Design and Development of Intelligent Traffic Management System

Major Project Report

Submitted in partial fulfillment of the requirements

for the degree of

Master of Technology

in

Electronics & Communication Engineering

(Embedded Systems)

By

Surabhi Singh

(15MECE26)

Electronics & Communication Engineering Department

Institute of Technology-Nirma University

Ahmedabad-382 481

May 2017

Design and Development of Intelligent Traffic Management System

Major Project Report

Submitted in partial fulfillment of the requirements

for the degree of

Master of Technology

in

Electronics & Communication Engineering

(Embedded Systems)

By

Surabhi Singh
(15MECE26)

Under the guidance of

Internal Project Guide:

Dr. Sachin Gajjar

Associate Professor, EC Department

Institute of Technology

Nirma University, Ahmedabad

Project Co-Guide:

Dr. N. P. Gajjar

P.G. Coordinator, EC Department

Institute of Technology

Nirma University, Ahmedabad

Electronics & Communication Engineering Department

Institute of Technology, Nirma University

Ahmedabad-382 481

Declaration

This is to certify that

a. The thesis comprises my original work towards the degree of Master of Technology in Embedded Systems at Nirma University and has not been submitted elsewhere for a degree.

b. Due acknowledgment has been made in the text to all other material used.

- Surabhi Singh

15MECE26

Certificate

This is to certify that the Major Project entitled **"Design and Development of Intelligent Traffic Management System"** submitted by **Surabhi Singh (15MECE26)**, towards the partial fulfillment of the requirements for the degree of Master of Technology in Embedded Systems, Nirma University, Ahmedabad is the record of work carried out by her under our supervision and guidance. In our opinion, the submitted work has reached a level required for being accepted for examination.The results embodied in this major project, to the best of our knowledge,haven't been submitted to any other university or institution for award of any degree or diploma.

Date: Place: Ahmedabad

Dr. Sachin Gajjar

Project Guide

Program Coordinator

Dr. Alka Mahajan

Director, Institute of Technology

Nirma University, Ahmedabad

Dr. D.K. Kothari

HOD, ECE Department

Institute of Technology

Nirma University, Ahmedabad

Acknowledgements

I would like to express my gratitude and sincere thanks to **Dr. D.K. Kothari**, Head of Electronics and Communication Engineering Department, and **Dr. N.P. Gajjar**, PG Coordinator of M.Tech Embedded Systems program for allowing me to undertake this thesis work and for his guidelines during the review process.

I take this opportunity to express my profound gratitude and deep regards to **Dr. Sachin Gajjar**, guide of my major project for his exemplary guidance, monitoring and constant encouragement throughout the course of this thesis. The blessing, help and guidance given by him time to time shall carry me a long way in the journey of life on which I am about to embark.

Lastly, I thank almighty, my parents, brother and friends for their constant encouragement without which this assignment would not be possible.

- Surabhi Singh

15MECE26

Abstract

The rate of migration from rural to urban areas is increasing across the world day by day. It is an estimate that by 2050, around 75 percent of the people will be living in cities. With the increase in population, the challenges in the city governance are also increasing like inadequate infrastructure, health services, social services etc. The solution for this problem is to make the provided facilities smart like smart street light, smart parking, smart waste management, smart health care etc. Intelligent Traffic Management System includes smart traffic light, smart street light and continuous monitoring of environmental parameters like temperature etc.

Ultrasonic sensor and magnetometer sensor have been interfaced with the Arduino Mega 2560 to detect the density of traffic on the road.The combination of Ultrasonic sensor and magnetometer sensor will increase the efficiency and accuracy of the project's outcome as the combination of two sensors will prevent a false alarm and leads to less disruption in handling traffic.A cloud platform has been used to record all the data for analysis. The gas, temperature and humidity sensors are used to monitor the environmental conditions which will be displayed on the LCD module. Decision-making technique, fuzzy logic has been used in the system to manage traffic lights.

Contents

List of Tables

List of Figures

Chapter 1

Introduction

1.1 Background

A **smart city** is an urban development vision to integrate multiple information and communication technology and Internet of Things solutions in a secure fashion to manage a city's assets. This includes local departments' information systems, schools, libraries, transportation systems, hospitals, power plants, water supply networks, waste management etc. The goal of building a smart city is to improve the quality of life by using the latest technology, to improve the efficiency of services provided to the citizens.

The concept of smart city originated when the world was facing a major economic crisis in 2008. The technological giant IBM started an initiative which is called smart planet under which it started its working for smart cities.

Nowadays we have **Clouds**, a digital universe of information freely available. A cloud size is approximately in thousands of Exabytes, a good analogy says it is roughly a stack of books from earth to pluto 80 times.

1.2 Motivation

As urban areas provide a lot more facilities than rural, people migrate in the need for better work opportunities and living conditions. This high migration rate puts a question mark on the quality of facilities provided in the cities. To reduce the wastage of resources and to improve the quality of outcome from the facility, we need to make the facility smart which in turn makes a city smart.
"Intelligent Traffic Light System" is a move towards a smart city which reduces the air pollution, traffic and time of a person to reach its destination.
"Smart Street Light System" reduces the energy waste on the streets, as these resources are exhaustible so there is a dire requirement to save them for future.

1.3 Objective

The main objective of this project is to develop an Intelligent Traffic Management System using a decision-making technique. The major points to cover in this project are:

a. To control the traffic light system according to traffic density.

b. To turn on the street lights when a vehicle detected.

c. To monitor the environmental parameters such as temperature, humidity etc and save data on cloud for analysis.

1.4 Approach

This section of the chapter defines the path through which the project will be moving towards the conclusion. The selection of the hardware is based on the many things like cost, working environment, availability, sustainability, accuracy etc. Arduino Boards are relatively inexpensive compared to other micro-controllers and easy to

use. It has a large community, therefore the help one beginner can get is good. There are many sensors which are Arduino compatible, are easily and cheaply available. It has both open sources extensible hardware and software availability.
The data will be saved on the cloud platform called ubidots as it is freely available. The data can be later used to draw comparison or analysis.

1.5 Scope

This project focuses on designing and developing a sustainable and economical Traffic Management System. The sensors used in the project can survive the outdoor conditions. The hardware used in this project consist of an Arduino Mega 2560 board, a high resolution LCD for displaying the messages, a DHT11 temperature and humidity sensor, gas sensor for environmental gases monitoring, Light Dependent Resistor(LDR) sensor to detect the strength of light intensity, Real Time Clock(RTC) is used to make the project in the real time situation and ultrasonic proximity sensor with magnetometer sensor for vehicle density detection.
The software section comprises of cloud facility like Ubidots to save the data on the cloud. It is free and easy to use. For simulation of the circuit, Proteus has been used which is easy to use and student accessible.
For decision making fuzzy logic seems to be fulfilling the requirement as it is less complex than other, multiple inputs-outputs can be used with a rule base which includes all possible real time situations and works similar to human brain.

1.6 Outline

The outline gives a little description about the chapters:

- Chapter 2: This chapter contains the details about the previously used techniques and their drawbacks. It also explains the choices I had for the hardware and why they are not suitable for the project.

- Chapter 3: This chapter contains the hardware which has been tested and will be used in the project development.
- Chapter 4: This chapter contains the description of the software which has been used and the coding for the clouds part.
- Chapter 5: This chapter contains the coding which has been done for the sensors and outcomes.
- Chapter 6: This chapter contains the conclusion of the work done to date and the future task points.

Chapter 2

Literature review

2.1 Existing Methodology For Intelligent Traffic Light System

In this section, a little description is shown of the existing techniques used for smart traffic light system.

- Magnetic Loops
- Camera Based Systems
- Microwave Radar
- Laser Based Systems
- Infrared Detectors

2.1.1 Magnetic Loops

The magnetic loop is a technology that has been used for vehicle detection and traffic control for the past few decades. These devices are installed inside each traffic lane and act as counters, counting vehicle passing over them. Some variants of the magnetic loop have been used to classify vehicles as well. The loop is a

continuous run of wire which is buried inside a track lane. The ends of the loop wire are connected through a loop extension cable to the vehicle detector. The detector powers the loop causing a magnetic field in the loop area. The magnetic flux linked with the loop changes whenever a metal object, such as a vehicle, moves over the loop. The detection scheme of loops is based on this principle. The change in flux is sensed by the detector which forces a normally open relay to close. The relay remains closed until the vehicle leaves the loop [1].

Inductive loops require extensive care during installation or repair. Troubleshooting problems in magnetic loops require costly test equipment or diagnostic software. The inductive loop requires a continuous power supply to function. Hence, it is quite evident that magnetic loops being intrusive, expensive to install and maintain do not fulfill our requirements [1].

2.1.2 Camera Based Systems

Camera based systems are able to detect, count and classify vehicles. These systems use video image processors to identify vehicles and their traffic flow parameters by analyzing imagery supplied by video cameras. Images supplied by cameras are digitized and then series of image processing algorithms are applied to them. Information about vehicle passage, presence and speed can be extracted by using various image processing techniques. Though camera based systems are more accurate than loop based systems and do not require lane discipline they have several disadvantages. Their performance is unsatisfactory in foggy conditions of poor visibility. Other environmental conditions such as light reflected from wet pavements and shadows affect the performance of Video image processors. Large vehicles can obscure smaller vehicles. Camera based systems are expensive to install and maintain as they require quite a lot of dedicated hardware and software. Chances of theft are also higher for such systems [1].

2.1.3 Microwave Radar

Microwave radars use specially allocated radio frequency for detecting vehicles. In the U.S. 10.525 GHz is allocated for this purpose. There are two types of microwave radar detectors. The first type of microwave radar uses the Doppler principle to detect vehicles. According to the Doppler principle, the difference in frequency between the transmitted and received signals is proportional to the speed of the vehicle. So this type of microwave radar first transmits electromagnetic energy at a constant frequency. If the detector senses any shift in the received frequency it deduces that vehicle has passed. On major problem with this type of microwave radar is that it cannot detect stationary vehicles. The second type of microwave radar detector transmits a frequency-modulated continuous wave that varies the transmitted frequency continuously with time. This enables the system to measure the range of the vehicle from the detector. Hence, this type of microwave radar can detect stationary vehicles as well. The speed of the vehicle can be calculated by measuring the time taken by a vehicle to move between two internal markers separated by a known distance. However, even these microwave radar systems have problems like over estimating speed and occupancy values [2].

2.1.4 Laser Based Systems

Laser based systems can be used to for counting, classifying and measuring the speed of vehicles. Laser based systems offer reliability and durability. Unlike systems based on magnetic loops the installation of these systems does not need any civil engineering work to be done on the floor of the road. Laser detectors, however, need to be installed in an overhead position. Thus, an overhead structure is needed for these systems. Also, these systems assume structured traffic on the road which is not the case in India [2].

2.1.5 Infrared Detectors

Passive infrared detectors do not transmit energy but instead use an energy sensitive photon detector located at the optical focal plane to measure the infrared energy emitted by objects in the detector's field of view. Thus, when a vehicle enters the detection region of the device, it produces a change in energy which is sensed by the photon detector. This system can only detect vehicle passage or presence. It cannot provide any information regarding the speed of the vehicle. Change in weather conditions such as fog, rain or snow results in performance degradation of these systems [1].

2.2 Smart Street Light System

The present framework is, the road lights will be turned on in the night prior to sunset and they are turned off the following morning after there is adequate sunlight on the streets. The drawback of the framework is that it is a manual operation which means man-power. The other drawback is the changing climate, the sunset and sunrise timing differs in every season. Sometimes the sunrise is early but the person who supposed to turn off lights comes on regular time, this will ultimately lead to power waste. In rainy season the manual handling of switches is risky therefore leading to a disadvantage. There is some time duration when there is no activity on the street still the lights are glowing with the full intensity which also leads to a large amount of power wastage [3].

