Garbage Level Detector Based on OSM Identifying Shortest Path

B.E. (CS) PROJECT REPORT

by

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ABSTRACT

Garbage monitoring and collection is one of the biggest problem and challenge of our city due to its large population. To solve this problem a system is built for garbage collection that is cost-effective as well as time saving. The main purpose of this project is to introduce a system for garbage collection which will reduce time and effort of the waste management authorities of Karachi. The proposed garbage collection system consists of two modules i.e. the hardware module and the android mobile application. The hardware module consists of Arduino microcontroller board, ultrasonic level sensor to detect the level of the garbage of bins and a Wi-Fi module for sending the sensor's data to the mobile application and also the shortest path towards the bin. When the level of the garbage becomes seventy percent filled the hardware installed on the bin will notify the driver to collect garbage from it. The android application installed on cell phone of driver of the vehicle will notify him about the level of the garbage and will provide the shortest path towards the bin. The application will reduce driver's effort and time required to identify the filled bins and collect garbage from the same. The proposed system will reduce the fuel consumption and time of collection several times compared to existing garbage collection process

ACKNOWLEDGEMENTS

First of all we thank Almighty Allah, the most gracious and the most merciful, for giving us strength to complete this project successfully. Then we would like to thanks our parents and friends who constantly support us in our difficult times during this project.

We would like to express our deepest gratitude to Dr. Saneeha Ahmed (Internal Advisor) who supported us though our project in every possible way. She always encouraged us despite of all the difficulties in making this project and appreciates us at every step. She advised us in the best way and suggested us solutions to our problems. It would be really impossible for us to complete this project without her endless support.

In the end, we would like to thank our advisory committee which has helped us in making right decisions regarding our project.

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CHAPTER 1

1 INTRODUCTION

1.1 OVERVIEW OF PROJECT

The population of Karachi city is increasing at a rate of 5% per year. Due to the increasing population, Karachi is facing many serious problems among which inefficient and old method of garbage monitoring and collection is one of them. Currently, there is no effective system for garbage collection and therefore several harmful diseases are rapidly spreading in our city effecting its citizens. The citizens of Karachi urgently needs a proper and effective method for garbage collection that will help them in maintaining cleanliness in their city.

In order to provide efficient garbage collection mechanism, an Internet of Things (IOT) based system is proposed. This system consists of two parts. The first component is the hardware device which will be installed on the bin and will detect garbage level in the bins. The second component is the android application that has been built for the driver of the vehicle collecting the garbage from the bins.

The system uses low cost equipment that is easily available in the local market. The hardware is designed using WEMOS D1 R1 ESP Board, ultrasonic level sensor HC-SR04. Ultrasonic level sensor is used to detect the level of the garbage in the bins and Wi-Fi module is used to provide Wi-Fi connectivity for Arduino board so that the sensor data consisting of garbage level is sent to the mobile application.

The android mobile application uses Java language and is built for the person responsible for collecting the garbage from the bins. The application will give two types of information to the driver First is the level of the garbage in the bins and the other is about the location of the bin from the location a shortest path is displayed on the google map..

One of our main focus of this project is to design such a device that will enable the person collecting the garbage to collect it before the bin is completely filled. In this way the bin will be emptied by the garbage collecting person before it is overloaded with the garbage causing problems for the people.

1.2 MOTIVATION AND NEED

Garbage collection and monitoring is a big problem globally and is even more severe in Karachi city. During past several years the city of Karachi has turned into huge pile of waste. While some municipal workers can be seen driving through the streets, many of the houses cannot be reached by these drivers due to huge population, crowded streets, delays in accessing locations, and large amount of efforts required to collect waste from door to door making the process of garbage collection a very tedious and difficult task for garbage collecting authorities of Karachi.

The main motive of this project is to provide solution for Pakistan's waste management. This project will enable the driver of Karachi's waste collection trucks to compute efficient routes towards the filled bins. This project will reduce time and effort of the waste management authorities.

1.3 OBJECTIVES OF OUR PROJECT

The main objectives of this project are:

- To build a cost-effective device for the detection of garbage level in the bins.
- To reduce the fuel consumption of the garbage collecting trucks by giving them shortest path towards the bin.
- To develop a user-friendly application for the garbage collecting person so that he will easily find the

  This project will be a step to make our city clean because if the trash bins are emptied regularly so there will be no trash outside the bins and the city will be cleaner than before.

1.4 BENEFITS OF PROJECT

This project will be helpful in the new societies that are emerging in Karachi like Bahria town or KMC. This project will be very helpful for the collection of the garbage from user's doorstep. The mobile app will allow drivers of municipal trucks to find the shortest possible path and save time and fuel required to reach the desired locations.

The system is made cost-effective so that the garbage cleaning authorities will easily implement it in different areas. The device will notify the driver about the level of the garbage before it is overfilled with the garbage so the bins will be emptied before they are completely filled with garbage. This will help in creating a clean and better environment for the people.

CHAPTER 2

2 LITERATURE REVIEW

2.1 BACKGROUND STUDY

Waste management is a global problem to which no effective solution has been developed. The best efforts have been demonstrated by Swiss and American waste management authorities by using the garbage as a fuel source and educating people about recycling. However, timely collection of garbage is still a unresolved problem. Even in technologically advanced countries, the garbage truck has to visit door to door in order to collect the waste. The citizens are responsible for placing the filled bins outside of their homes for collection. In case the house owner is out of station and does not replace the bin, the garbage truck will at least visit the locality only to find the empty bins. As the drivers of these trucks have to visit several streets in limited hours their precious time and fuel can be saved by alerting them about the status of the bin. The remarkable works done for efficient waste management will be discussed in the next subsection.

2.2 RELATED WORK

The work that has been done up till now in this domain is discussed below:

2.2.1 SMART WI-FI DUSTBIN SYSTEM

In this system there is a smart dustbin which is based on the concept of internet of things. The system is designed in a way that a numeric code is generated whenever the waste is shoved into the trash bin. This code is used to

activate Wi-Fi module which will later transmit the bin status to the Wi-Fi module on android phone [1].

2.2.2 IOT BASED SMART GARBAGE DETECTION SYSTEM

This garbage detecting system is based on Arduino microcontroller board and sensors. The smart garbage bins are equipped with the sensors for the detection of garbage. The garbage is monitored by using a web page.

The proposed system will allow citizens to actively participate and log their complaints regarding the garbage monitoring .Moreover the concerned authorities will also get the opportunity to monitor the status of the streets' waste bins through a web based application [2].

2.2.3 IOT BASED WASTE MANAGEMENT SYSTEM FOR SMART CITY

This system is designed to prevent the rain water from entering into the trash bins. For this purpose, the system first detects the rain and then closes the lid of the trash bin to prevent it from rain water. When there is no raining then the lid of the bin remains open.

When the installed Ultrasonic sensors reaches a predefined value, a message is sent to the responsible person containing the status and location of the bin.

The authorities will have access to the information about the bins using Wi-Fi [3].

2.2.4 IOT BASED GARBAGE MONITORING SYSTEM

In this garbage monitoring system the trash bins are connected with the Wi-Fi module.

To monitor the garbage level, the system is connected with microcontroller board, ultrasonic sensor and GSM module. The working principle of this system is that the sensor will detect the level of the trash and then it will send the sensor's data to the microcontroller board.

