the spot and the nearest ambulance reaches the accident spot. The traffic lights in the path of the ambulance are controlled. The ambulance is guided to hospital by server through shortest route.

2.2.3 Advanced Automation Control in an Ambulance under Emergency Condition

-By Lella Sai Krishna, Samineni Vijay Chowdary, M.Pushpavalli, P.Sivagam, , **Year Of Publication:-** 2017

In this paper, they proposed - India is facing huge traffic congestion and the traffic disturbance in many major cities around is very severe. Mainly in urban areas, most of the people are using cars as transport when they go out. Due to this traffic blockage, there is a rise in road accidents which direction to a ruin of individual human lives. To avoid this we have implemented a scheme which can control the traffic signals automatically in its path way and reduce the amount of traffic congestion at the signal. The ambulance is implemented with embedded system units, which finds the accident spot and delivers the spot to the close by ambulance through GPS. The ambulance guides the traffic lights in the roadway to the hospital and it also checks the next consecutive signal to shorten the time loss. The vehicle unit is equipped with vibration sensor to determine the vibration if it exceeds the level. The embedded unit sense the accident happens and its sends the neighbourhood ambulance unit through wireless transmission. RFID reader is needed to extricate the ambulance from other vehicles.

2.2.4 Traffic Management for Emergency Vehicle Priority Based on Visual Sensing

-By K. Nellore and G. Hancke, Sensors, vol. 16, no. 11, p. 1892, Oct. 2016

They present a new approach to calculate the distance between the emergency vehicle and intersection using a real-time video feed from the cameras at intersections. An intelligent algorithm to shorten the travel time by scheduling both the green light sequence and green light duration based on the measured distance is also presented. A MAC (Media Access Control) protocol named PE-MAC is also proposed to deliver the emergency vehicle information to the TMC with less delay. A VANET (Vehicular Ad hoc Network) model for the UTMS is developed, the NS is configured according to the proposed protocol and simulated in NS-2(The Network Simulator).

2.3 CONCLUSION

In this chapter, papers surveyed for formulating the ideas of the project are explained and the details of the literature are discussed**.**

CHAPTER 3

BLOCK DIAGRAM AND DESCRIPTION

3.1 INTRODUCTION

This chapter deals with the block diagram and a brief description about the components and the mathematical derivations used in the project.

3.2 BLOCK DIAGRAM

The block diagram of the project is shown in figure 3.1.

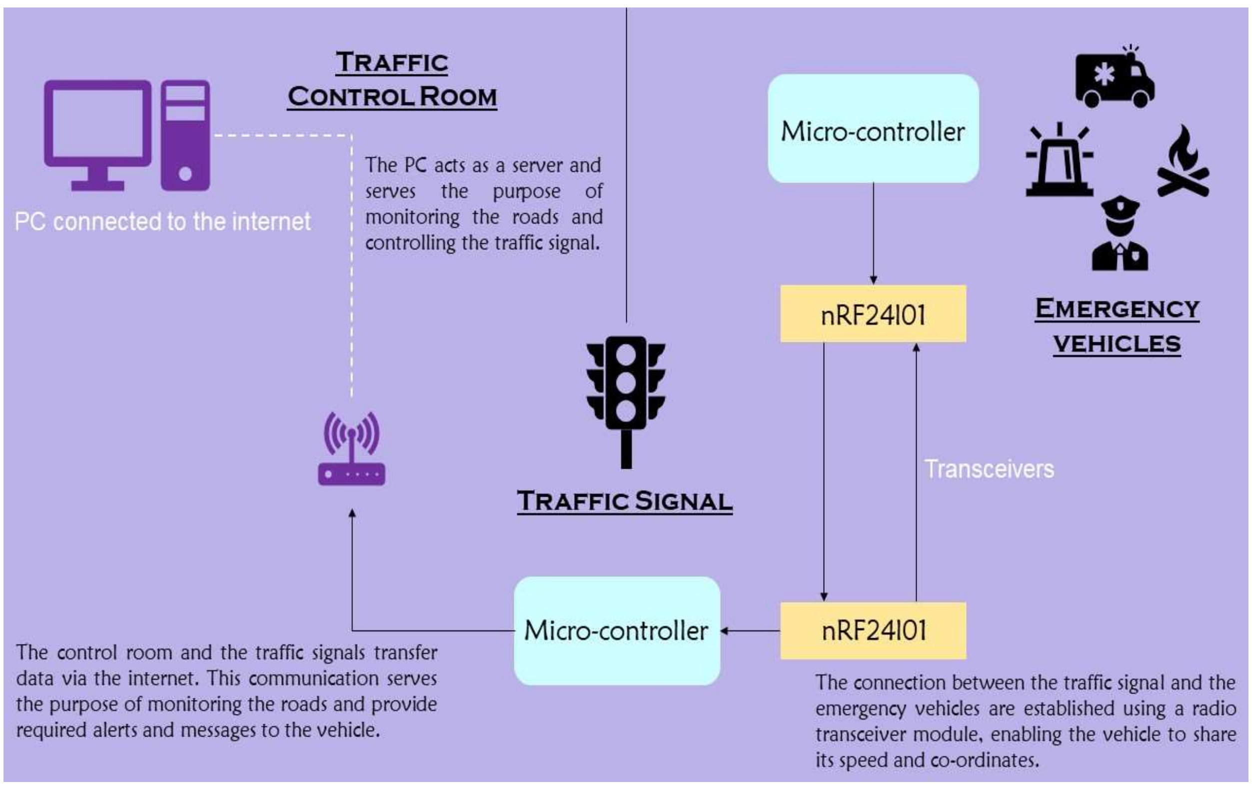

Fig.3.1(a) Block diagram

This block diagram describes the working of the system. Every junction has a microcontroller equipped with a radio transceiver. Emergency vehicles are equipped with another set of Arduino and transceiver. The vehicle will share its coordinates with the junction using the transceiver. In the junction using the coordinates provided, the signal will determine the distance of the vehicle from the signal and calculate the time needed for the vehicle to cross the signal. For the time calculated, the signal will turn green. Once the vehicle crosses the junction normal operation of the signal is re-established. The road conditions can be monitored in the control room. If any disturbances occur in a route the control room can update the conditions. The updates are shared via the internet to junction using the wifi module. In that case, if a vehicle approaches, the junction will alert the vehicle the condition of the road.