India, as a developing country needs to plan some smart ways to save power which leads to the growth of the country. The goal of this project is to plan an automated street lighting framework which focuses on the saving of power; to construct a vitally energy efficient smart street lighting framework with integrated sensors and controllers; to outline a smart lighting framework with particular methodology plan, which makes the framework adaptability and expandability and configuration a smart lighting framework which similarity and versatility with other commercial

products and mechanized automated system, which may incorporate more than lighting frameworks.

2.3 Options for Hardware

There are different and most commonly used options are available to design the hardware for the project.

2.3.1 Microcontroller

Arduino has a variety of development boards ranging from low to high. I started with Arduino UNO because I had done some simple experiments with it before and it is cheaper than other boards. It is one of the mostly used and successful board in the Arduino family. It has every possible characteristic which a small, compact and good development board can provide. The only drawback it has is the less number of analog and digital pins. It cannot be used with a large number of other hardware components and big LCD shield simultaneously.

2.3.2 Display Module

This is the most commonly used LCD Module for Arduino and other small projects. It is majorly preferred due to low cost, easy maintenance and easy usage. This LCD module can be easily interfaced with any Arduino board and other developmental boards but we have discarded it due to the space problem. We cannot display a large number of things at a time on this LCD, plus sometimes it fails to respond in the desired manner due to large wiring. I interfaced it with the board and all other sensors available but it is only showing black square boxes instead of the sensor values.

2.3.3 Sensors

Infrared Sensors are the cheapest sensors available in the market for detecting an obstacle. It uses infrared rays for object detection, the rays are invisible and reach up to few centimeters and they can work in a real-time scenario. Therefore, we can say that it is perfect for small projects but on the other hand it has many disadvantages. It is very sensitive to IR lights and sunlight. Black objects or dark colored objects absorb the radiations, so the reflected rays never come back to the IR receiver. All these disadvantages makes it uses inappropriate for outdoor projects and more importantly for traffic detection [4].

Chapter 3

Hardware Design

3.1 Arduino Mega 2560

The Arduino Mega 2560 is a micro-controller board based on the ATmega2560. It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the micro-controller; simply connect it to a computer with a USB cable or power it with AC-to-DC adapter or battery to get started [5]. The pin description of the board is as follows:

- VIN

  It is used as an input voltage to the Arduino board when board is using an external power source. You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin [5].

- 5V

  It is the regulated power supply used to power the micro-controller, other components on the board and the components connected to the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply [5].

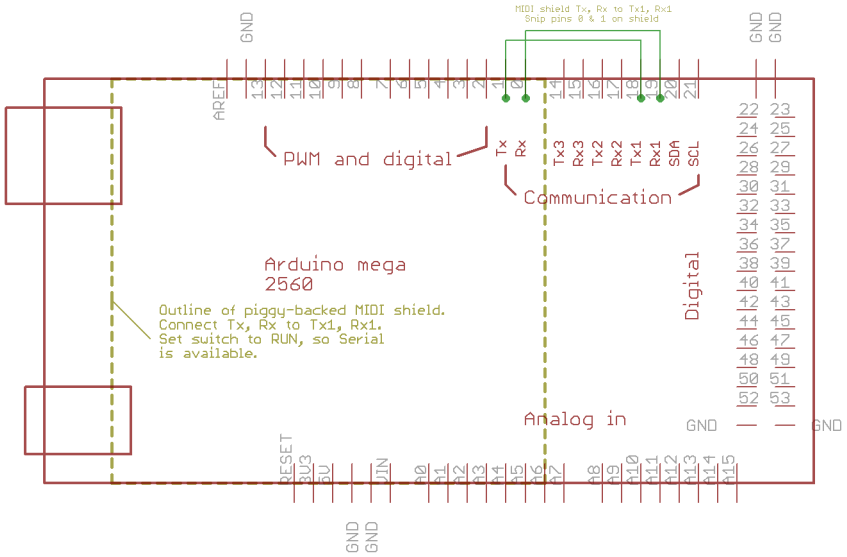

Figure 3.1: Pin Diagram Arduino Mega 2560 [5]

- 3V3

  A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.

- GND

  Ground pins.

- Serial Pins

  Serial: 0 (RX) and 1 (TX); Serial 1: 19 (RX) and 18 (TX); Serial 2: 17 (RX) and 16 (TX); Serial 3: 15 (RX) and 14 (TX). Used to receive (RX) and transmit (TX) TTL serial data. Pins 0 and 1 are also connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip [5].

- External Interrupts

  2 (interrupt 0), 3 (interrupt 1), 18 (interrupt 5), 19 (interrupt 4), 20 (interrupt 3), and 21 (interrupt 2). These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value [5].

- PWM

0 to 13. Provide 8-bit PWM output with the analogWrite() function (which is used to write an analog value to the desired pin).

- SPI

  50 (MISO), 51 (MOSI), 52 (SCK), 53 (SS). These pins support SPI communication using the SPI library. The SPI pins are also broken out on the ICSP header, which is physically compatible with the Uno, Duemilanove and Diecimila [5].

- LED

  There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

- I2C

  20 (SDA) and 21 (SCL). Support I2C communication using the Wire library [5].

- AREF

  Reference voltage for the analog inputs.

- Reset

  Bring this line LOW to reset the micro-controller. Typically used to add a reset button to shields which block the one on the board

COMMUNICATION : The Arduino Mega2560 has a number of facilities for communicating with a computer, another Arduino, or other micro-controllers. The ATmega2560 provides four hardware UARTs for TTL (5V) serial communication. An ATmega8U2 on the board channels one of these over USB and provides a virtual com port to software on the computer (Windows machines will need a .inf file, but OSX and Linux machines will recognize the board as a COM port automatically. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash

Table 3.1: Technical Specification of Arduino Mega 2560 [5]

1.	Micro-controller	ATmega2560
2.	Operating Voltage	5V
3.	Input Voltage (recommended)	7-12V
4.	Input Voltage (limits)	6-20V
5.	Digital I/O Pins	54 (of which 14 provide PWM output)
6.	Analog Input Pins	16
7.	DC Current per I/O Pin	40 mA
9.	DC Current for 3.3V Pin	50 mA
10.	Flash Memory	256 KB of which 8 KB used by boot-loader
11.	SRAM	8 KB
12.	EEPROM	4 KB
13.	Clock Speed	16 MHz

when data is being transmitted via the ATmega8U2 chip and USB connection to the computer (but not for serial communication on pins 0 and 1) [5].

3.2 Ethernet Shield

To make the full advantage of the cloud services Arduino must be connected to the internet and that what the Ethernet shield does. It is a way to connect the board to the Internet and provide access to the cloud to store values. Now **Shields** are the boards which can be plugged on the top of the board to extend its capabilities and ease the use of hardware.

Ethernet shield is used to connect the board to the internet. It is based on Wiznet W5100 ethernet chip. It provides a network (IP) stack capable of both TCP and UDP. It can support four simultaneous socket connections. Ethernet library can be used to write sketches which connect the board to the internet using the shield. Ethernet shield connects to an Arduino board using long wire-wrap headers which

extend through the shield. This keeps the pin layout intact and allows the use of another shield on the top of it [6].

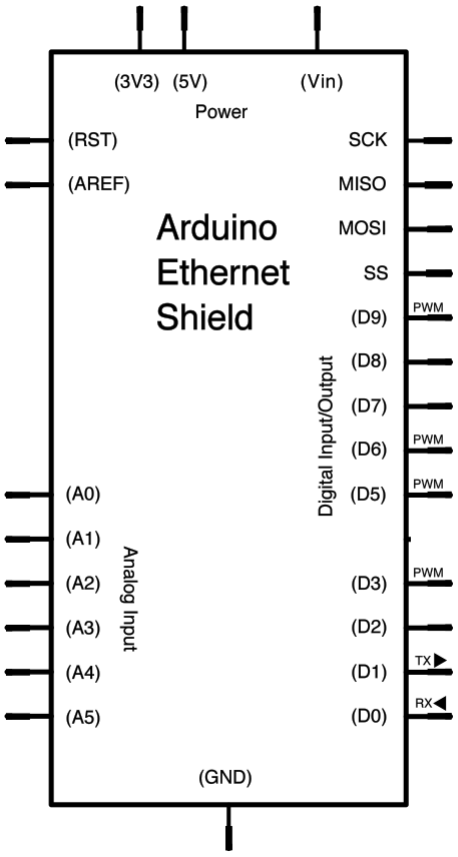

Figure 3.2: Block Diagram Ethernet Shield [6]

Arduino communicates with both the W5100 and SD card using the SPI bus (through the ICSP header). This is on digital pins 50, 51, and 52 on the Mega, the pin numbers can vary from board to board. Pin 10 is used to select the W5100 and pin 4 for the SD card. These pins cannot be used for general i/o. On the Mega, the hardware SS pin, 53, is not used to select either the W5100 or the SD card, but it must be kept as an output or the SPI interface won't work [6].

Ethernet shield uses SPI bus to communicate to the board as well as to SD card but it cannot happen simultaneously. The communication is possible with only one at a time. The shield provides a standard RJ45 ethernet jack. The reset button on the

shield resets both the W5100 and the Arduino board.The shield consist of a number of LEDs which indicates the following things [6]:

- PWR: indicates that the board and shield are powered
- LINK: indicates the presence of a network link and flashes when the shield transmits or receives data
- FULLD: indicates that the network connection is full duplex
- 100M: indicates the presence of a 100 Mb/s network connection (as opposed to 10 Mb/s)
- RX: flashes when the shield receives data
- TX: flashes when the shield sends data
- COLL: flashes when network collisions are detected

W5100 is well suited for many embedded applications like:

- Serial-to-Ethernet: Access Controls, LED displays, Wireless AP relays etc.
- Home Network Devices: Set-Top Boxes, PVRs, Digital Media Adapters
- Embedded servers
- Factory and Building Automation

3.3 Display

A 2.4 TFT LCD has been used in this project which has many added advantages over normal 16x2 LCD. This TFT display is colorful and 2.4" diagonal with a bright (4 white-LED) back-light. It has 240x320 pixels with individual RGB pixel control, this has way more resolution than a black and white normal 16x2 LCD display. This display has a resistive touchscreen so one can detect finger presses anywhere on the

screen [7].

This display has a controller built into it with RAM buffering so that almost no work is done by the microcontroller. It can be used in two modes, first is 8-bit and second is SPI. For 8-bit mode, you'll need 8 digital data lines and 4 or 5 digital control lines to read and write to the display. SPI mode requires only 5 pins total (SPI data in, data out, clock, select, and d/c) but is slower than 8-bit mode [7].

Four additional pins are required if we want to use the touchscreen from which two should be analog and two should be digital and a touchscreen library needs to be installed.