The data that is being sent to the microcontroller will be then observed and processed and in this way the level of garbage can be monitored on weekly basis [4].

2.2.5 MULTI PURPOSE GARBAGE MONITORING SYSTEM USING IOT

In this system a garbage management system is built using different types of sensors for the detection of garbage level and weight. The garbage level is detected by level sensor and the weight is determined by using weight sensors that are placed at the bottom of the trash bin.

The information about garbage level and weight is sent to the garbage cleaning authorities [5].

2.3 OUR SYSTEM COST

The above projects and solutions we have discussed have many advantages but they are extremely costly and cannot be afforded by common people.

Keeping this in mind we focused to make such a project that will be cost-effective and will also work effectively so that it can be used by the waste management authorities.

The total cost of our project is given below:

Table 2.1 Cost of Project

Hardware Component	**Quantity Used**	**Cost**
WEMOS D1 R1 ESP Board	1	Rs. 1000/-
Ultrasonic Sensor Module HC-SR04	1	Rs. 400/-
Battery	1	Rs.200/-

The total cost of our project is: Rs.1600/-

CHAPTER 3

3 ARCHITECTURE OF PROJECT

3.1 HARDWARE ARCHITECTURE

The system is divided into two modules that are hardware and software module. The hardware components that are used to build the hardware module are mentioned below:

3.1.1 ULTRASONIC LEVEL SENSOR

In this project an ultrasonic sensor HC-SR04 has been used that provides sound based navigation and ranging to find the distance to an object. The sensor has high accuracy and sensitivity.

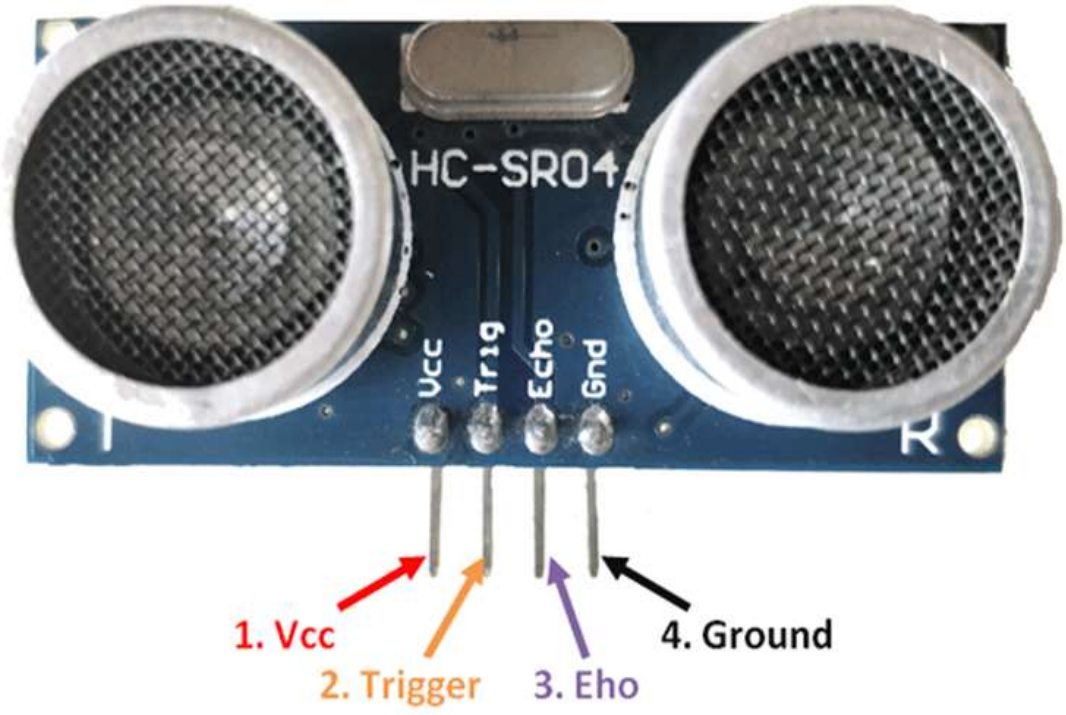

Figure 3.1 Ultrasonic Level Sensor HC-SR04

3.1.1.1 PIN CONFIGURATION OF ULTRASONIC LEVEL SENSOR

There are total four pins in an ultrasonic level sensor namely:

- **VCC PIN**

VCC is the pin that powers the ultrasonic level sensor. The input voltage required to power an ultrasonic level sensor is 5 Volts.

- **GND PIN**

This pin is connected to the ground of the system for which we are using the ultrasonic level sensor.

- **TRIGGER PIN**

It is the input pin of sensor. It generates a pulse that strikes to the object to which we have to find the distance.

- **ECHO PIN**

It is the output pin of sensor. It receives the pulse and the microcontroller finds the distance to the object by reading this pin.

3.1.1.2 FEATURES OF ULTRASONIC LEVEL SENSOR

Table 3.2 Features of HC-SR04 Sensor

Operating Current	15mA
Operating Frequency	40Hz
Required voltage to power the sensor	5V
Measuring Angle	15

Range of finding distance	2cm-400cm

3.1.1.3 WORKING OF HC-SR04 SENSOR

The ultrasonic level sensor works in the following three steps. There are two modules present in an ultrasonic level sensor.

1. First, the transmitter module of sensor emits an ultrasonic wave which propagates through air and then strike the object present in its way. The ultrasonic wave travels though speed of sound in the air.
2. When the wave strikes the object it is reflected back to the sensor.
3. The reflected wave is received by the receiver module of sensor. [7]

The working of ultrasonic sensor can be understood by the figure given below.

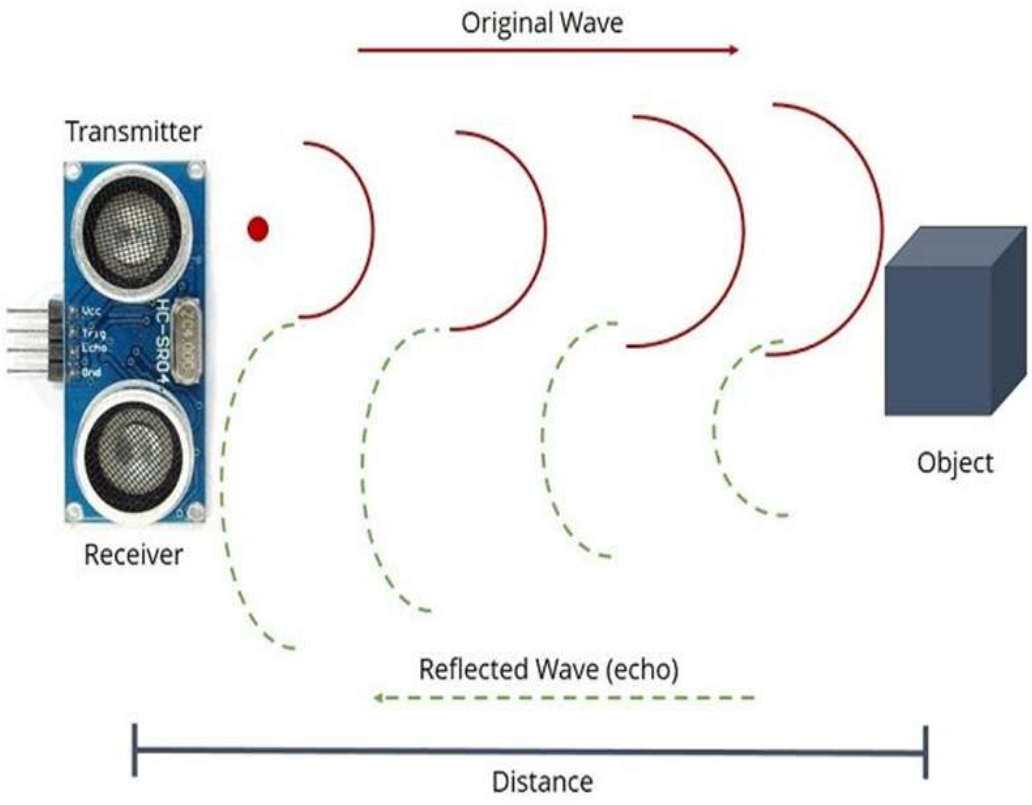

Figure 3.2 Working of HC-SR04 Sensor

The basic working formula of level sensor is based on the formula of distance:

Distance=Speed*Time

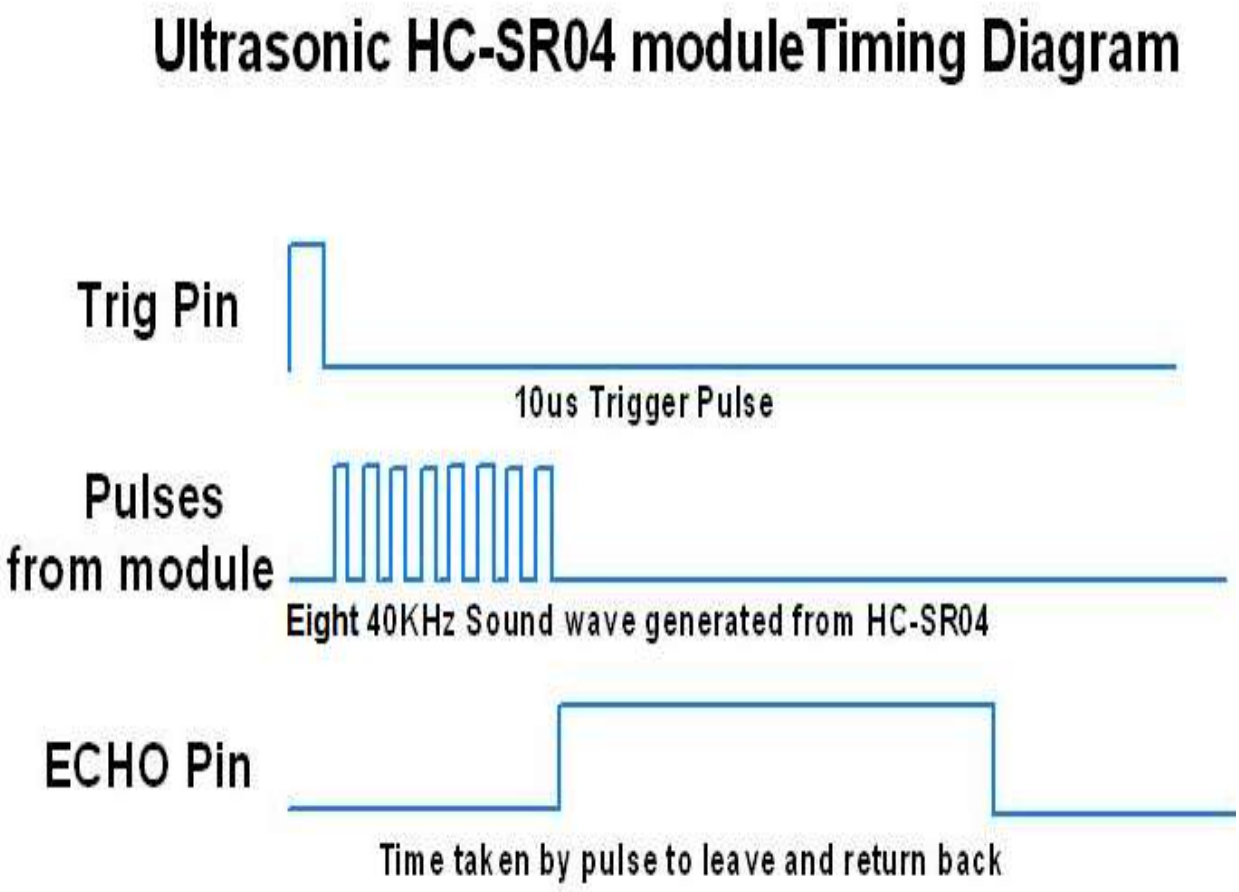

Figure 3.3 Timing Diagram of HC-SR04

Ultrasonic level sensors are a great choice for detecting level of anything because it has a number of benefits such as:

- These sensors works on ultrasonic waves so it does not matter which color the object is or if the object is transparent or not. The senor will just emits a wave so the color of the object has no significance for ultrasonic sensors.
- Ultrasonic sensors are not affected by the environment where it is being used whether it is operated in sunlight or in dark.

- ✦ Level sensors are very easily available in the market and they are not expensive at all.
- ✦ The working of ultrasonic sensor is very easy and therefore it can be easily used. It is not harmful for the surrounding environment and people. [8]

3.1.2 WIFI ESP8266 DEVELOPMENT BOARD WEMOS D1

WEMOS is a Wi-Fi development board which is based on ESP8266 12E. WEMOS D1 is built similarly to Arduino UNO.

By selecting D1 board from Arduino IDE Tools menu we can directly program WEMOS D1 board without using another Arduino microcontroller board. [9]

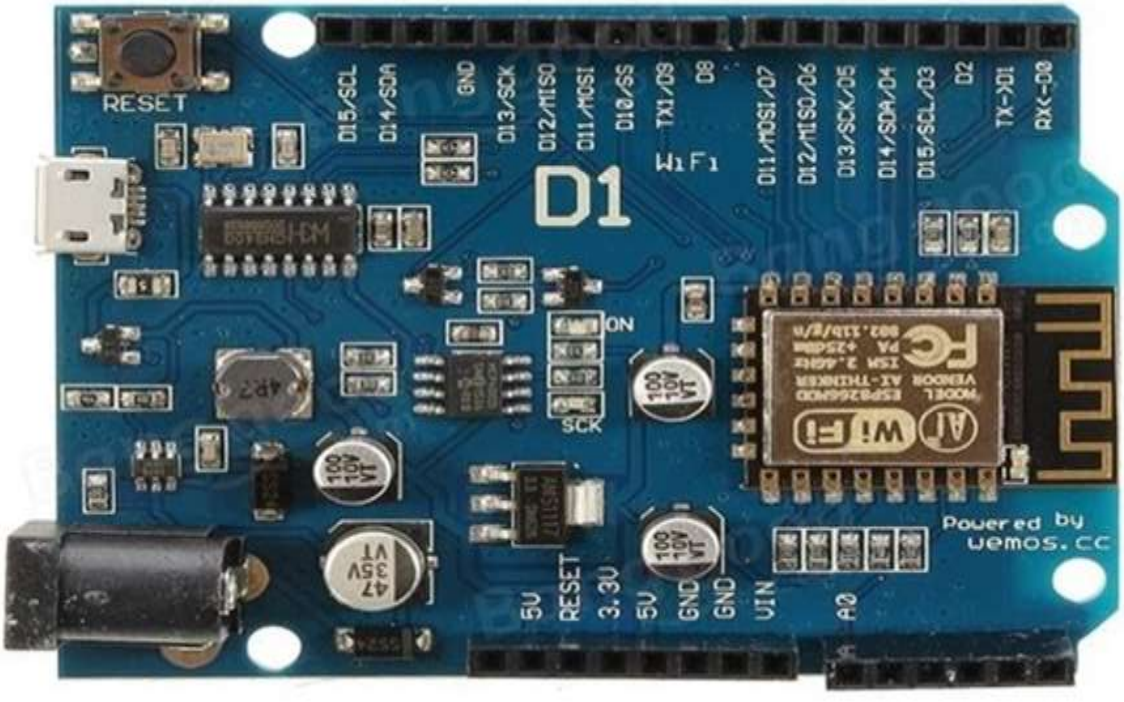

Figure 3.4 WEMOS D1 R1 Board

3.1.2.1 SPECIFICATIONS AND REQUIREMENTS

The features and specifications of WEMOS R1 D1 is described in the table below: [15]