3.3 FLOW CHART

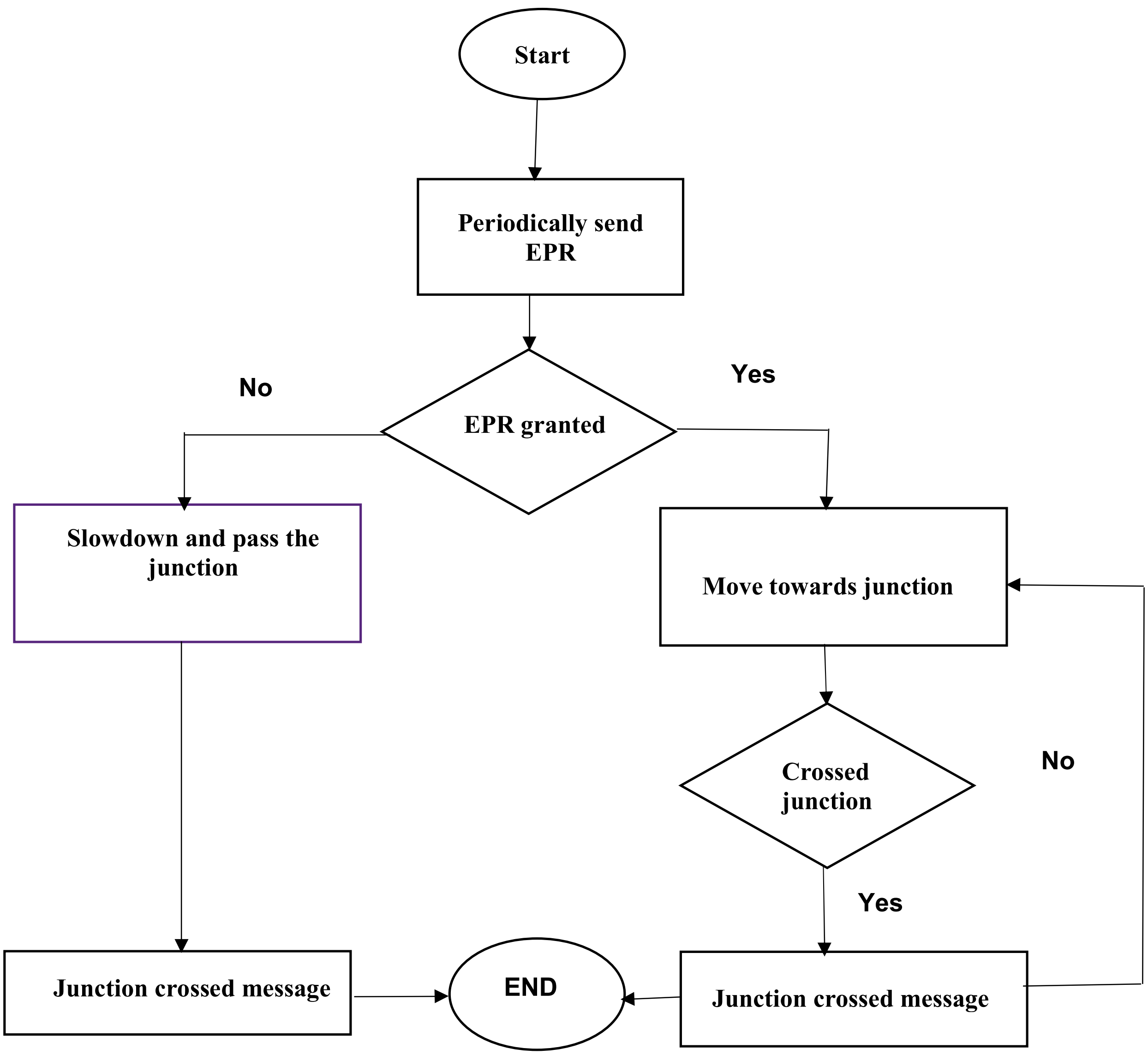

Fig.3.1(b) flow chart

An emergency vehicle announces its presence by periodically sending emergency priority request (EPR) messages (containing location coordinates and velocity information) to the intersection controller. When an EPR message is received by the intersection controller, it sends an 'EPR granted' message to the emergency vehicle. If an emergency vehicle receives this message, then it continues to move towards the intersection at constant speed. To calculate the time an emergency vehicle requires to reach the intersection, the microcontroller in the intersection controller utilises the Haversine formula. The microcontroller controls the operation of all traffic lights based on the received information. If a message is received from an emergency vehicle, the normal operation of the traffic lights is interrupted and priority is granted to the approach from which the arrival of emergency the vehicle is expected. Once the vehicle crosses the junction it sends clear message to the controller, then he normal operation of traffic light is regained. In case, if the permission is not granted, the vehicle will slow down and cross the junction and sends clear message to the controller.

3.4 HARDWARE DESCRIPTION

3.4.1 nRF24L01

The nRF24L01 is a wireless transceiver module, meaning each module can both send as well as receive data. It uses the 2.4 GHz band and it can operate with baud rates from 250 kbps up to 2 Mbps. If used in open space and with lower baud rate its range can reach up to 100 meters. The transceiver consists of a fully integrated frequency synthesizer, a power amplifier, a crystal oscillator, a demodulator, modulator and Enhanced Shock Burst™ protocol engine. Output power, frequency channels, and protocol setup are easily programmable through a SPI interface. The power consumption of this module is just around 12mA during transmission, which is even lower than a single LED. The operating voltage of the module is from 1.9 to 3.6V, but the good thing is that the other pins tolerate 5V logic, so we can easily connect it to an Arduino without using any logic level converters.

Fig.3.2 nRF24L01

Table 3.1 nRF24L01 Specifications

PARAMETER	RANGE
Frequency Range	2.4 GHz ISM Band
Maximum Air Data Rate	2 Mb/s
Modulation Format	GFSK
Max. Output Power	0 dBm
Operating Supply Voltage	1.9 V to 3.6 V
Max. Operating Current	13.5mA
Min. Current (Standby Mode)	26μA
Logic Inputs	5V Tolerant
Communication Range	800+ m (line of sight)