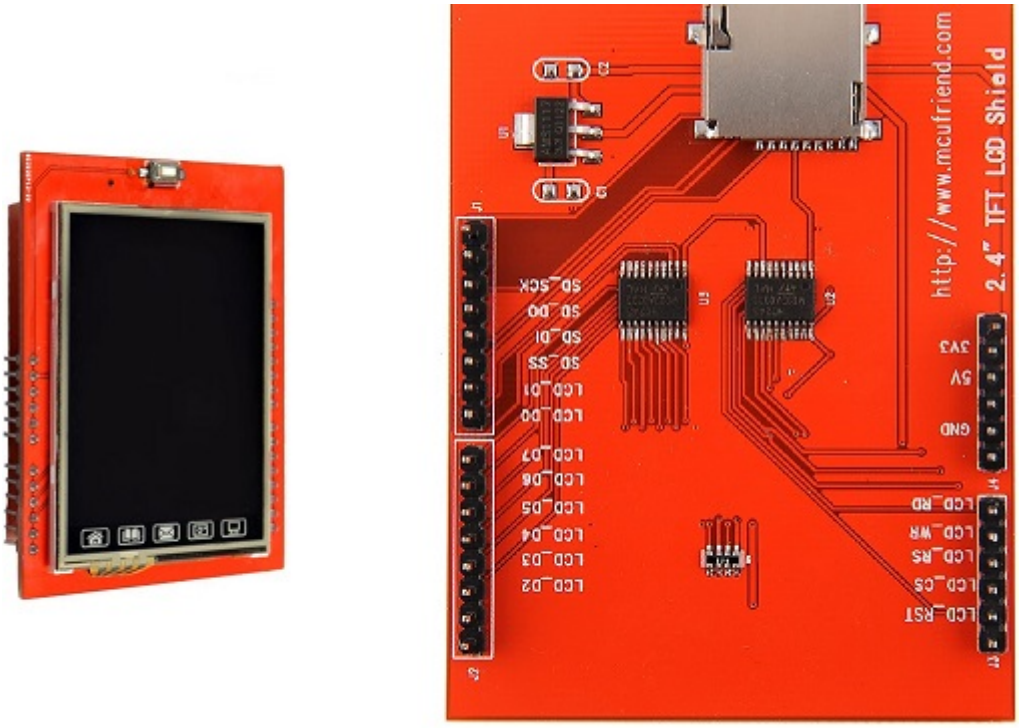

Figure 3.3: 2.4" TFT LCD [8]

There are different types of LCD drivers are present in the market like SPDF5408, ILI9325, ILI9328, HX8347G etc, now depending on the manufacturer of the product, controller, LCD driver and size specification the libraries support may vary. List of few feature the LCD consist[8]:

- 2.4 diagonal Touch LCD TFT display
- 240320 resolution, 18-bit (262,000) colour
- ILI9325 chip driver
- 8-bit digital interface, plus 4 control lines
- Uses digital pins 5-13 and analog 0-3. That means you can use digital pins 2, 3 and analog 4 and 5. Pin 12 is available if not using the microSD
- Works with Arduino UNO, Arduino Mega
- 5V compatible
- 4 white LED backlight. On by default but you can connect the transistor to a digital pin for backlight control

3.4 Real Time Clock

Real Time Clock(RTC) module is used to display the current timing and to calculate the waiting time for the traffic lane.The DS1302 module has been used in this project because of its easy availability, easy use and compatibility with microcontroller.It can count seconds, minutes, hours, date, day, year.

Feautures [9]:

- It has both 12 hours and 24 hours format.
- It has burst mode read/write.
- Real Time Clock read/write (8 bytes)
- Battery backed RAM read/write (31 bytes)

It has 3 wire interface: bi-directional data, clock, reset. It has a built-in trickle charger which can be used as a rechargeable battery.

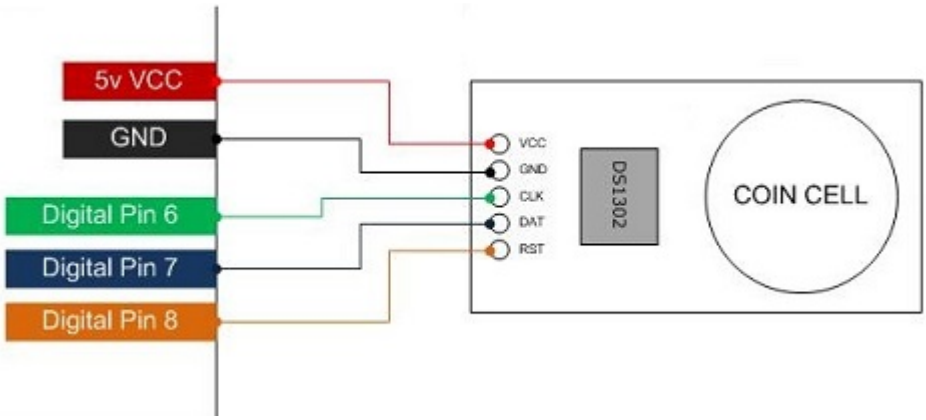

Figure 3.4: Real Time Clock DS1302 [10]

3.5 Sensors

3.5.1 Gas Sensor

In current scenario monitoring the environmental gasses is important as they lead to many health problems. If monitoring them continuously can remind us of saving the environment it is better to have a reminder of it. They are mainly used in industries to monitor the safety of workers and other people.

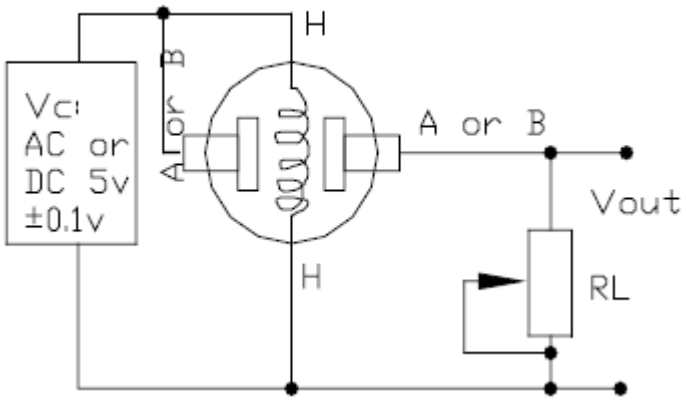

Figure 3.5: Basic Structure of Gas Sensor [11]

Working: There are a variety of gas sensor modules available and each has a

different sensitivity level now these sensitivity levels helps in differentiating between the different module for different gasses. The module has steel exoskeleton which consists of the sensing element. Now when the gas first interacts with the module it gets ionized into its constituents and adsorbed by the sensing element which creates a potential difference or we can say it changes the resistance of the sensing element and the value of current going out of the leads changes which indicate the presence of the required gas. This is the basic working of every gas sensor module.

a. **MQ-2**

This gas sensor is mainly used in gas leakage detecting equipment because it can detect many harmful gasses like LPG,i-butane, Propane, Methane, Alcohol, Hydrogen and Smoke. It is an analog sensor. The accurate value of the gasses can be provided by the sensor when that particular gas is in the sensing range of the sensor otherwise it may show some random values [11]. The detecting concentration scope of mq-2 for different gases is as follows [11]:

- LPG and propane: 200ppm-5000ppm
- Butane: 300ppm-5000ppm
- Methane: 5000ppm-20000ppm
- H2: 300ppm-5000ppm
- Alcohol: 100ppm-2000ppm

b. **MQ-135**

This sensor is widely known as air quality sensor, it is also an analog sensor. It is used for detecting gases like NH3, NOx, alcohol, benzene, smoke and CO2. The detecting concentration scope for this sensor is as follows [12]:

- NH3: 10ppm-300ppm
- Benzene: 10ppm-1000ppm
- Alcohol: 10ppm-300ppm

These both the sensors have a pre-heat time of 24 hours. The pre-heat time is a time after which the sensor can give some sensible values.

3.5.2 Temperature and Humidity Sensor

The DHT Temperature and Humidity Sensor features a calibrated digital signal output with the temperature and humidity sensor complex. There are two types of DHT sensor one is DHT11 and second one is DHT22. In this project we are using DHT11, It ensures high reliability and excellent long-term stability. A high-performance 8-bit micro-controller has been connected to it. This sensor has a resistive element and an NTC thermistor for temperature measuring. It has many advantages over those analog temperature sensor like excellent quality, fast response, anti-interference ability and high-cost performance. Each DHT11 sensors features

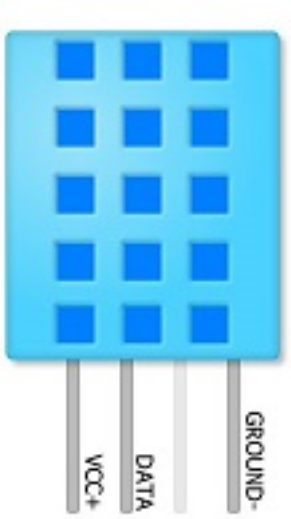

Figure 3.6: DHT11 Temperature and Humidity Sensor [13]

that extremely accurate calibration of humidity calibration chamber. The calibration coefficients stored in the OTP program memory, internal sensors detect signals in the process, and we should call these calibration coefficients. The single-wire serial interface system is integrated to become quick and easy. Small size, low power, signal transmission distance up to 20 meters, makes it a variety of applications and

even the most demanding applications. The product is 4-pin single row pin package. Convenient connection, special packages can be provided according to users need [14].

Its operating voltage is 5V DC. When power is supplied to sensor, dont send any instruction to the sensor within one second to pass unstable status. One capacitor valued 100nF can be added between VDD and GND for power filtering. Single-bus data is used for communication between MCU and DHT11 [14].

3.5.3 Light Dependent Resistor(LDR) Sensor

LDR is known by multiple names like photo-resistor, photocell, photo-conductor.Its resistance varies with the intensity of light falling on it, therefore, it is used in many applications for detecting the presence of lights is important like street lights, indoor home appliances, outside lights etc. A typical light dependent resistor has a resistance in the darkness of 1MOhm and in the brightness a resistance of a couple of KOhm [15].

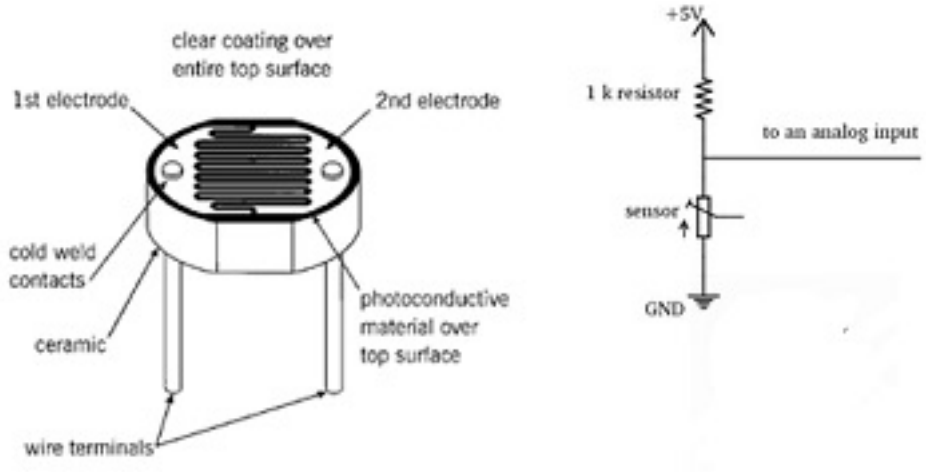

Figure 3.7: Light Dependent Resistor [15]

Working: LDR works on the principle of photo-conductivity.When the light falls

on its surface, then the conductivity of the material reduces means the electrons in the valence band are excited to the conduction band. The incident light photons must have energy greater than the band gap of the semiconductor.This makes the electrons to jump from the valence band to conduction [15]. When the light falls on

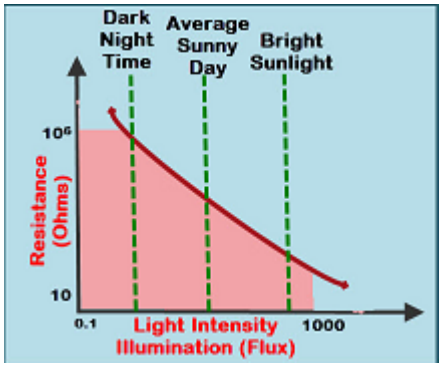

Figure 3.8: Light Intensity vs LDR Resistance [15]

resistor the value of resistance decreases and resistance increases when the intensity of the light falling on LDR is low.