Table 3.3 Specifications of WEMOS D1 Board

Based on microcontroller	ESP-8266EX
Required operating voltage	3.3V
Total digital input/output pins	11
Clock frequency in hertz	80MHz/160MHz
Flash memory	4MB
Weight	25g
Length	68.6mm
Width	53.4mm
Number of Analog input pins	1
Compatibility	Compatible with Arduino IDE

3.1.2.2 PIN CONFIGURATION OF WEMOS D1 BOARD

The WEMOS D1 board has a reset button, a programming interface, digital GPIO pins and a DC power supply unit.

The pin configuration diagram and table is shown below:

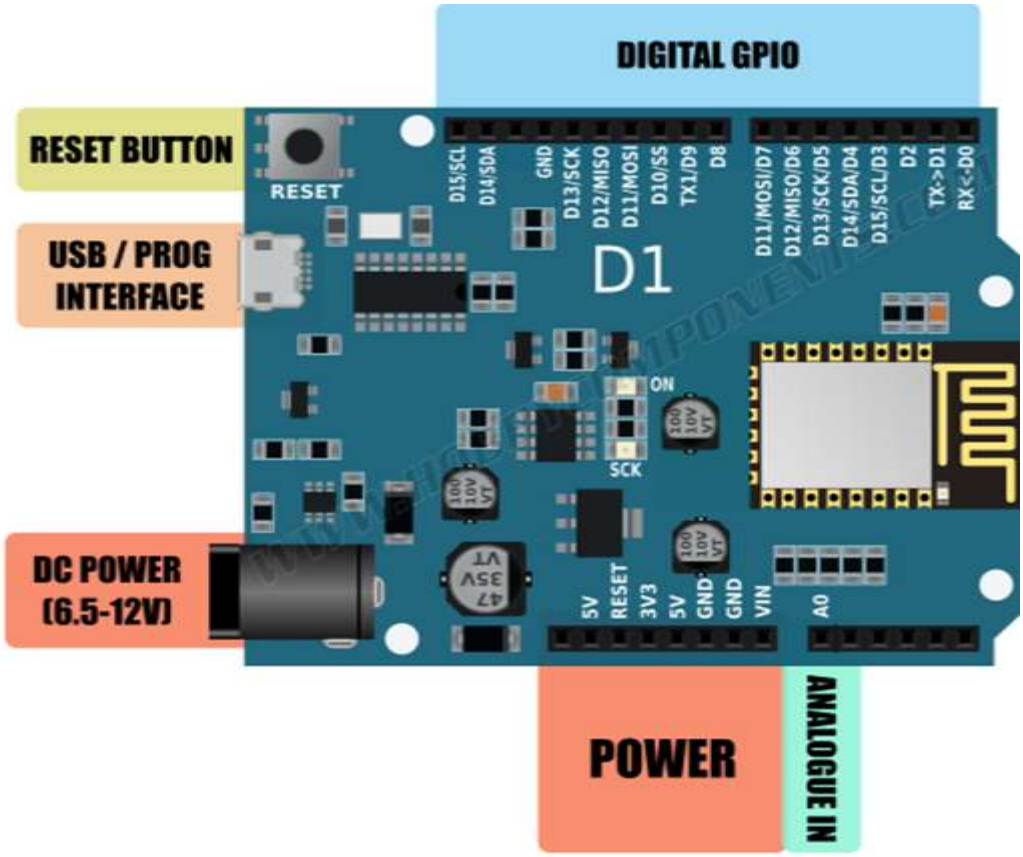

Figure 3.5 Pin Configuration of WEMOS D1 R1 Board

Table 3.4 Pin Configuration of WEMOS Board

Pin	**Function**
RX	RXD
TX	TXD
A0	Analog input pin
D0	I/O pin
D1	I/O pin
D2	I/O pin
D3	I/O pin

D4	I/O pin
D5	I/O pin
D6	I/O pin
D7	I/O pin
D8	I/O pin
Gnd	Provides ground
5V	Supply 5V
3V3	3.3V
RST	Reset

3.1.2.3 INSTALLING WEMOS D1 BOARD IN ARDUINO IDE

To work on WEMOS D1 board it is important to first install the board in Arduino IDE. First we have to give a link in the additional boards manager URLs option present in preferences option menu. By using this link the board manager option will find the required WEMOS D1 board. [14]