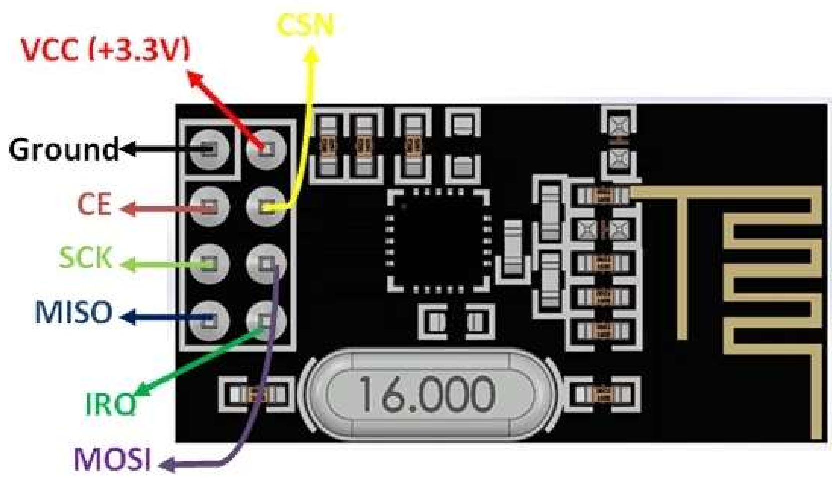

Fig.3.3 nRF24L01 pin diagram

Table.3.2 nRF24L01 Pin Configuration

Pin name	Abbreviation	Function
Ground	Ground	Connected to the Ground of the system
Vcc	Power	Powers the module using 3.3V
CE	Chip Enable	Used to enable SPI communication
CSN	Ship Select Not	This pin has to be kept high always; else it will disable the SPI
SCK	Serial Clock	Provides the clock pulse using which the SPI communication works
MOSI	Master Out Slave In	Connected to MOSI pin of MCU, for the module to receive data from the MCU
MISO	Master In Slave Out	Connected to MISO pin of MCU, for the module to send data from the MCU
IRQ	Interrupt	It is an active low pin and is used only if interrupt is required

The nRF24L01 provides a feature called Multiceiver. It's an abbreviation for Multiple Transmitters Single Receiver. In which each RF channel is logically divided into 6 parallel data channels (as shown in figure called Data Pipes. In other words, a data pipe is a logical channel in the physical RF Channel. Each data pipe has its own physical address (Data Pipe Address) and can be configured. PRX (primary receiver) can receive data addressed to six different data pipes in one frequency channel. Up to six nRF24L01s configured as PTX can communicate with one nRF24L01 configured as PRX. All data pipe addresses are searched for simultaneously. Only one data pipe can receive a packet at a time.

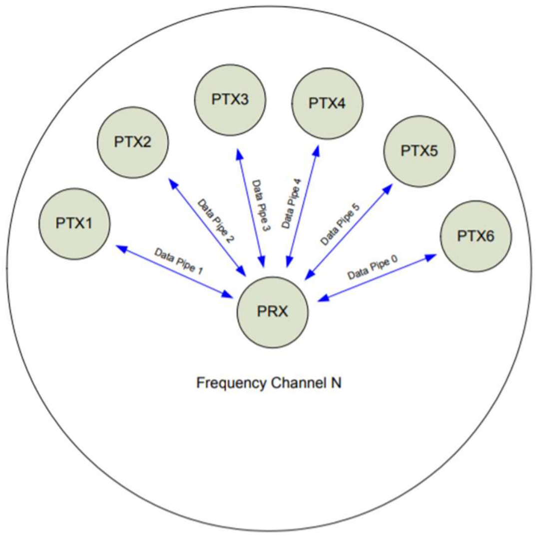

Fig.3.4 Multiceiver

3.4.2 NEO-6M GPS Module

The NEO-6M GPS module is a well-performing complete GPS receiver with a built-in 25 x 25 x 4mm ceramic antenna, which provides a strong satellite search capability. With the power and signal indicators, you can monitor the status of the module

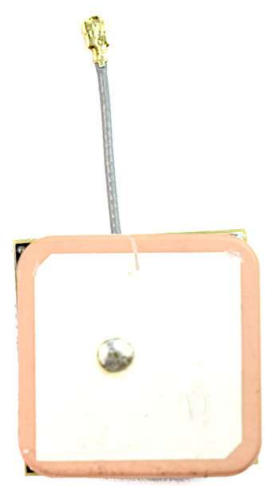

Fig.3.5(a) NEO 6M Fig.3.5(b) Antenna

TABLE.3.3 GPS MODULE SPECIFICTIONS:

PARAMETER	RANGE
Receiver Type	50 channels, GPSL1(1575.42Mhz)
Horizontal Position Accuracy	2.5m
Navigation Update Rate	1HZ (5Hz maximum)
Capture Time	Cool start: 27sHot start: 1s
Navigation Sensitivity	-161dBm
Communication Protocol	NMEA, UBX Binary, RTCM
Serial Baud Rate	4800-230400 (default 9600)
Operating Temperature	-40°C ~ 85°C
Operating Voltage	2.7V ~ 3.6V
Operating Current	45mA
TXD/RXD Impedance	510Ω

The operating voltage of the NEO-6M chip is from 2.7 to 3.6V. The module comes with MIC5205 ultra-low dropout 3V3 regulator from MICREL. The logic pins are also 5-volt tolerant, so we can easily connect it to an Arduino or any 5V logic microcontroller without using any logic level converter. It can track up to 22 satellites on 50 channels. It can provide up to two meters accuracy, with tracking receive strengths as low as -161 dBm, and update rates as high at 5 per second (5Hz). The u-blox 6 positioning engine also boasts a Time-To-First-Fix (TTFF) of under 1 second. An antenna (fig.3.4(b)) is required to use the module for any kind of communication. So, the module comes with a patch antenna having -161 dBm sensitivity.

3.5 SOFTWARE DESCRIPTION

3.5.1 ARDUINO UNO R3:

The Arduino Uno is a microcontroller board based on the ATmega328,an 8-bit microcontroller with 32KB of Flash memory and 2KB of RAM It has 20 digital input/output pins (of which 6 can be used as PWM outputs and 6 can be used as analog inputs), a 16 MHz resonator, a USB connection, a power jack, an in-circuit system programming (ICSP) header, and a reset button.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to serial driver chip. Instead, it features an ATmega16U2 programmed as a USB-to-serial converter.

Fig.3.6 Arduino UNO

This is the 3rd revision of the Uno (R3), which has several changes:

- The USB controller chip changed from ATmega8U2 (8K flash) to ATmega16U2 (16K flash). This does not increase the flash or RAM available to sketches.
- Three new pins were added, all of which are duplicates of previous pins. The I2C pins (A4, A5) have been also been brought out on the side of the board near AREF.
- The reset button is now next to the USB connector, making it more accessible when a shield is used.