3.5.4 Proximity Sensor

Proximity Sensors are widely used to detect any object in the defined range. The object can vary from a human being to any metal. In this project, we will be using an ultrasonic sensor and magnetometer sensor to detect the density of traffic.

a. **Ultrasonic Sensor**

Figure 3.9: Ultrasonic Sensor [16]

The ultrasonic sensor HC-SR04 uses sonar technology to detect an object.

The sonar technology means **SO**und **N**avigation **A**nd **R**anging, it uses sound waves to navigate, communicate and detect objects.These are based on acoustic waves with a frequency above human audible range for say 40khz. For our project, the main focus is on distance measurement which is known as "time of flight". The process of calculating the distance is, a transducer is used in which the wave bounces off the target and travels back to the receiver in a particular time then the receiver records the length of this time interval, and calculates the distance traveled based on the speed of sound [17]. Sunlight and

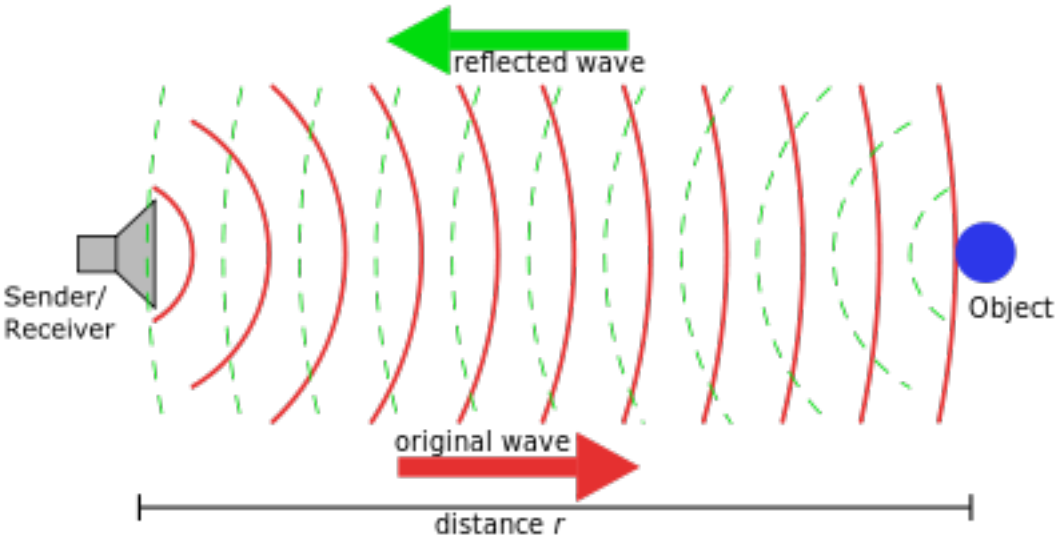

Figure 3.10: Working of Ultrasonic Sensor [17]

dark objects don't affect the working of this sensor but it can show variable results for soft materials like clothing.Main features of this sensor are [18]:

- Power Supply :+5V DC
- Working Current: 15mA
- Ranging Distance : 2cm 400 cm/1 13ft
- Measuring Angle: 30 degree
- Trigger Input Pulse width: 10uS

- Dimension: 45mm x 20mm x 15mm

b. **Magnetometer Sensor** The HMC5883L is a triple axis magnetometer means it can sense the change in magnetic field in three directions. It is designed for low magnetic field sensing. It uses Honeywell's Anisotropic Magneto-resistive technology. It is a vector sensor means it can calculate both the direction and magnitude of Earth's magnetic field [19].

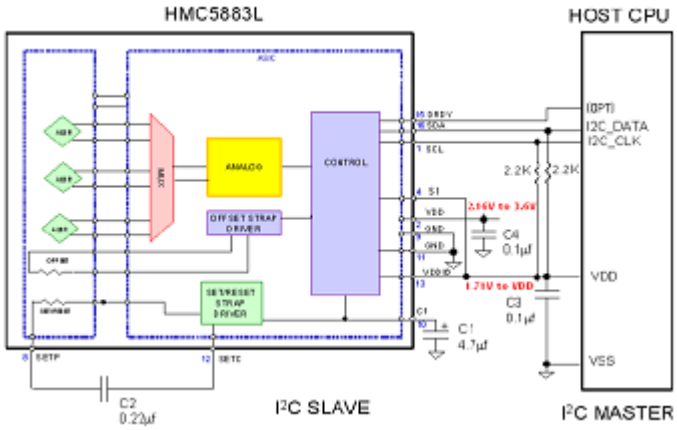

Figure 3.11: Internal Schematic Diagram [20]

Applications [19]:

- Compassing - Automotive, GPS, watches, antenna positioning, binoculars, goggles, thermal imaging.
- Laser Range Finders, Surveying.
- Navigation - vehicle navigation systems, air/marine/land, drones, radio controlled helicopters and aircraft.
- Position Sensing - valve control, displacement sensing, water metering.
- Vehicle detection - parking meters, electronic traffic signals.
- Security - metal detectors, magnetic anomaly detection
- Dead Reckoning - backup navigation for GPS receivers

- Medical devices, current sensors, etc.

Working: The Magnetic Tunnel Junction is a concept by which such low magnetic field strength can be sensed. The sensing mechanism consist of two layers one is pinned and other is free, the pinned layer is a magnetic layer which shows a fixed orientation in a specific direction and the free one is sense layer which senses the direction of applied magnetic field.This modulates the measured resistance in a wheat-stone based configuration means output voltage [21].

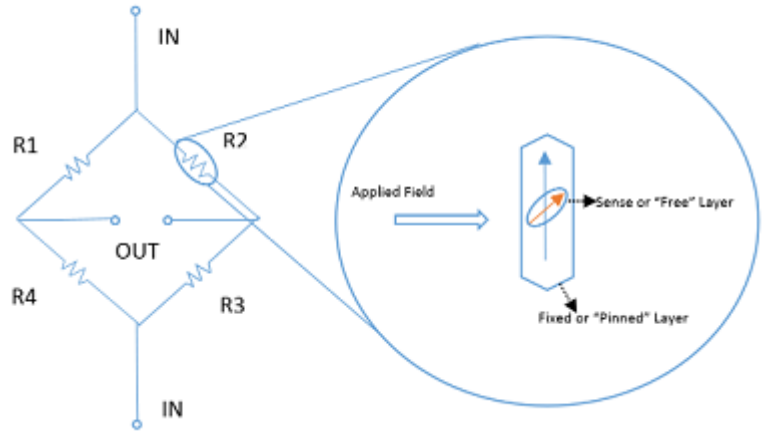

Figure 3.12: Configuration of Magnetometer [21]

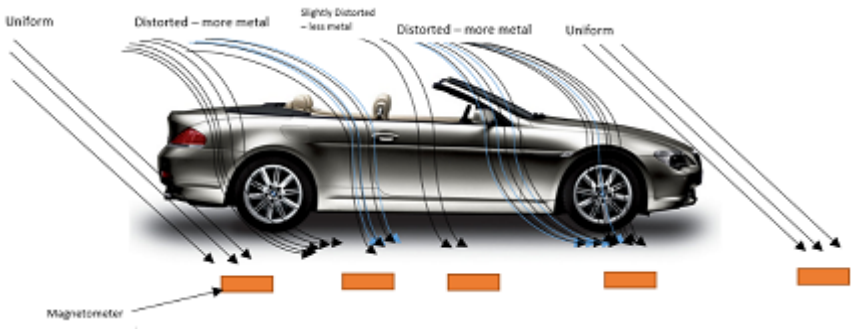

Figure 3.13: Earths magnetic field lines distorted by ferrous metal of the car [21]

Chapter 4

Software Design

4.1 Arduino IDE

Arduino integrated development environment (IDE) or Arduino software, which is a cross-platform application written in the programming language Java. It includes a code editor, a message area, a text console, a toolbar and many more other feature which makes its use easy and fruitful. There is a serial monitor which allows us to view and test the operation of the board. Arduino being the open source software, it is possible to add user developed libraries. Arduino supports many data logging clouds for storing the values of sensors so it makes programming easy for data logging [22].

The programs saved in the IDE are known as sketch and saved with the extension .ino. The IDE language can be expanded by using c++ libraries. It consists of two default loops:

- setup(): this function is called once when a sketch starts after power-up or reset. It is used to initialize variables, pin modes, start using libraries, etc [22].
- loop(): after setup() is called, this function is called repeatedly until the board powers off. It actively controls the Arduino board and allows the program to

change or respond. [22]

we can have other loops but these are the main and default loops which a program must have. After the process of compiling and linking with the GNU tool chain, the IDE employs the program avrdude to convert the executable code into a text file in hexadecimal coding that has to be loaded into the Arduino board by a loader program in the board's firmware [22].
Some built-in functions:

- Serial.begin(): This function is used to start the serial monitor and set the baud rate.
- Serial.print(): This is used to print the message or any value of the sensor on the serial monitor.
- analogRead(): This is used to read the value from the specified analog pin with a 10-bit resolution.
- analogWrite(): This is used to write a value on the analog pin which is specified.
- dealy(): This function pauses the program for the specified time which is in milliseconds.
- digitalRead(): This is used to read the value from the specified digital pin with a result of either high or low.
- digitalWrite(): This is used to specify either logic high or low on a digital pin.
- pinMode: This function is used to define the specified pin either to work as output or input.

4.2 Proteus Design Suite

Proteus is an electronic design automation tool. It is used for PCB designing, schematic designing and circuit simulation in real time. **Intelligent Schematic Input System**(ISIS) is a software in which we can do the schematic designing and simulation in real time. It has a wide variety of components and their libraries included in it for the designing purpose and we can add new libraries also to enhance our design. **Advanced Routing and Editing Software**(AREF) is used for PCB designing. AREF gives the advantage of viewing the output in 3D [23].

4.3 Fritzing

Fritzing is an open source, software tool used for designing electronics projects prototype. It is useful for everyone either the person is beginner or professional in building circuits.Fritzing community basically designed it for documenting projects, teaching purpose, sharing ideas and designs worldwide and printed circuit board manufacturing [24].

It is best for Arduino related projects because maximum parts can be found in the library plus in the updated version one can run the code too. So this can be considered as a whole package for Arduino projects [24].

4.4 Ubidots

Ubidots offers a platform for developers that enables them to easily capture sensor data and turn it into useful information. Use the Ubidots platform to send data to the cloud from any Internet-enabled device. You can then Configure actions and alerts based on your real-time data and unlock the value of your data through visual tools. Ubidots offers a REST API that allows you to read and write data to the resources available: data sources, variables, values, events and insights. The API

supports both HTTP and HTTPS and an API Key is required [25].

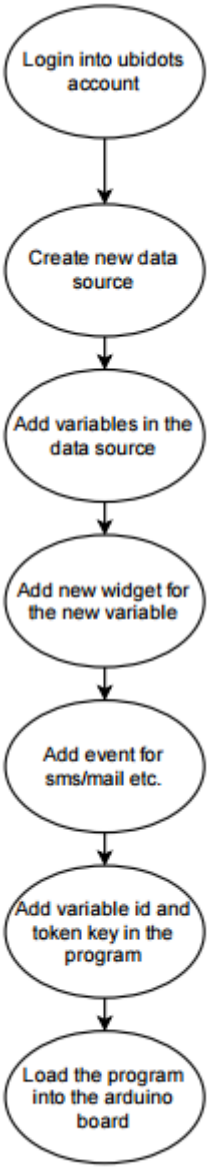

Figure 4.1: Ubidots Flowchart

4.5 Fuzzy Logic

In recent years the use of fuzzy logic for developing intelligent system has increased a lot. It is used in many applications like washing machine, camcorders, medical instrumentation and decision making systems.
Fuzzy works like a human brain, it can work with incomplete and imprecise information. The formation of fuzzy if-then rules is a key component of fuzzy system. The fuzzy set doesn't have crisp boundaries and the transition from one set to another is characterized by its membership functions.