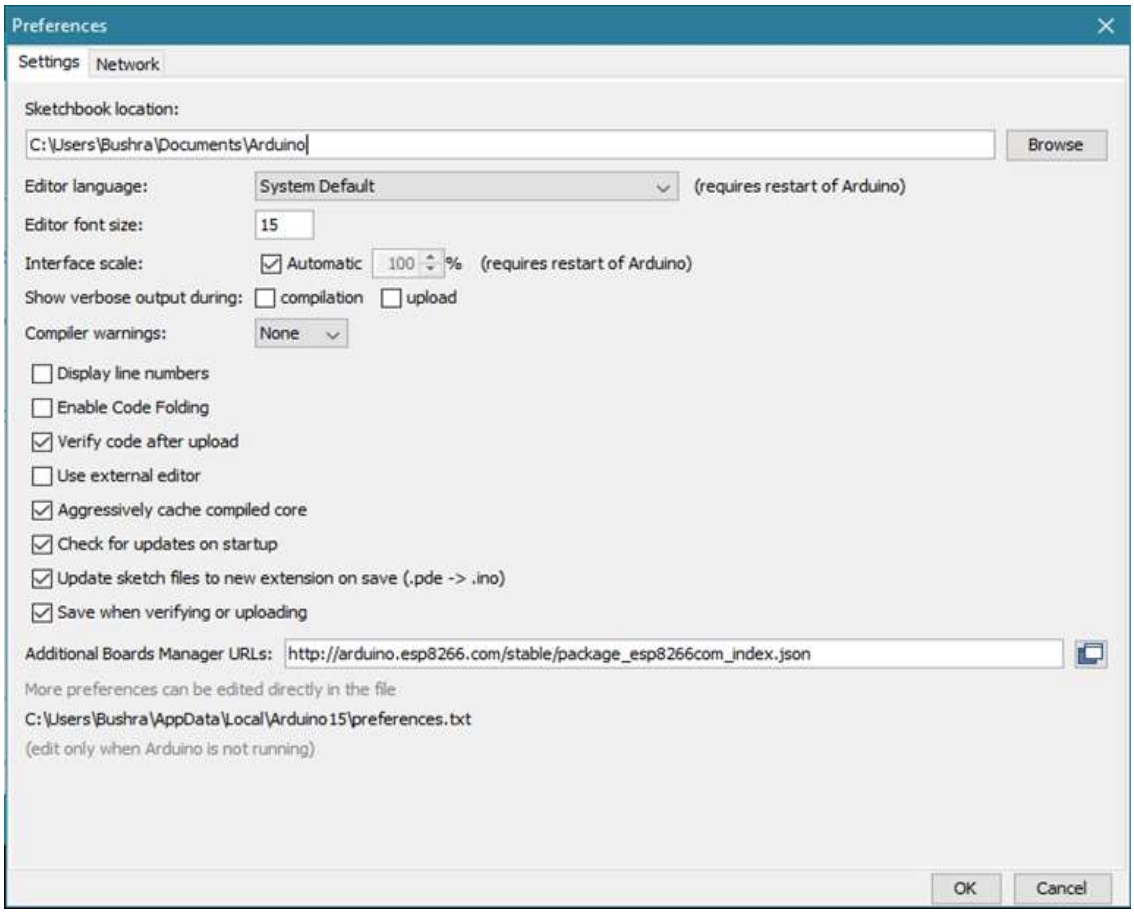

Figure 3.6 Giving Link of WEMOS Boar

After doing this we have to find the required board from board manager present in the tools menu.

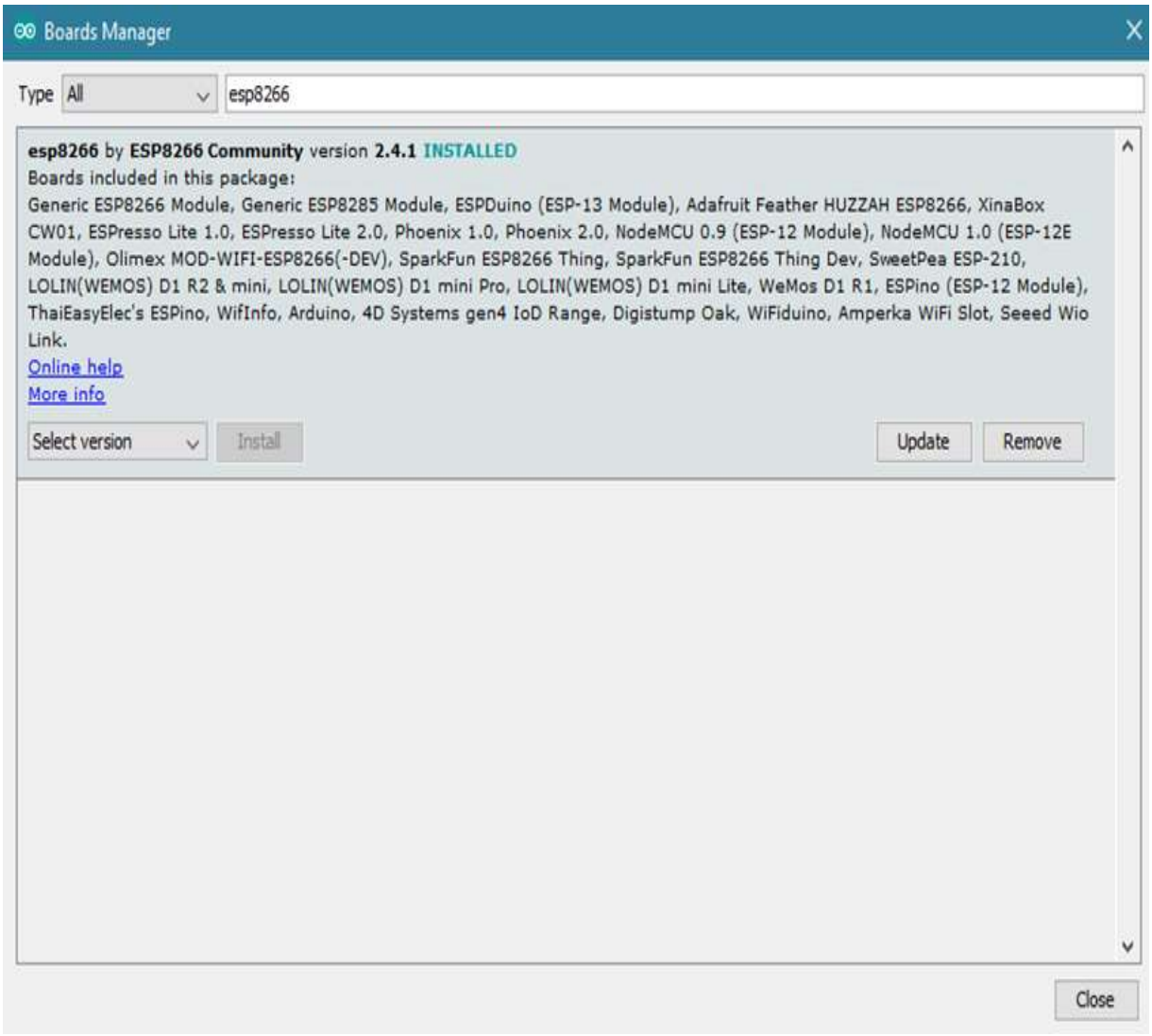

Figure 3.7 ESP8266 Board in Board Manager

After this we can select the WEMOS board for the project as shown below:

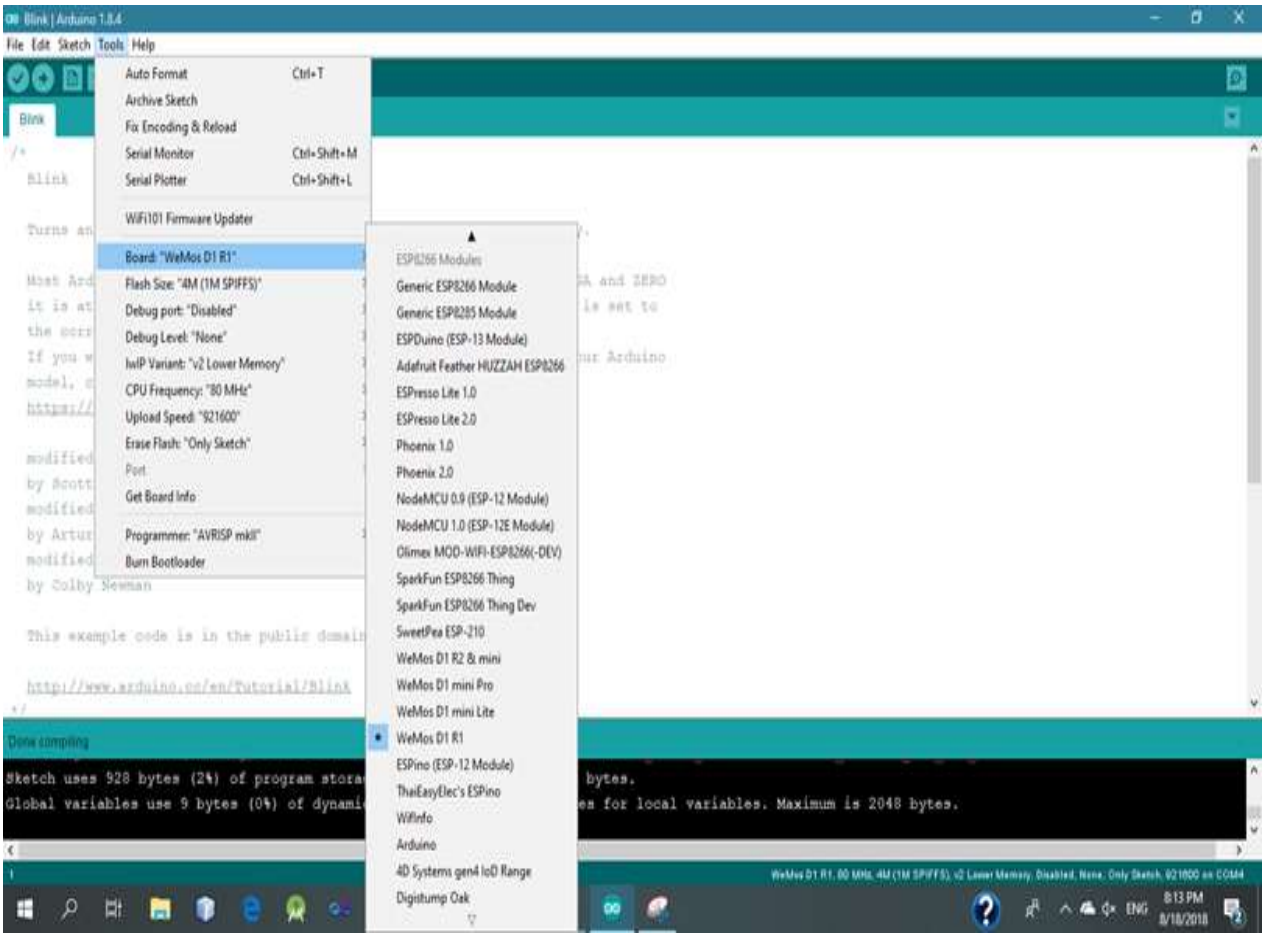

Figure 3.8 WEMOS D1 R1 Board Option

3.2 SOFTWARE ARCHITECTURE

The software that are used in making this project are Arduino IDE and Android Studio. Arduino IDE is used for the coding of hardware module and Android Studio is used for the coding of mobile application.

3.2.1 ARDUINO IDE

Arduino IDE is a software that is used to compile and upload code in an Arduino microcontroller board. It stands for Integrated Development Environment. It can work with different operating systems like Windows, Linux and Mac.

The advantage of using this software is that it is user-friendly and can be easily used by the beginners. The latest version of Arduino IDE is 1.8.5. The language used for coding in Arduino is C++.

3.2.1.2 ENVIRONMENT OF ARDUINO IDE

Arduino IDE has a very graphically interactive environment. It is designed in such a way that even non-professionals and beginners can understand it in a less time. Many useful tutorials are available for Arduino users on Arduino Forum.

The environment of Arduino IDE looks like this:

Figure 3.9 Environment of Arduino IDE

3.2.1.2.1 MENU BAR

There are five menus available in the menu bar: File, Edit, Sketch, Tools and Help.

The **File menu** gives different options to the user e.g. the user can **open** a new sketch or file or can open a saved file. We can **save** a sketch or change the settings of a page by using **page setup** option and can also print it by using **print option** from file menu.

The other option in file menu is **Edit**. The edit option gives various options such as we can **copy** something from a sketch or **paste** a part of code into the sketch. We can also **undo** or **redo** changes we have made in our code.

Now, the sketch menu is a very important options consisting of options like **compiling** an Arduino code and then **uploading** it to the Arduino board. There is an option of **Include Library** which allows us to use any library we want according to the project environment and we can also add a new library by using **manage libraries option** from Include Library.

Another menu in Arduino IDE is Tools. In tools menu, there is an option of **Serial Monitor** which shows us the output of our Arduino code. The type of Arduino board can be changed by using **board option** which has a list of every Arduino board e.g. UNO, NANO etc.

The last menu is Help. If there is any query regarding Arduino we can simply look into **frequently used questions** and for beginners there is an option of **getting started** that explain details about Arduino. [10]

3.2.1.2.2 BUTTON BAR

The figure below shows the button bar.

Figure 3.10 Button Bar

There are six buttons present in the button bar. The buttons have the same functions provided by the option in File menu and toolbar but the

programmer uses these six options most often.

The button with a tick on it compiles the Arduino code. The button with a forward arrow uploads the code to the Arduino board. The button with a page sign creates a new sketch. The button with an upward arrow opens a save sketch and the last button with a downward arrow saves a sketch. [10]

3.2.1.3 SETUP AND LOOP IN ARDUINO CODE

Arduino sketch has two functions that are Setup ( ) and Loop ( ).

3.2.1.3.1 SETUP ( )

Any code written inside setup ( ) run only once. In setup ( ) the pin mode is declared like which pin is to be set as input and output. Also, the libraries should be added and the initialization of variables is done inside setup ( ) part of the sketch.

3.2.1.3.2 LOOP ( )

This part of Arduino sketch runs repeatedly until the Arduino is powered off. The main part of the code that we want to be run repeatedly is written inside it. It runs after the loop ( ) part of the code.