Table.3.4 Arduino Specification

PARAMETER	RANGE
Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB of which 0.5 KB used by bootloader
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz

The below diagram shows the pin configuration:

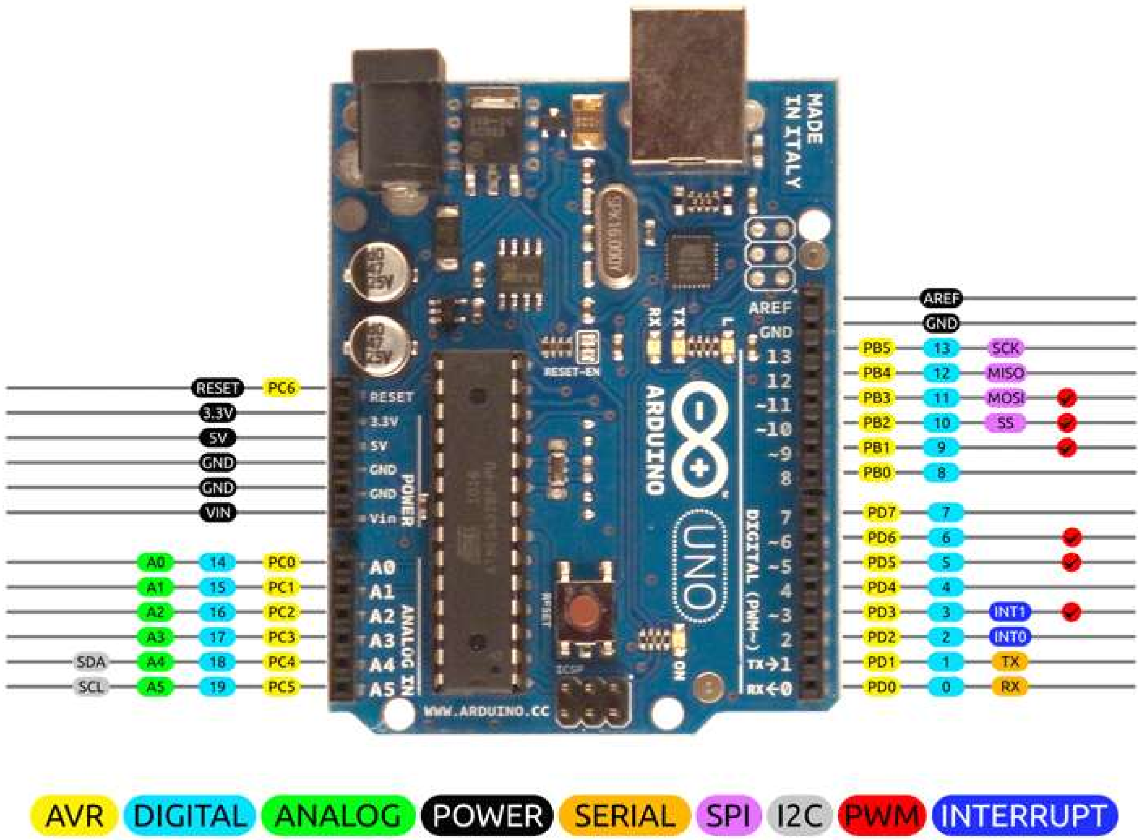

Fig.3.7 pin diagram of Arduino UNO R3

Table 3.5 Arduino Pin Description

Pin Category	Pin Name	Details
Power	Vin, 3.3V, 5V, GND	Vin: Input voltage to Arduino when using an external power source. 5V: Regulated power supply used to power microcontroller and other components on the board. 3.3V: 3.3V supply generated by on-board voltage regulator. Maximum current draw is 50mA. GND: ground pins.
Reset	Reset	Resets the microcontroller.
Analog Pins	A0 – A5	Used to provide analog input in the range of 0-5V
Input/Output Pins	Digital Pins 0 - 13	Can be used as input or output pins.
Serial	0(Rx), 1(Tx)	Used to receive and transmit TTL serial data.
External Interrupts	2, 3	To trigger an interrupt.
PWM	3, 5, 6, 9, 11	Provides 8-bit PWM output.
SPI	10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK)	Used for SPI communication.
Inbuilt LED	13	To turn on the inbuilt LED.
TWI	A4 (SDA), A5 (SCA)	Used for TWI communication.
AREF	AREF	To provide reference voltage for input voltage.

3.5.2 RASPBERRY PI 3

The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. The Raspberry Pi 3 Model B+ is the latest product in the Raspberry Pi 3 range, boasting a 64-bit quad core processor running at 1.4GHz, dual-band 2.4GHz and 5GHz wireless LAN, Bluetooth 4.2/BLE, faster Ethernet, and PoE capability via a separate PoE HAT.

With its 0.1″-spaced GPIO header and small size, the Raspberry Pi also works as a programmable controller in a wide variety of robotics and electronics applications.