4.5.1 Advantages of using Fuzzy Logic

There are many advantages of fuzzy logic which makes it useful to use it as decision-making technique in intelligent systems. The highlighted points are:

- Fuzzy logic is flexible and easy to understand as its concept belongs to simple set theory.
- Fuzzy can have multiple inputs/outputs and it can be used for both linear and non-linear types of data.
- Fuzzy logic can work with imprecise and partial data.
- It is not necessary that fuzzy will replace another decision making technique, it can also be used to augment the working of another conventional technique.
- Fuzzy logic works the way a human brain works as it was designed by keeping the same in mind.

4.5.2 Fuzzy Inference System

It is the framework based on fuzzy logic. The three main component of this framework is: fuzzy rule base, fuzzy database and fuzzy reasoning.

Fuzzy **R**ule **B**ase consist of fuzzy rules using if-then method. The fuzzy if-then rule also known as fuzzy implication, fuzzy rule or fuzzy conditional statement. Example, for one input and one output : if temperature is high then day is hot. Here temperature is the input, day is the output, high and hot are linguistic values defined by fuzzy set. Now there can be multiple inputs/outputs possible in fuzzy. The combination of "temperature is high" is known as antecedent and "day is hot" is known as consequent [26].

Fuzzy **D**atabase defines the membership functions used in the rule base. A membership function is a curve that shows how each point of the input space is mapped to a membership value in a defined range. There can be a multiple number of membership function to define the variables degree [26].

Fuzzy **R**easoning is a procedure for fuzzy inference. In this step conclusions are drawn from the if-then rule base and all the known information. In this process, the given input may or may not have a crisp value but the result produced is not a crisp value its always a fuzzy set. Therefore to get a crisp value of the output defuzzification is required [26].

There are three types of fuzzy models first is **Mamdani** Fuzzy Model, second is **Sugeno** Fuzzy Model and third one is **Tsukamoto** Fuzzy Model. In this project, Mamdani Model has been used. These all three models differ in rules, aggregation and deffuzification techniques.

4.5.3 Mamdani Fuzzy Model

The Mamdani Model was first applied to a steam engine and boiler combination. The method used in mumdani model is min-max, better description can be seen in the diagram: This figure explains the min-max, the min is used in the implication process and max is used for aggregation process. The detailed procedure is explained later in fuzzy inference process. To get the crisp output from the fuzzy set centre of area(COA) method is used.

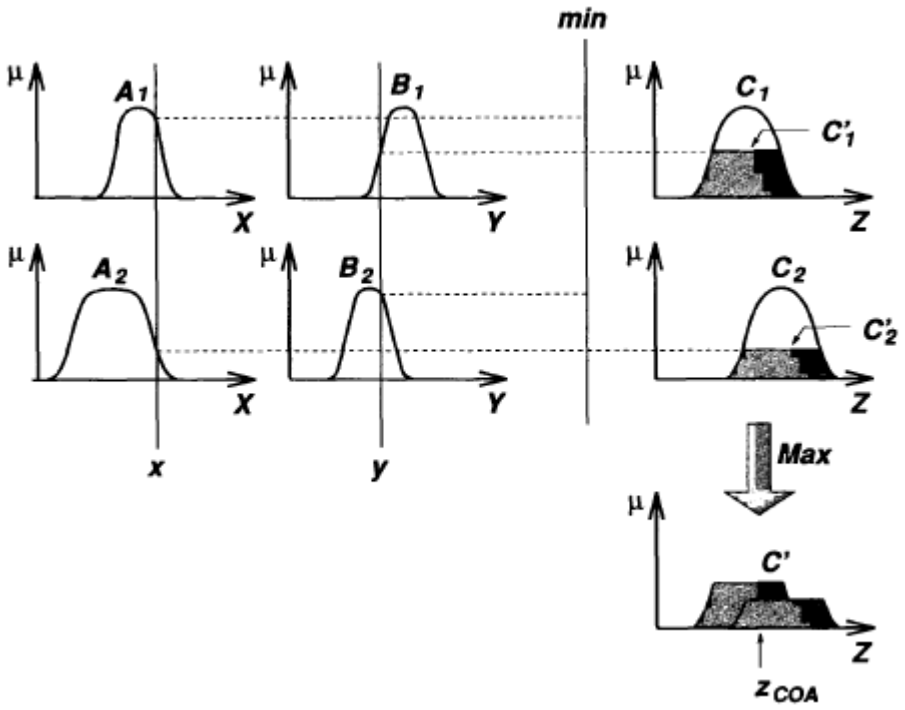

Figure 4.2: Mamdani Fuzzy Inference System using min-max [26]

4.5.4 Fuzzy Inference Process

Fuzzy inference is the process of mapping input-output using fuzzy set theory.In this project mamdani fuzzy inference system is used. This mapping then provides a rule book according to which decisions can be made on the situation.Fuzzy inference process comprises of following steps [27]:

a. **Fuzzify Inputs** The first step is to select the input and allocate it appropriate fuzzy set.

b. **Apply Fuzzy Operator** After the fuzzification is done, we have to choose the operator according to the output we require. The two standard operators are AND and OR. The method used in this project for AND operator is 'minimum' and for OR operator 'maximum'.

   In fuzzy one can also create it own operator according to the requirement, we only have to write a function for it and add it to the library of fuzzy.

c. **Apply Implication Method** The consequent is reshaped using a function associated with the antecedent. The input for the implication process is a single number given by the antecedent, and the output is a fuzzy set. The implication is implemented for each rule. Two built-in methods are supported, and they are the same functions that are used by the AND method: min (minimum), which truncates the output fuzzy set.

d. **Aggregate All Outputs** Decisions are based on the fuzzy rules and all the known facts. Aggregation is a process in which all the fuzzy set of outputs for every single rule is combined to produce a single fuzzy set. There exist three methods for aggregation one is maximum, second is probor and third one is sum but mamdani uses 'maximum'.

e. **Defuzzify** The input for deffuzification is an aggregated fuzzy set and the output is a single crisp value. For mamdani centroid method has been used which returns the centre of are under the curve.

Chapter 5

Testing

5.1 Software Testing

This chapter consist of all the outcomes of the project.

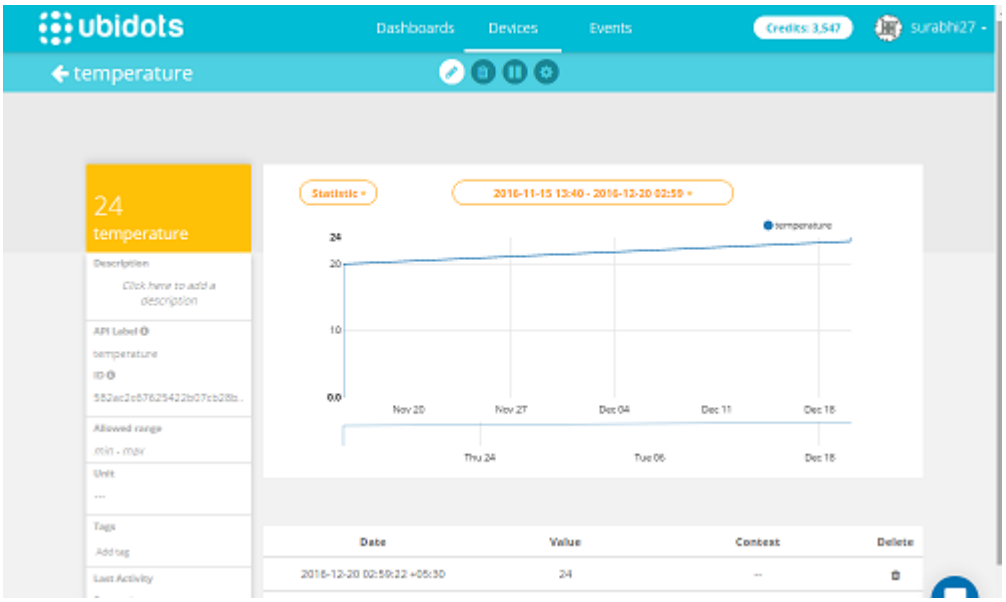

Figure 5.1: Ubidots temperature measurement flow chart

These pictures shows the cloud ubidots on which all the data like temperature, humidity and air quality has been recorded for analysis purpose.

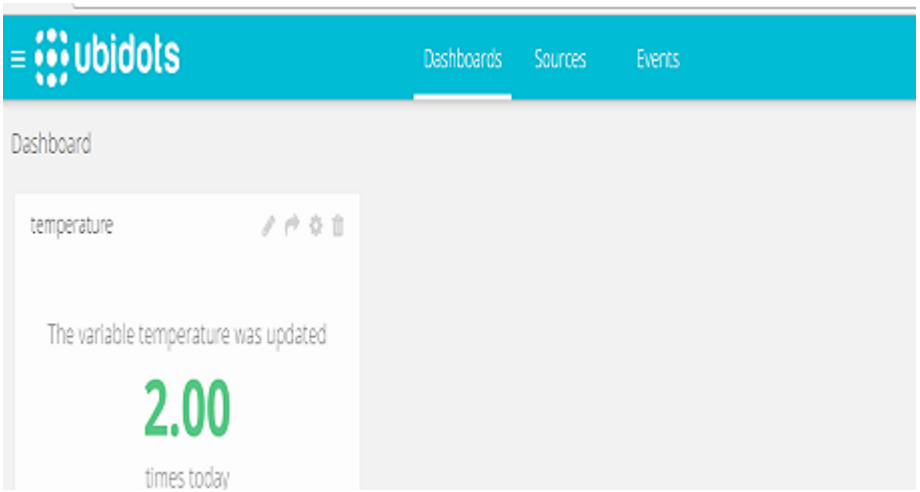

Figure 5.2: Ubidots Dashboard

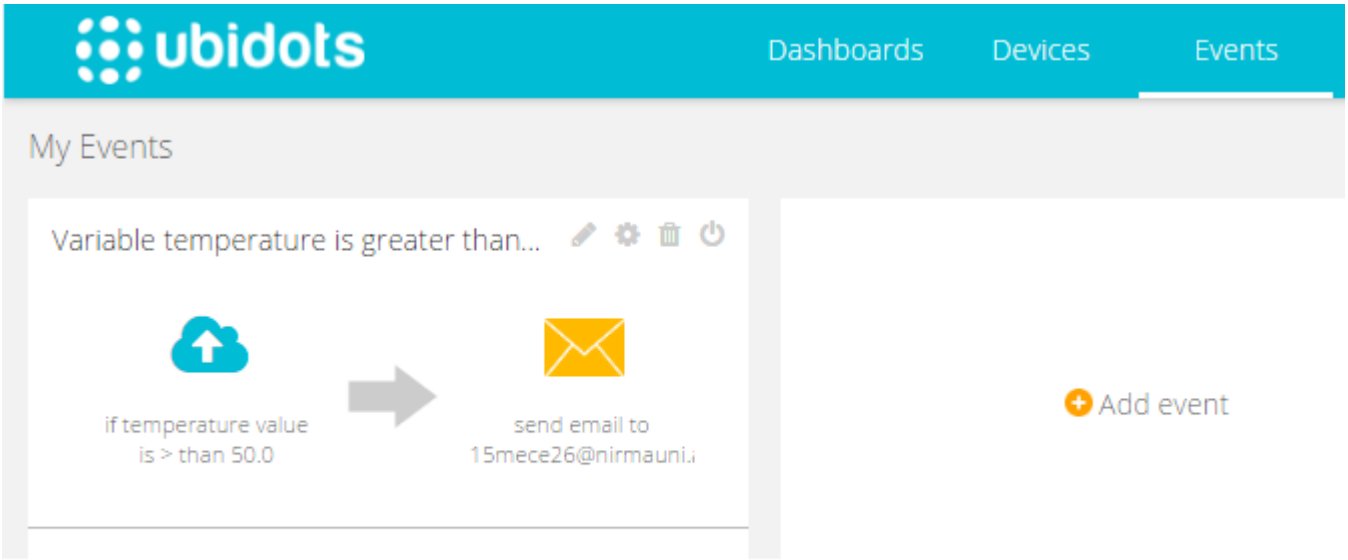

Figure 5.3: Ubidots Events List

Next this section consist of two flowchart for smart traffic light system and smart street light system.