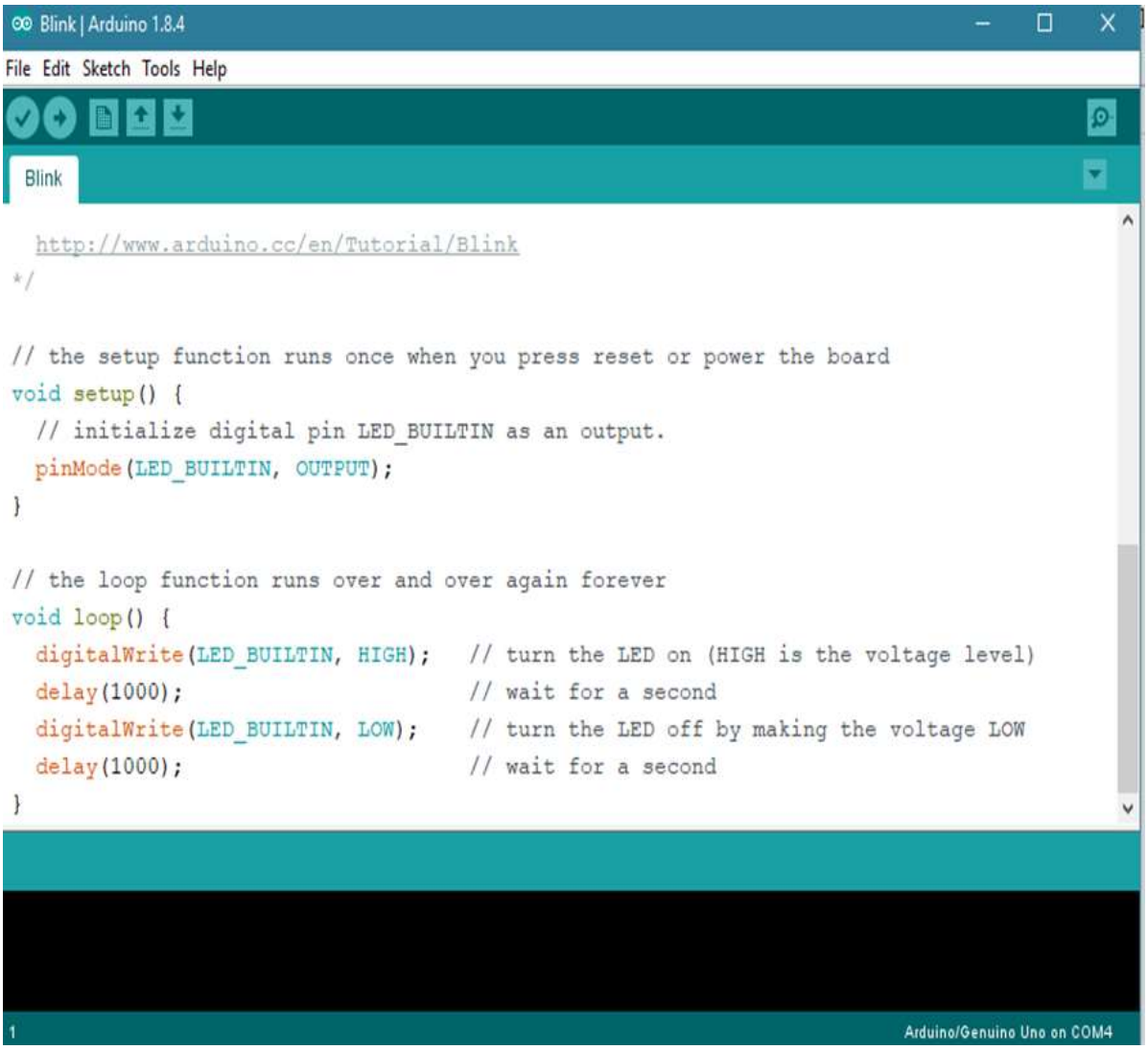

Figure 3.11 Setup( ) and Loop( ) Functions in a Blink Program

3.2.2 ANDROID STUDIO

Android studio is a software that is used to build mobile applications. It can be used on different operating systems like Windows, Mac and Linux.

3.2.2.1 FEATURES OF ANDROID STUDIO

Some features of Android Studio are described below:

- ✦ It has an emulator that has various options and is very fast.

- The performance of Android Studio is stable than other IDEs such as Eclipse and it is released with less number of bugs.
- To organize the code Android Studio makes use of modules. It manages the code in such a way that each module has its gradle build file and state their dependencies. Gradle is a build system that makes use of the best features of other systems and merges them into one. [15]
- Unlike other IDEs such as Eclipse, Android Studio has a graphical user interface. It has a drag and drop feature too. [11]