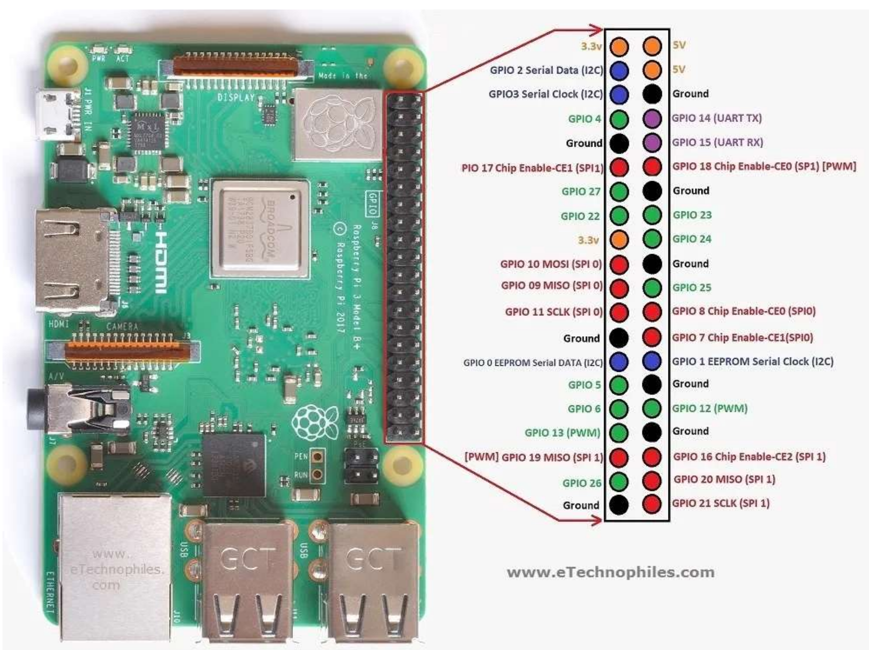

Fig.3.8 Raspberry Pi 3 model B+

Table 3.6 Raspberry Pi Specification

PARAMETER	SPECIFCATION
Processor:	Broadcom BCM2837B0, Cortex-A53 64-bit SoC @ 1.4GHz
Memory:	1GB LPDDR2 SDRAM
Connectivity	2.4GHz and 5GHz IEEE 802.11.b/g/n/ac wireless LAN, Bluetooth 4.2, BLE Gigabit Ethernet over USB 2.0 (maximum throughput 300Mbps) 4 × USB 2.0 ports
Access:	Extended 40-pin GPIO header
Video & sound:	1 × full size HDMI MIPI DSI display port MIPI CSI camera port 4 pole stereo output and composite video port
Multimedia:	H.264, MPEG-4 decode (1080p30); H.264 encode (1080p30); OpenGL ES 1.1, 2.0 graphics
SD card support:	Micro SD format for loading operating system and data storage
Input power:	5V/2.5A DC via micro USB connector 5V DC via GPIO header Power over Ethernet (PoE)–enabled (requires separate PoE HAT)

3.6 MATHEMATICAL CALCULATION

3.6.1 Distance Calculation

Haversine formula derivation:

Haversine distance between two points using the gps coordinates

We consider that we are having two points P_1 and P_2 determined by their respective latitude-longitude pairs: $P_1(\theta_1, \varphi_1)$, $P_2(\theta_2, \varphi_2)$. In cartesian coordinates we have $P_1 = P_1(x_1, y_1, z_1)$ and $P_2 = P_2(x_2, y_2, z_2)$, where x, y, and z are determined by the spherical coordinates

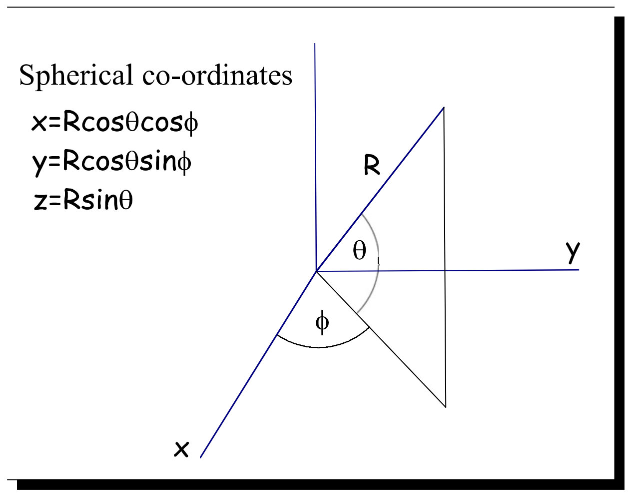

Figure 3.9(a) Spherical co-ordinates

The Euclidean distance d between P_1 and P_2 is given by the three-dimensional Pythagorean theorem:

$$d^2 = (x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2.$$

Converting the cartesian coordinates to spherical coordinates, we get

$$\begin{aligned} d^2/R^2 = {} & (\cos\theta_1 \cos\varphi_1 - \cos\theta_2 \cos\varphi_2)^2 \\ & + (\cos\theta_1 \sin\varphi_1 - \cos\theta_2 \sin\varphi_2)^2 \\ & + (\sin\theta_1 - \sin\theta_2)^2 \\ = {} & \cos^2\theta_1 \cos^2\varphi_1 - 2\cos\theta_1 \cos\varphi_1 \cos\theta_2 \cos\varphi_2 + \cos^2\theta_2 \cos^2\varphi_2 \\ & + \cos^2\theta_1 \sin^2\varphi_1 - 2\cos\theta_1 \sin\varphi_1 \cos\theta_2 \sin\varphi_2 + \cos^2\theta_2 \sin^2\varphi_2 \\ & + \sin^2\theta_1 - 2\sin\theta_1 \sin\theta_2 + \sin^2\theta_2 \\ = {} & 2 - 2\cos\theta_1 \cos\theta_2 \cos(\varphi_1 - \varphi_2) - 2\sin\theta_1 \sin\theta_2 \end{aligned}$$

To compute the distance D along the surface of the Earth

$$\sin(\alpha) = D/2R$$

We get

$$\sin(\alpha) = 2\sin(\alpha/2)\cos(\alpha/2)$$

$$= d(\sqrt{4R^2 - d^2}) / 2R^2$$

Therefore the terms D,R and d are given by

$$D = R\alpha = R\sin^{-1}(d(\sqrt{4R^2 - d^2}) / 2R^2)$$

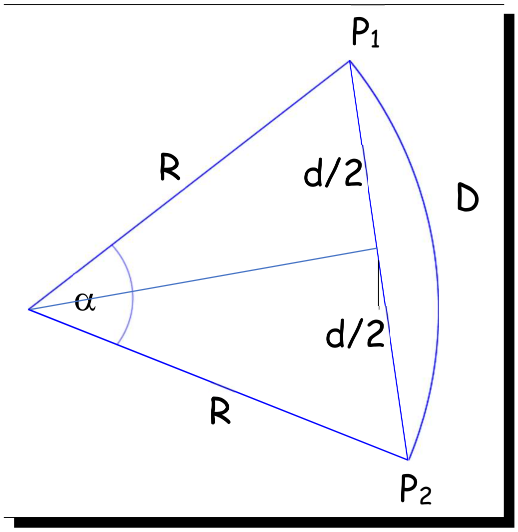

Figure3.9 (b) arc length

The distance is generally represented in terms of haversine function as

$$\cos A = 1 - 2 \text{ haversin } A$$

We then have the formula after substitution on d in the equation as

$$d^2/R^2 = 2 - 2\cos\theta_1 \cos\theta_2 \cos(\varphi_1 - \varphi_2) - 2\sin\theta_1 \sin\theta_2$$

$$= 2 - 2\cos\theta_1 \cos\theta_2[1 - 2 \text{ haversin } (\varphi_1 - \varphi_2)] - 2\sin\theta_1 \sin\theta_2$$

$$= 2 - 2\cos(\theta_1 - \theta_2) + 4\cos\theta_1 \cos\theta_2 \text{ haversin } (\varphi_1 - \varphi_2)$$

$$= 4 \text{ haversin } (\theta_1 - \theta_2) + 4\cos\theta_1 \cos\theta_2 \text{ haversin } (\varphi_1 - \varphi_2)$$

Then we have that

$$d^2/2R^2 = \text{haversin } (\theta_1 - \theta_2) + \cos\theta_1 \cos\theta_2 \text{ haversin } (\varphi_1 - \varphi_2)$$

$$\text{haversin}\alpha = \text{haversin } (\theta_1 - \theta_2) + \cos\theta_1 \cos\theta_2 \text{ haversin } (\varphi_1 - \varphi_2)$$

Finally the equation is given by

$$D = R\alpha = R\sin^{-1}(\sqrt{\text{haversin}\alpha})$$

3.7 CONCLUSION:

This chapter gives a detailed explanation about the working and brief description of components used to accomplish the project.