The flowchart shows the flow of working of the smart street light circuit and smart intelligent traffic light circuit.

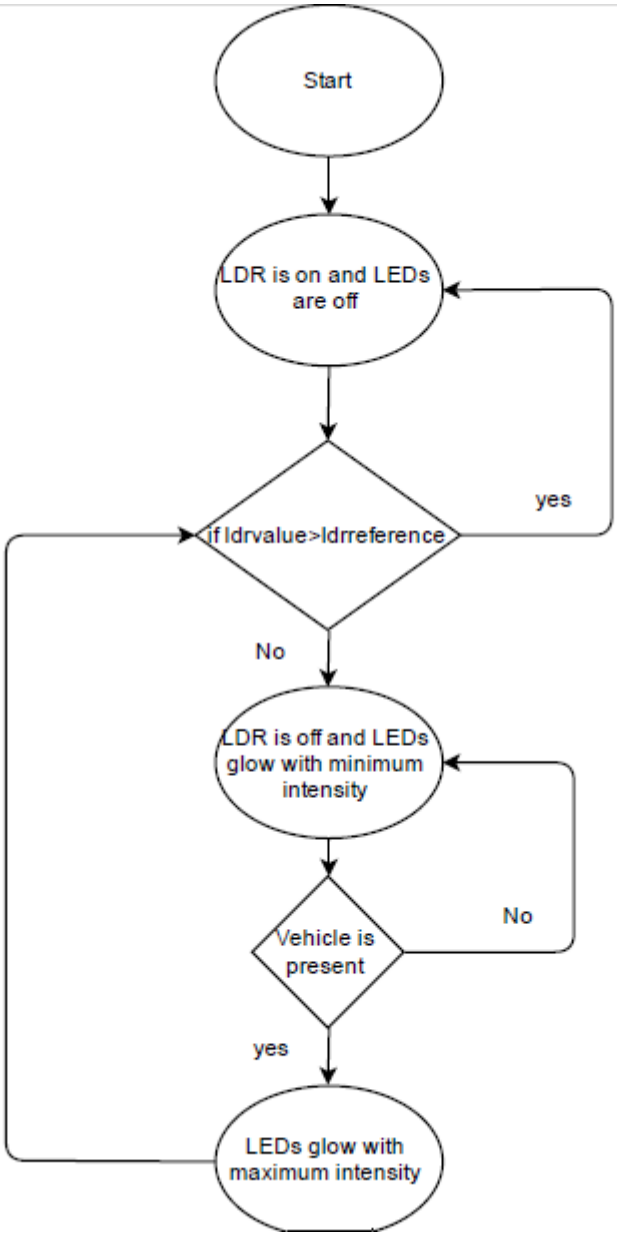

Figure 5.4: Smart Street Light Flow Chart

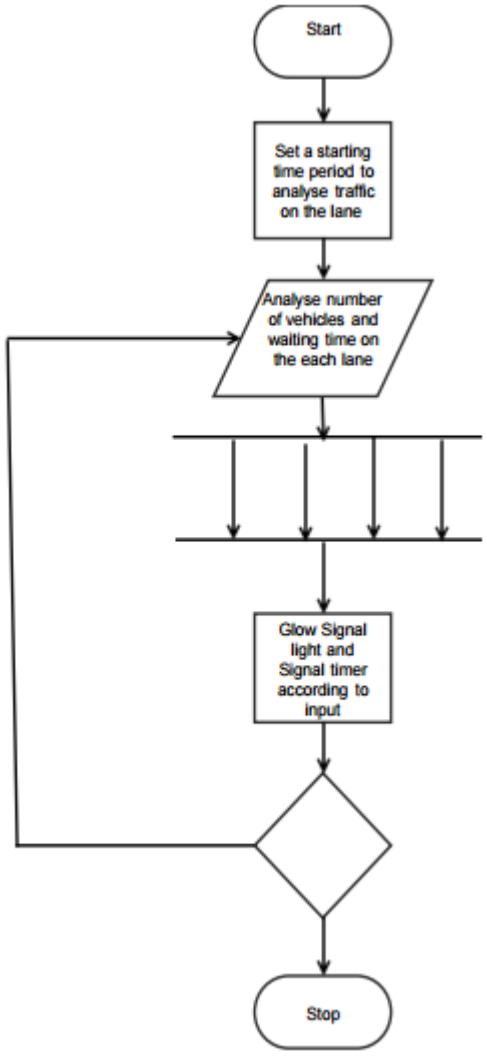

Figure 5.5: Intelligent Traffic Light Flow Chart

5.2 Hardware Testing

Hardware testing shows the rule table used for traffic light system. It also shows the outcome of every single rule in MATLAB. The circuits for both "Smart Street Light System" and "Smart Traffic Light System" are drawn in fritzing and there testing is successfully done.

Table 5.1: Fuzzy Logic Rule Base for Intelligent Traffic System

Rule No.	No. Of Vehicles	Waiting Time	Signal	Signal Time
1.	Low	Less	Red	High
2.	Low	Mean	Yellow	Average
3.	Low	High	Green	Short
4.	Medium	Less	Red	Short
5.	Medium	Mean	Yellow	Short
6.	Medium	High	Green	Average
7.	High	Less	Green	Average
8.	High	Mean	Green	High
9.	High	High	Green	High

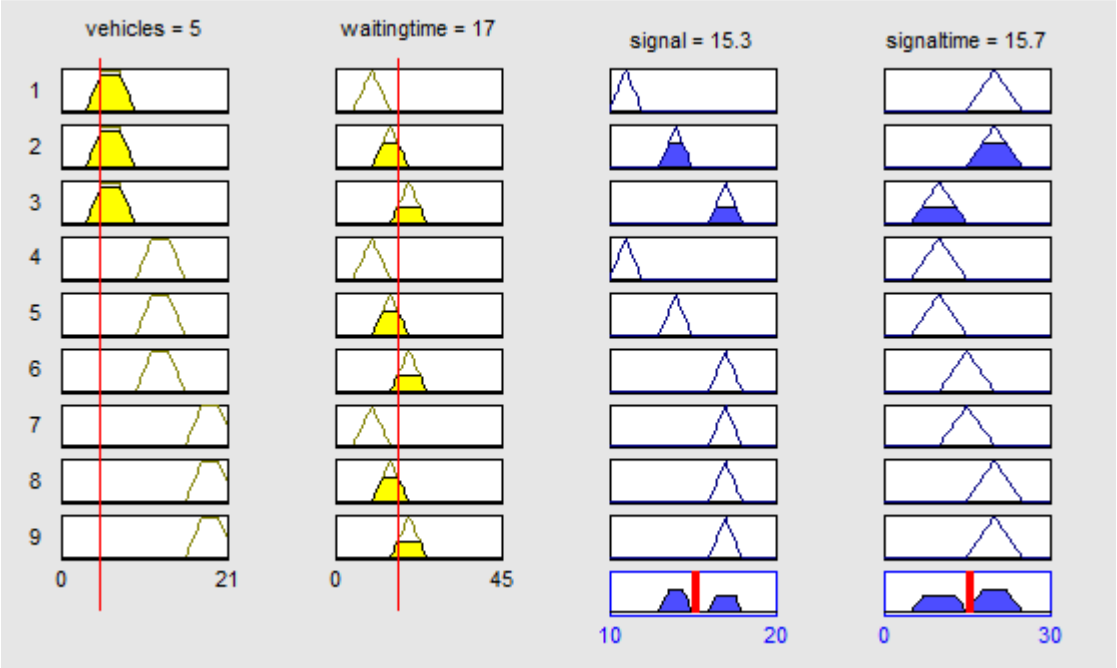

Figure 5.6: Fuzzy Rule Two

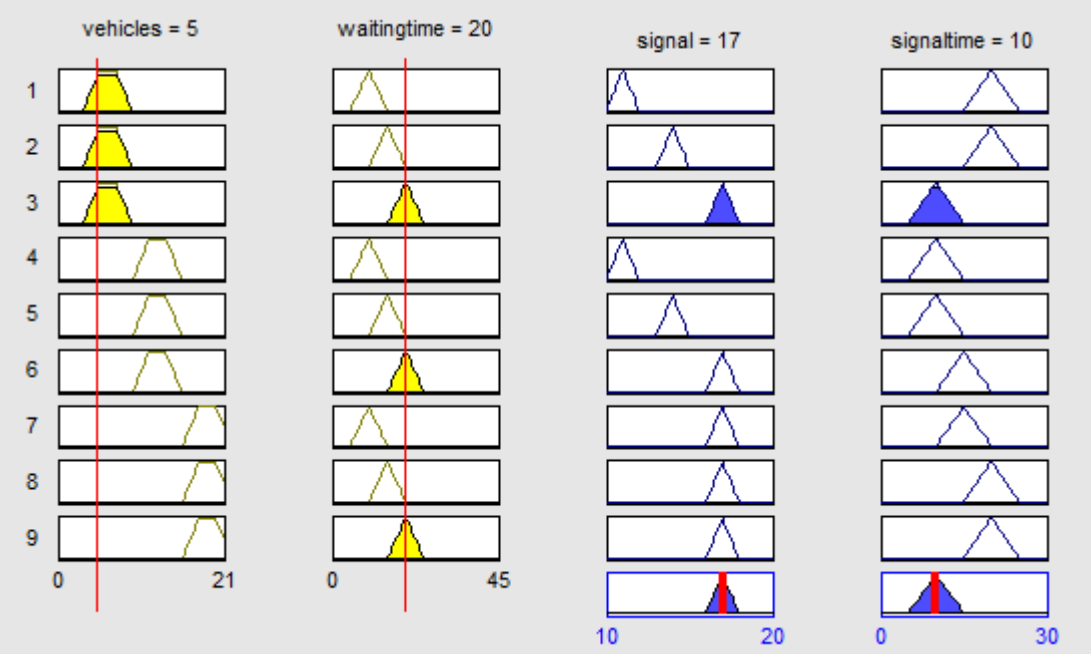

Figure 5.7: Fuzzy Rule Three

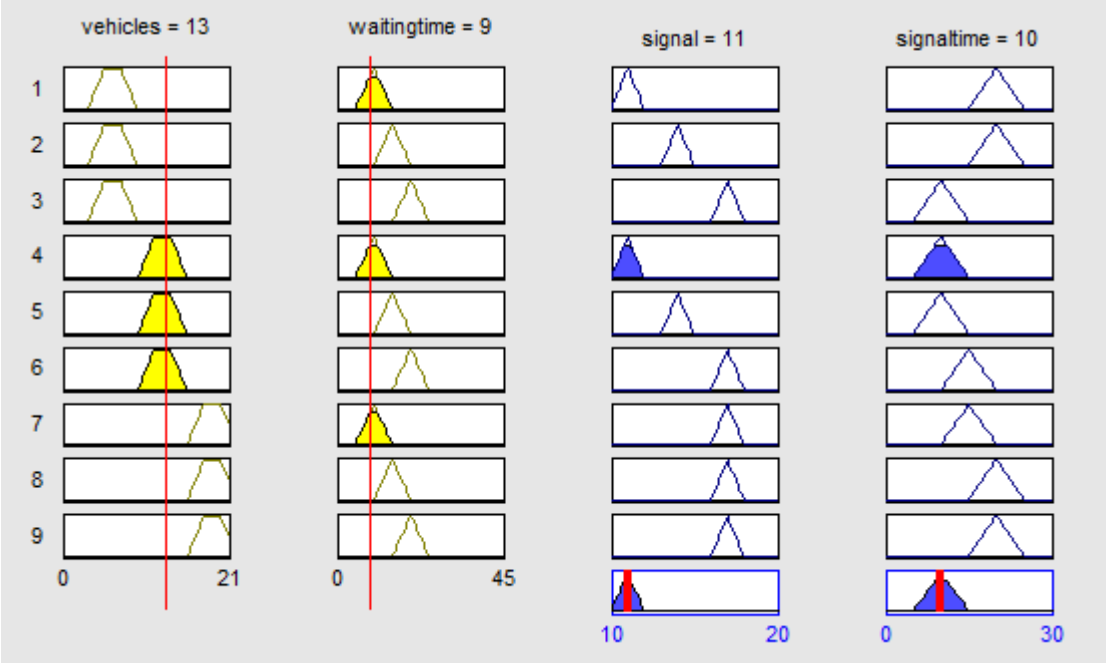

Figure 5.8: Fuzzy Rule Four

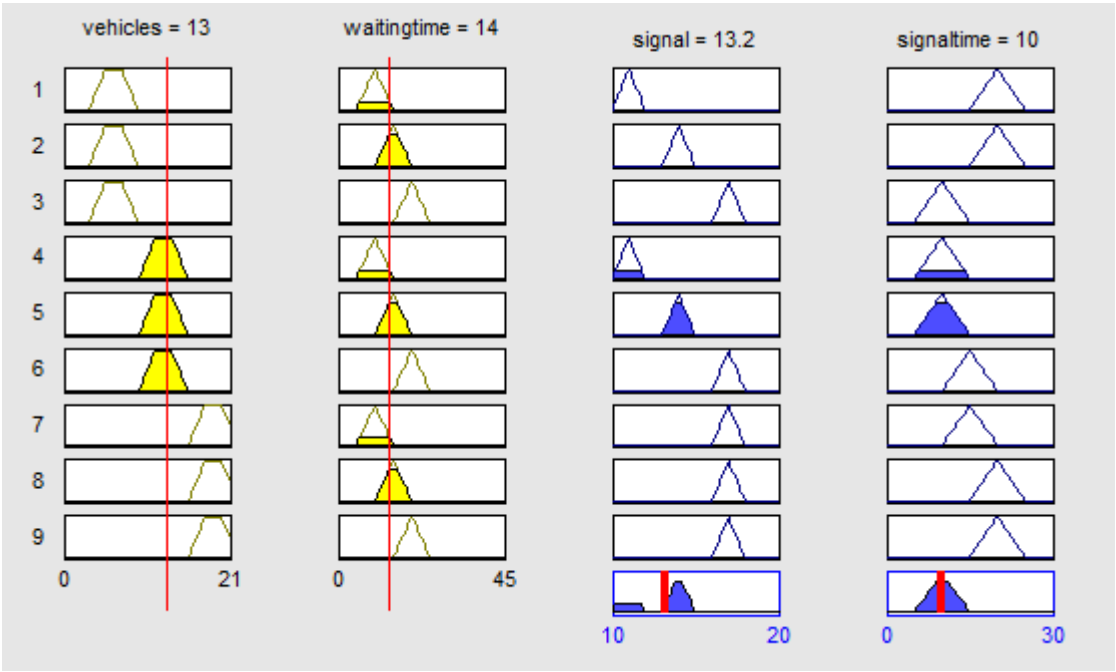

Figure 5.9: Fuzzy Rule Five

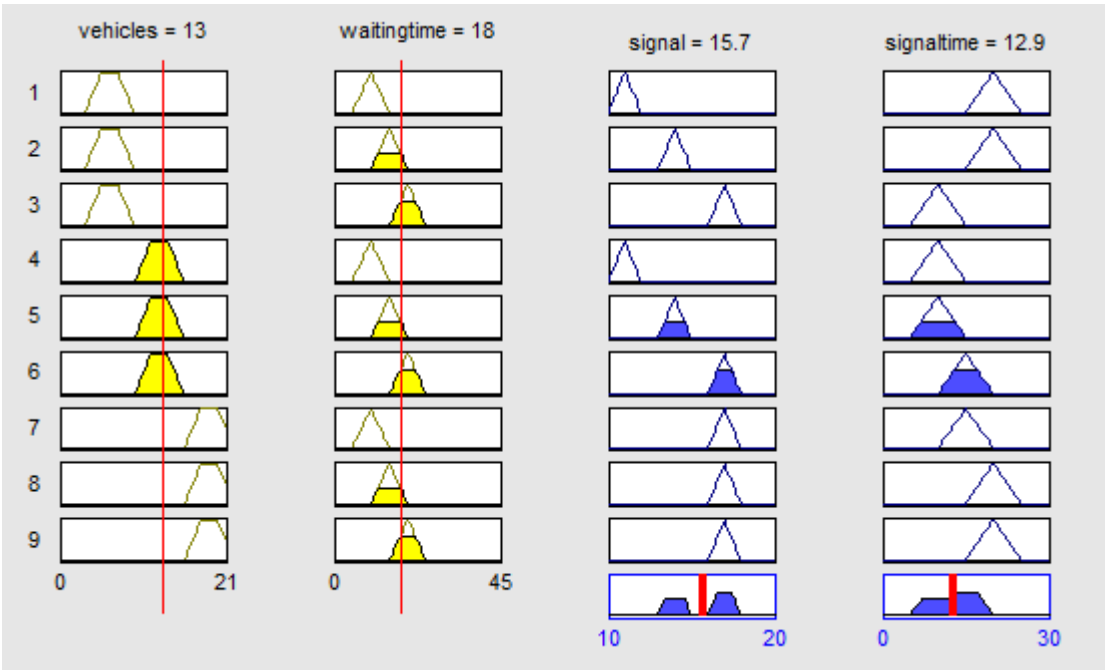

Figure 5.10: Fuzzy Rule Six

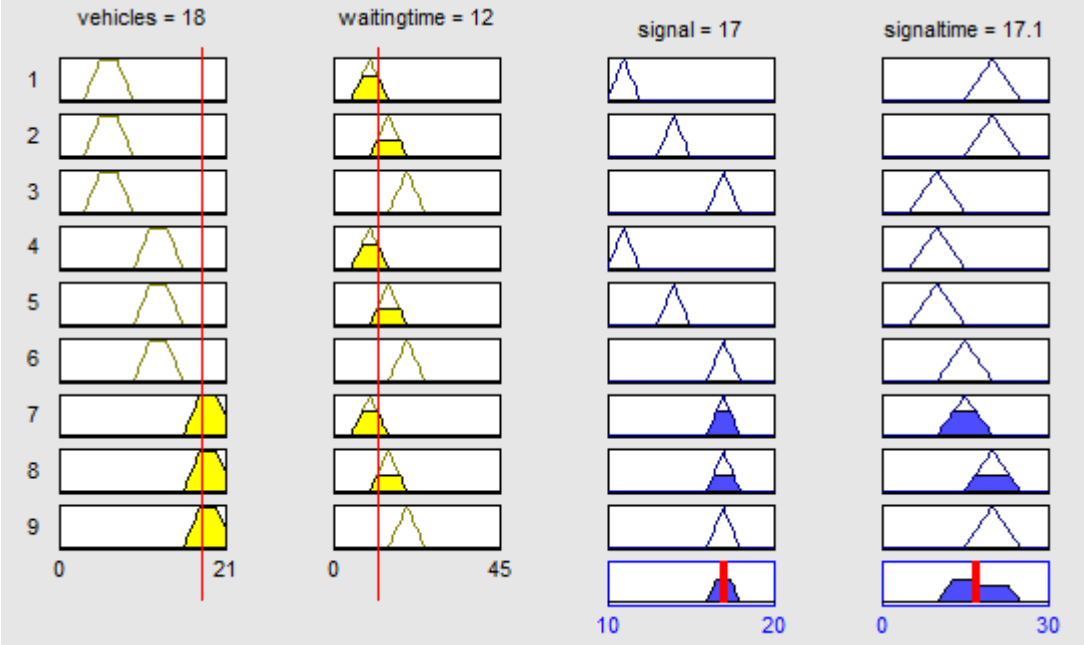

Figure 5.11: Fuzzy Rule Seven

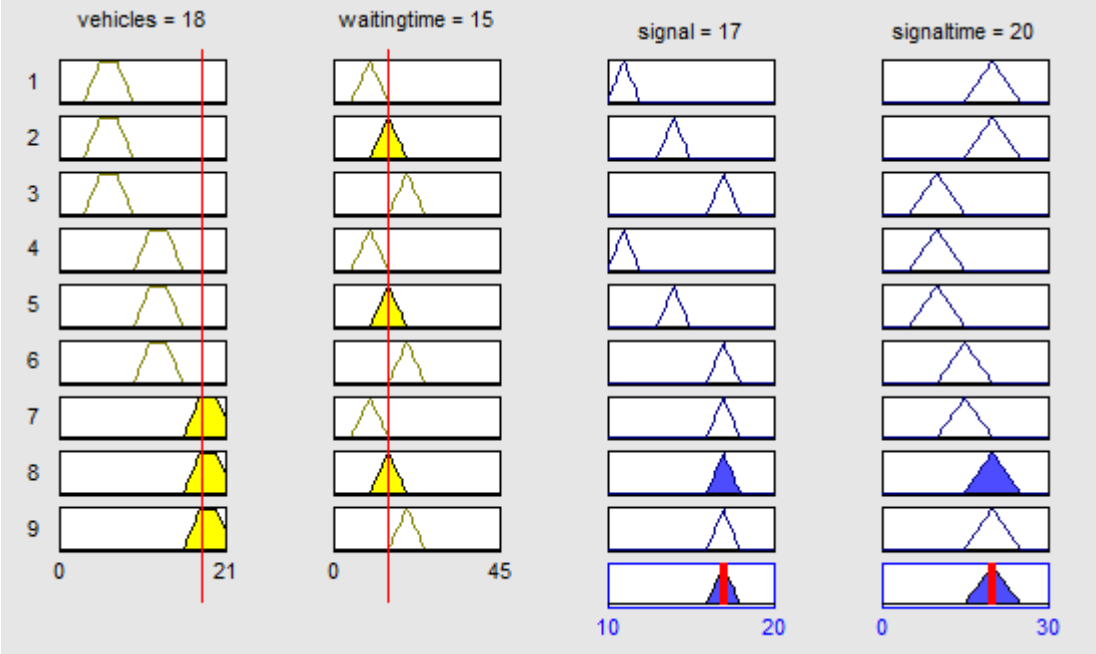

Figure 5.12: Fuzzy Rule Eight

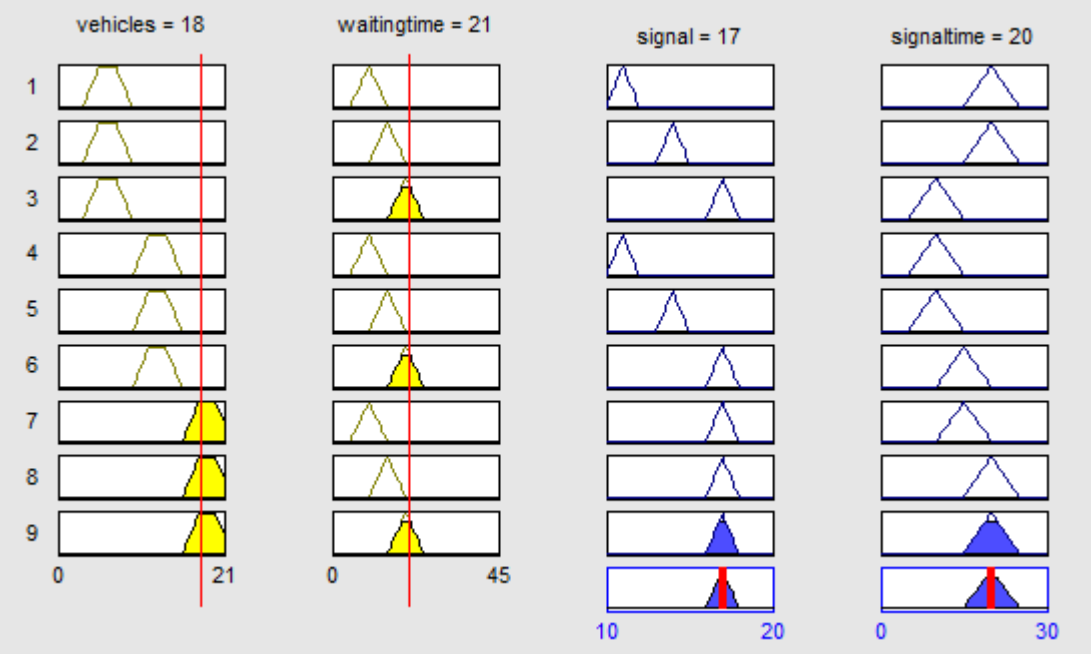

Figure 5.13: Fuzzy Rule Nine

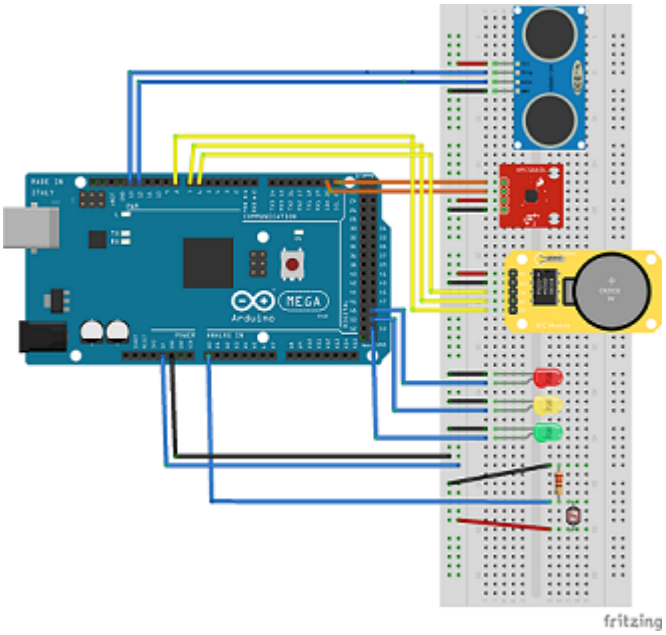

Figure 5.14: Intelligent Traffic Light Diagram

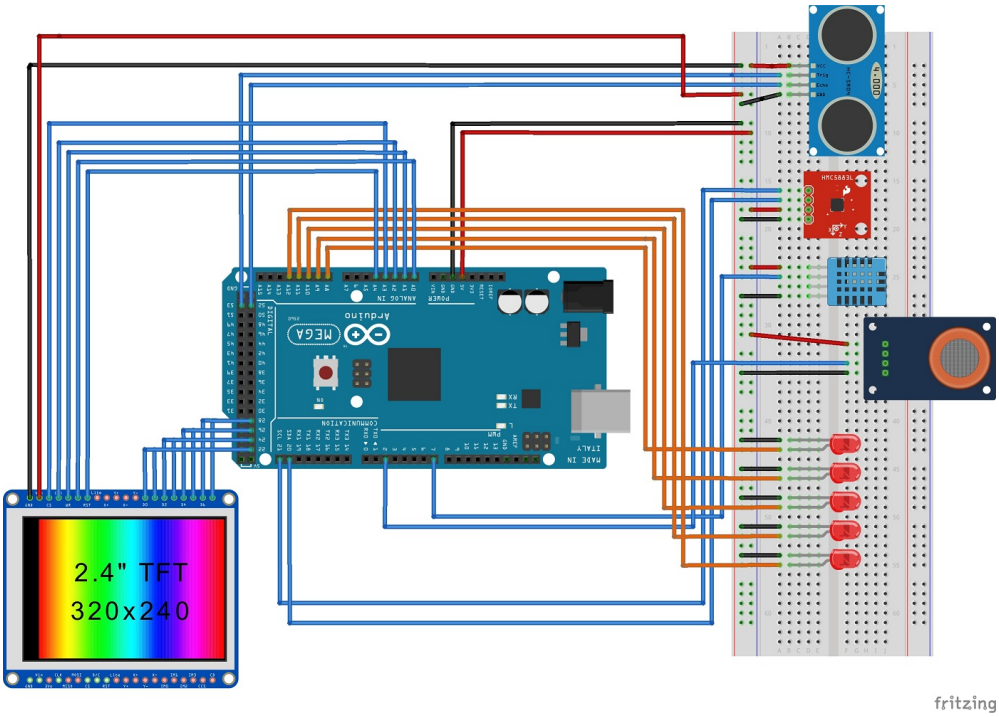

Figure 5.15: Smart Street Light System

Chapter 6

Conclusion and Future Scope

6.1 Conclusion

The main objective of this project is to develop an Intelligent Traffic Management System using a decision-making technique. The objective has been successfully achieved along with the required testing. The Arduino Mega 2560 controls the sensors for vehicle detection, light intensity detection and real time clock very effectively. The gas sensor and temperature sensor monitors the environmental parameters quite accurately. These circuits will prove very helpful for improving the current traffic scenario. Fuzzy logic is used for decision making, though it is an old technique but it is an exemplary method to augment the working of any system as it has the potential to work like a human brain.

6.2 Future Scope

There is always a possibility for improvement in every project. More sensor parameters can be added to improve its working, like seismic sensors can be added for alert and prediction for disaster prone areas.

Bibliography

[1] @articlelanke2013smart, title=Smart Traffic Management System, author=Lanke, Ninad and Koul, Sheetal, journal=International Journal of Computer Applications, volume=75, number=7, year=2013, publisher=Foundation of Computer Science

[2] @articledhar2008traffic, title=Traffic and Road Condition Monitoring System, M, author=Dhar, Ashish, journal=Tech. Stage, volume=1, year=2008, publisher=Citeseer

[3] @phdthesismeher2015design, title=Design and Implementation of Smart-Street Light System Using ARDUINO UNO, author=Meher, Swadhin, year=2015

[4] R. R., Proximity Sensor, RON ROBOTICS, 14-Oct-2016. [Online]. Available: http://www.rakeshmondal.info/sensors/proximity-sensor. [Accessed: 13-September-2016].

[5] @articlearduino2014arduino, title=Arduino Mega 2560, author=Arduino, CC, journal=Internet: http://arduino. cc/en/Main/ArduinoBoardMega2560,[Nov., 2013], year=2014

[6] Mouser Electronics," Arduino Ethernet Shield", A000056-DATASHEET.

[7] A. Industries, Adafruit 2.4" TFT LCD with Touchscreen Breakout w/MicroSD Socket, adafruit industries blog RSS. [Online]. Available: https://www.adafruit.com/product/2478. [Accessed: 13-November-2016].

[8] R. W. D. Team, 2.4 inch Arduino Touch LCD Shield, Robokits India. [Online]. Available: $http://robokits.co.in/arduino/shield/2.4-inch-arduino-lcd-shield$. [Accessed: 22-September-2016].

[9] IoT-playground, iot-playground/Arduino, GitHub, 01-Feb-2015. [Online]. Available: https://github.com/iot-playground/Arduino/tree/master/external-libraries/DS1302RTC. [Accessed: 10-April-2017].