CHAPTER 4

PROGRAMMING AND RESULTS

4.1 INTRODUCTION

This chapter deals with the progress of the project, programming part and the simulation results obtained.

4.2 PROGRAMMING

4.2.1 Programming – Overview

In control room, a pc with internet connection acts as a server and with this setup, the roads can be monitored and traffic signal can be controlled. The details about road blockage can be updated as well. The control room and the traffic signal communicate via an active internet connection.

The connection between the traffic signal and the emergency vehicles approaching the same is achieved by using a radio transceiver module (nRF24l01) connected to a pair of micro-controllers. This enables the emergency vehicles to share data like speed, latitude and longitude, through which the real-time distance between the vehicle and traffic signal can be calculated, which in-turn opens up an opportunity to calculate the time taken for the vehicle to reach the traffic signal. This calculated time is an approximate value of how long the traffic signal system has to be interrupted. Once the emergency vehicle passes the traffic signal, the signal returns back to its normal flow.

A simple User Interface has been designed for the control room enabling the users to add junctions with their IP address and also mark whether a traffic junction is active or not, in case of road closures. This data can be later used by the emergency vehicles to navigate to the required location much faster. An alternative route can be picked by the drivers in case of road blockage as all the required details are available beforehand.

This setup helps the emergency vehicles to seamlessly reach the destinations with lesser scuffle.

4.2.2 Algorithm

For Finding Distance:

STEP 1: Start.

STEP 2: Check for connection between the traffic signal and the vehicle.

STEP 3: Emergency vehicle sends data like speed, latitude and longitude.

STEP 4: Print latitude and longitude

STEP 5: Using Haversine formula calculate the distance between vehicle and traffic signal.

STEP 6: Now, with speed and distance, calculate the time taken for the emergency vehicle to reach the traffic junction.

STEP 7: Print the distance and time taken by the vehicle to reach the traffic junction.

STEP 8: Stop

Connection Between Control Room and Junction – Junction Side:

STEP 1: Start

STEP 2: Check if the connection between control room and traffic junction is established.

STEP 3: Check with UI for traffic junction details.

STEP 4: If the junction is marked ON, do not send any alert, let the traffic signal proceed with normal sequence.

STEP 5: If the junction is marked OFF, send alert – “Road is blocked please choose alternate route".

STEP 6: Close connection

STEP 7: Stop

Connection Between Control Room and Junction – Control Side:

STEP 1: Start

STEP 2: Check if the connection between control room and traffic junction is established.

STEP 3: Add a junction using “Add” button by entering the traffic junction’s name and IP address.

STEP 4: Repeat step 3 if you want to add more traffic junctions.

STEP 5: View junction details using “View Junctions” button

STEP 6: If there is no road blockage in front of the junction, leave the junction turned ON.

STEP 7: When the road is blocked in front of junction, turn the traffic junction OFF.

STEP 8: Stop

Distance output

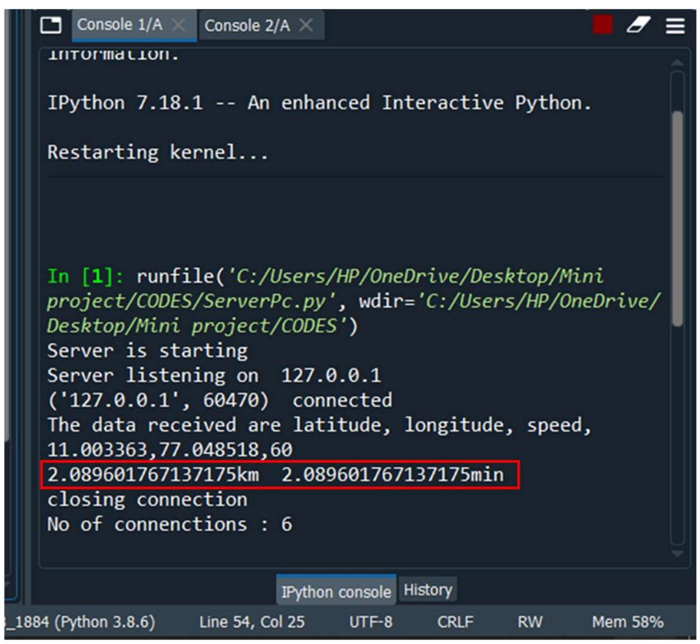

Fig.4.1 Distance and Time

The above output snippet clearly shows that the data from the emergency vehicle is received and distance in kilometres and total time taken to reach the junction in minutes has been calculated with the help of latitude, longitude and speed.

4.3 USER INTERFACE

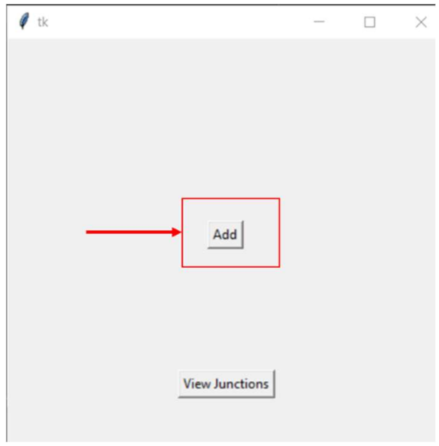

Fig.4.2(a) User Interface

The UI is very user friendly; it allows the user to add junctions with their respective IP address, view junction details and also, switch the junction off and on when required, during road closures. The user will also will be able to view the latitude and longitude of the traffic signal. When the road is blocked, it advices the driver to choose an alternative route, enabling faster travel.