[10] Maxim Integrated,ds1302 pinout - Google Search, ds1302 pinout - Google Search. [Online]. Available: https://www.google.co.in/search?q=ds1302

[11] Robokits, " MQ-2 SENSOR", datasheet.

[12] Robokits, " MQ-135 SENSOR", datasheet.

[13] DHT11-google search,dht11 - Google Search. [Online]. Available: https://www.google.co.in/search?q=dht11source=lnmstbm=ischsa=Xved=0ahUKEwjes6G9w-zTAhUKRo8KHUbXBIkQ-AUIBigBbiw=1366bih=662imgrc=DlScuKXaFN8i6M: [Accessed: 13-November-2016].

[14] DHT11 - Humidity and Temperature Sensor, Sunrom Electronics. [Online]. Available: http://www.sunrom.com/p/dht11-humidity-and-temperature-sensor. [Accessed: 11-Sepetember-2016].

[15] Light Dependent Resistor — LDR and Working Principle of LDR, electrical4u. [Online]. Available: https://www.electrical4u.com/light-dependent-resistor-ldr-working-principle-of-ldr/. [Accessed: 14-march-2017].

[16] ultrasonic sensor - Google Search, ultrasonic sensor - Google Search. [Online]. Available: https://www.google.co.in/search?q=ultrasonic

[17] Ultrasound, sensors:ultrasound SensorWiki.org, 14-Apr-2016. [Online]. Available: http://sensorwiki.org/doku.php/sensors/ultrasound. [Accessed: 7-September-2016].

[18] R. W. D. Team, HC-SR04 Ultrasonic Sensor Distance Measuring Module, Robokits India. [Online]. Available: http://robokits.co.in/sensors/ultrasonic-sensor/hc-sr04-ultrasonic-sensor-distance-measuring-module. [Accessed: 13-August-2016].

[19] Honeywell Microelectronics and Precision Sensors,"Magnetic Sensors Product Catalog",Catalog-2015.

[20] Robokits,"Triple Axis Magnetometer-HMC5883L",DATASHEET.

[21] A. Sivakumar, NXP Home ¿, NXP Blog, 30-Sep-2015. [Online]. Available: https://blog.nxp.com/connected-car/howto-detect-vehicle-presence-or-movements-with-magnetometers. [Accessed: 13-May-2017].

[22] Arduino, Wikipedia, 09-November-2016. [Online]. Available: https://en.wikipedia.org/wiki/Arduino. [Accessed: 29-November-2016].

[23] Proteus Design Suite, Wikipedia, 28-Apr-2016. [Online]. Available: https://en.wikipedia.org/wiki/Proteus-Design-Suite. [Accessed: 13-December-2016].

[24] Fritzing Publishers," Fritzing Information Brochure",fritzing.org-2017

[25] Accelerate Internet of Things Innovation, IoT platform — Internet of Things — Ubidots. [Online]. Available: https://ubidots.com/. [Accessed: 10-Novemer-2016].

[26] @articlejang1997neuro, title=Neuro-fuzzy and soft computing, a computational approach to learning and machine intelligence, author=Jang, Jyh-Shing Roger and Sun, Chuen-Tsai and Mizutani, Eiji, year=1997

[27] Documentation, Fuzzy Inference Process - MATLAB Simulink - MathWorks India. [Online]. Available: https://in.mathworks.com/help/fuzzy/fuzzy-inference-process.html. [Accessed: 1-March-2017].

[28] @articlevidhya2014density, title=Density based traffic signal system, author=Vidhya, K and Banu, A Bazila, journal=International journal of innovative research in science, engineering, and technology, volume=3, number=3, pages=2218–2223, year=2014

[29] @articleYawle2016Smart, title=Smart Traffic Control System, author=Prof.R.U.Yawle, Kiran.K.Modak, Parmeshwar.S.Shivshette, Snehal.S.Vhaval, journal=International Journal of Electronics and Communication Engineering, volume=3, issue=3, year=2016

[30] @articlesemarak1996intelligent, title=Intelligent traffic lights control by fuzzy logic, author=Semarak, Jalan, journal=Malaysian Journal of Computer Science, volume=9, number=2, pages=29–35, year=1996