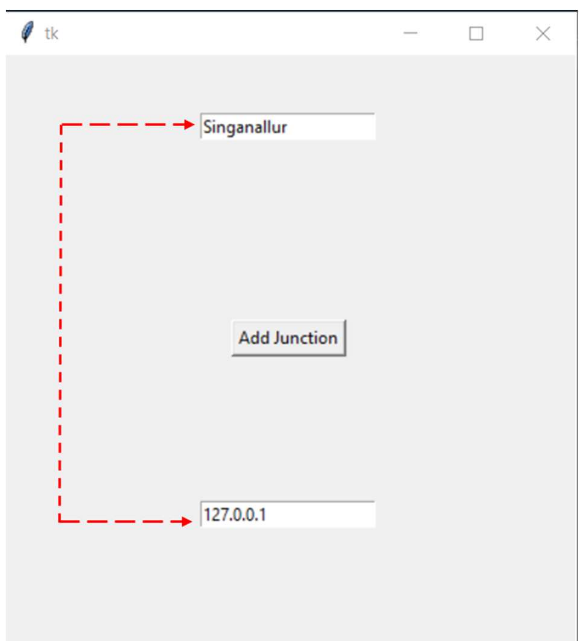

Fig. 4.2(b) Adding Junction

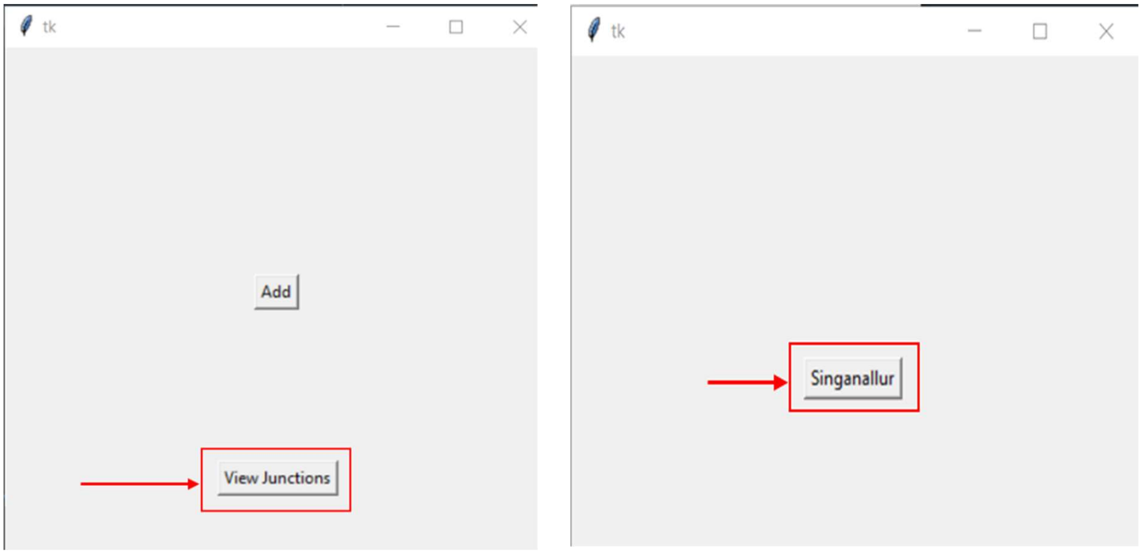

Fig.4.2(c) View Junction

Fig.4.2(d) Details of Traffic Signal

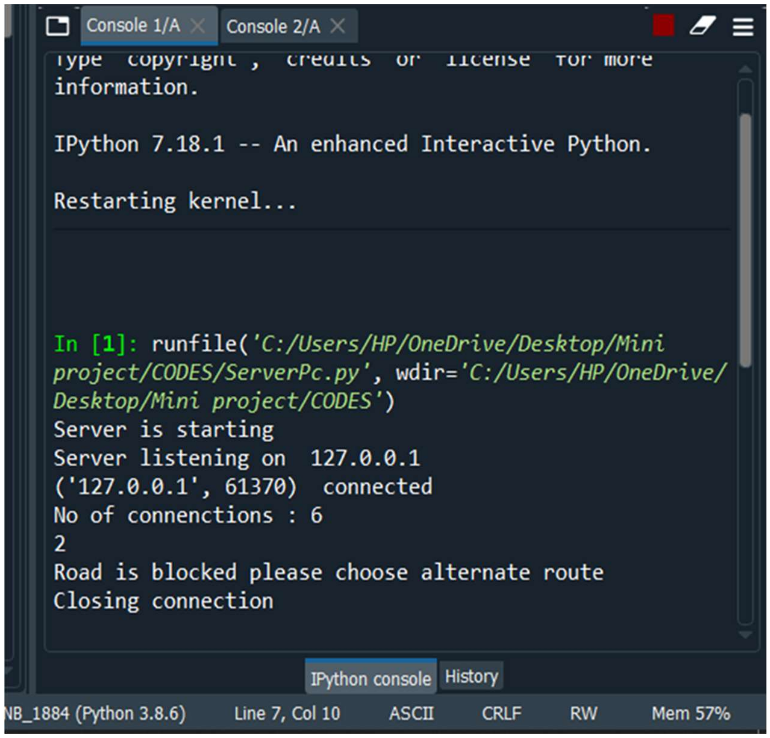

Fig.4.3(a) Junction OFF in UI

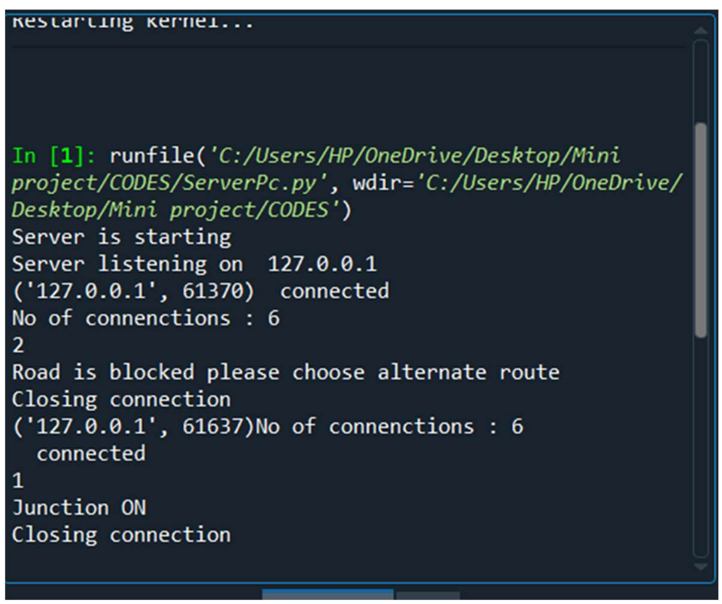

Fig.4.3(b) Junction ON in UI

4.4 CONCLUSION

Thus, the function used for distance calculation and creating a user interface have been done and the results are verified.

CHAPTER 5

HARDWARE SOLUTION

5.1 INTRODUCTION

This chapter deals with the progress of the project, demonstrating the hardware part of the traffic signal system, which is connected to a micro-controller.

5.2 HARDWARE SOLUTION

The traffic junction setup is demonstrated using 12 LED lights (4 sets of 3 Red, Yellow and Green lights). The 4 sets represent 4 traffic signals in a cross junction. In this project, instead of a Yellow light, Blue LEDs have been used depicting the same.

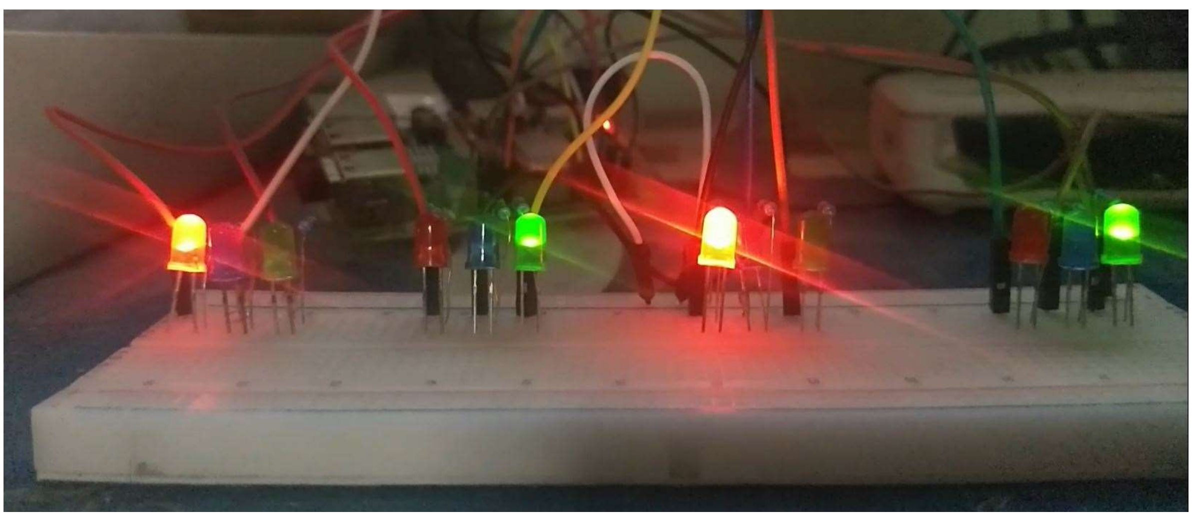

Fig.5.1(a) Normal traffic signal sequence

The picture above represents the normal signal flow, with 2 sets of LEDs green (representing opposite traffic signals in a cross junction) and 2 set of LEDs red. The signal proceeds with the normal flow and gets interrupted only when it establishes connection with an emergency vehicle.

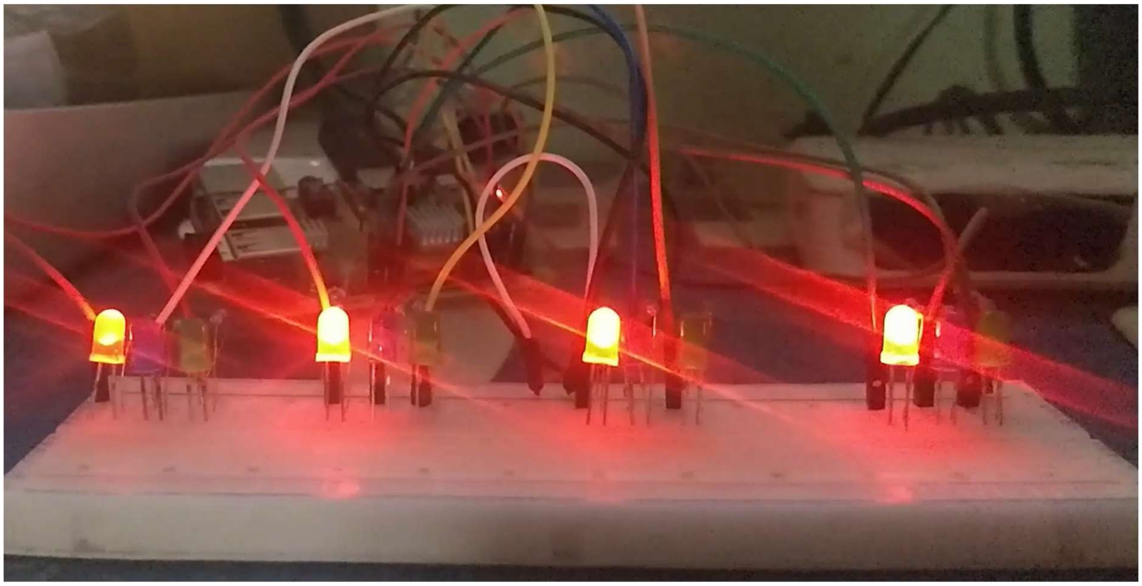

Fig.5.1(b) Traffic signal sequence interrupted

The above picture shows that the regular traffic signal flow has been interrupted since it has received a signal from an emergency vehicle that it is approaching the signal and depending upon the direction of the vehicle, the signal is smart enough to react and do the necessary changes. Once the emergency vehicle crosses the signal, it gets pushed back to the normal traffic signal sequence as shown in Fig 5.1(a).

5.3 CONCLUSION

Thus, the demonstration of the hardware part of traffic signal system has been done and the results are verified.

CHAPTER 6

CONCLUSION

6.1 Future Scope

In modern fast paced lifestyle, the number of cars and two wheelers on the roads are increasing tremendously. It does not stop there, due to increase in vehicles on roads the government tenders highway and flyover construction projects. With huge number of vehicles on road and construction work going on everywhere, the delay caused for the traffic to clear is a pain and emergency vehicles are not an exception in this case. Hence, implementing intelligent traffic signal systems is an advantage and can end up saving a lot of lives and properties.

6.2 Socio-Economic Impact

There is a famous saying – "A stich in time saves nine". Hence, giving vital importance to the time spent on road by the emergency vehicles plays a major role in saving lot of lives and money. The lesser the time emergency vehicle spends on road idling, the more reaction time the emergency vehicle gets and the fuel spent is also decreased.

6.3 Project Conclusion

In a world full of busy roads, traffic signals play a vital role in clearing the traffic which plays an important part in providing Emergency Services. In this project a system is designed, which is not completely based on internet and sensors, so it is efficient in times of disasters, since the system will not fail even if internet is down. Hence, a green corridor can be provided seamlessly.