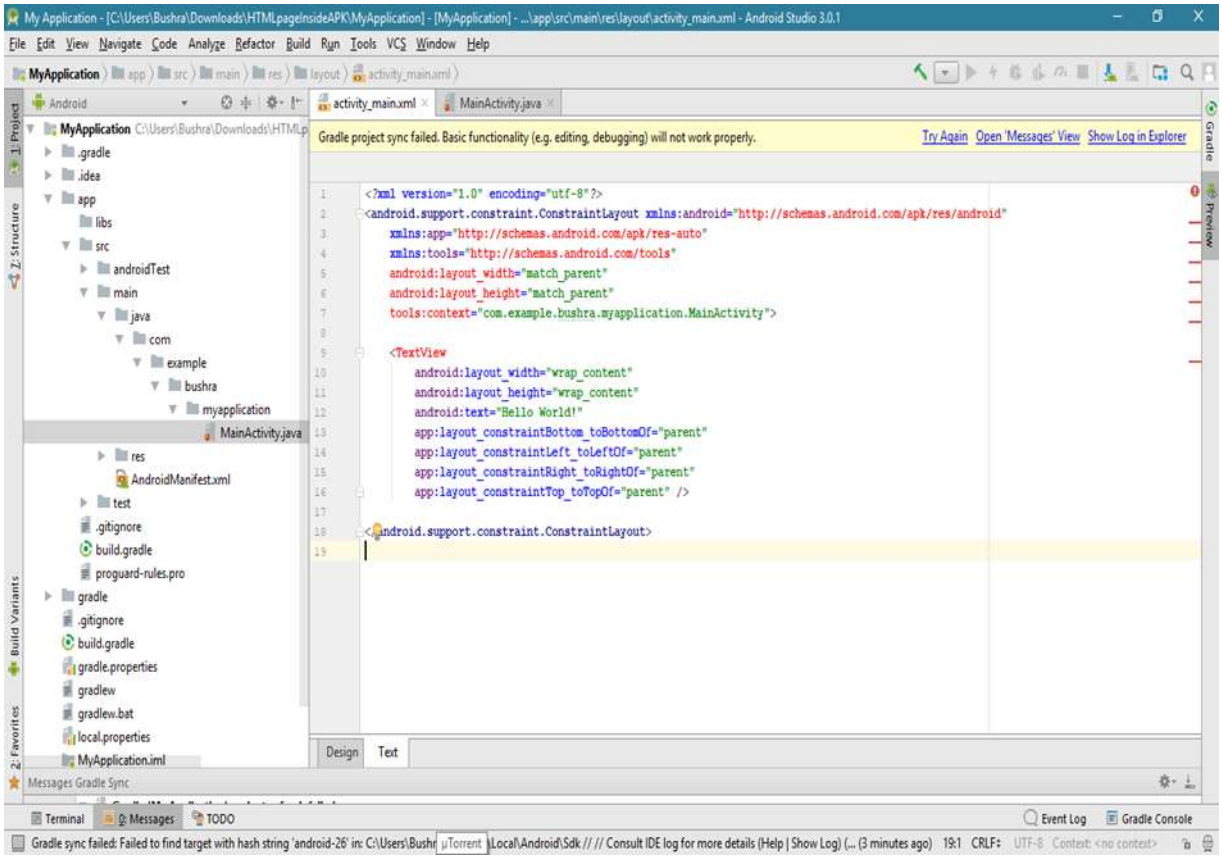

Figure 3.12 Android Studio

CHAPTER 4

4 METHODOLOGY

4.1 DESIGN OF OUR SYSTEM

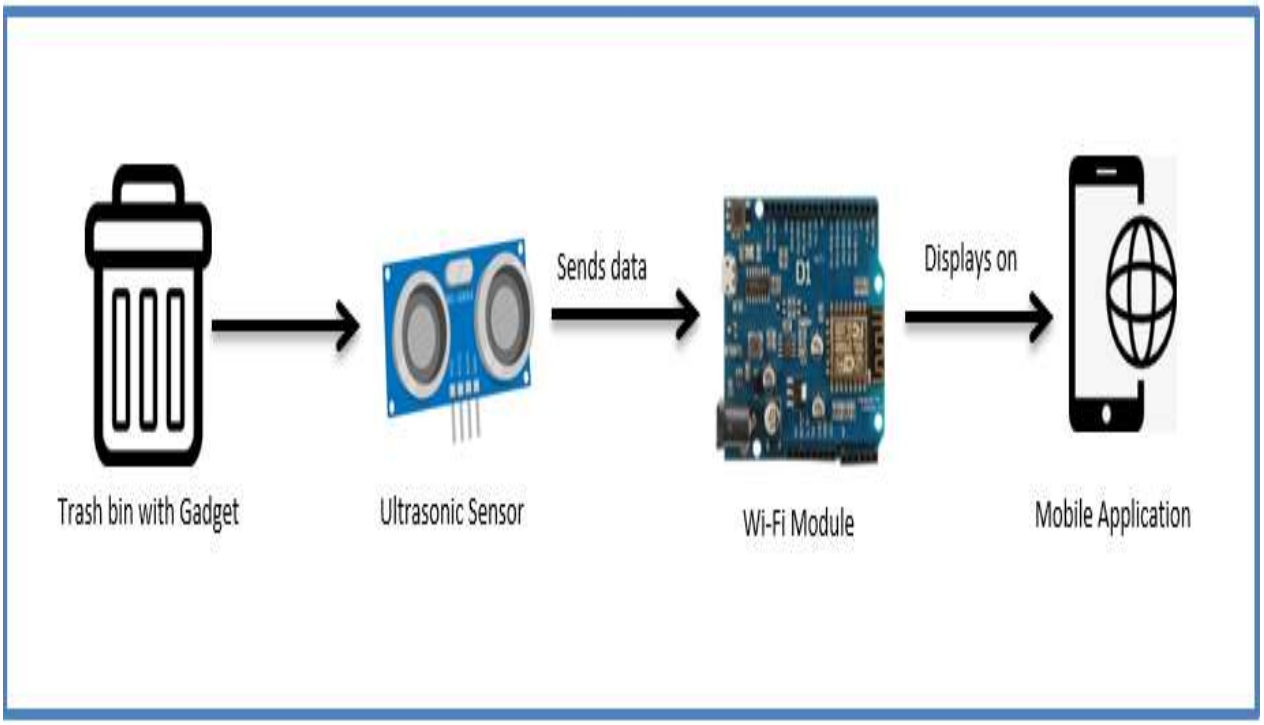

Figure 4.13 Design of our project

4.1.1 TRASH BIN

The trash bin will be attached with the garbage detecting device comprising of level sensor and WEMOS D1 Board.

4.2.2 ULTRASONIC LEVEL SENSOR HC-SR04

The second part is ultrasonic level sensor. It will detect the level of the garbage in the bins. The level is measured using distance of the garbage form the lid of the bin. If the distance between garbage and lid is greater then the level of

garbage is less and when there is small distance between the garbage and lid of bin then the level of garbage will be more.

4.2.3 WEMOS D1 BOARD

For Wi-Fi connectivity we have used WEMOS D1 board. It connects the hardware module to our Wi-Fi device. The WEMOS is used in access point mode which means that the WEMOS itself will be an access point for Internet and its Wi-Fi connectivity will be shown on mobiles and laptops. WEMOS will not connect to other local area networks.

4.2.4 MOBILE APP

When the device is connected with the Wi-Fi then it sends the sensor data to the mobile app. After being connected with the WEMOS internet the app will display the level of garbage and also the shortest path to the bin and its location.

4.3 FLOWCHART OF PROJECT

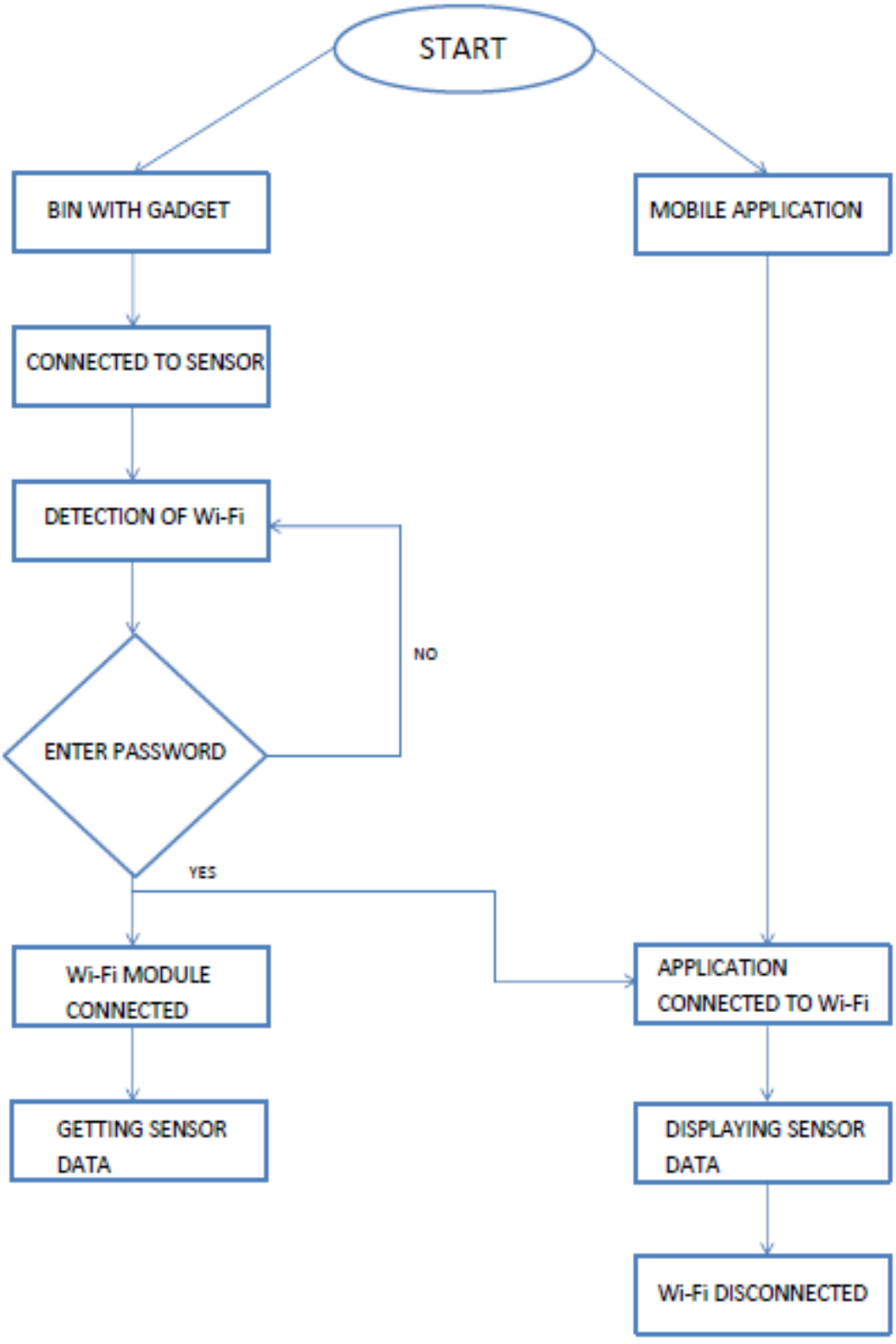

Figure 4.14 Flowchart of project

4.4 WI-FI CONNECTION

Wi-Fi connectivity is the most important thing in our project since everything is based on it. Without Wi-Fi connectivity our hardware module will not be able to send the data of the sensor to the android mobile application. Therefore, the first thing is to connect the internet with the hardware module.

4.4.1 HARDWARE USED FOR INTERNET CONNECTIVITY

WEMOS D1 R1 ESP Board. The WEMOS is used to provide internet to the module. As the WEMOS is in access point mode therefore it will provide internet to the mobile in which the app is being run. A password value is set for WEMOS. When this password is entered in the mobile, the mobile will be connected to the WEMOS internet.

4.4.1.1 HOW WEMOS D1 R1 WORKS?

The main thing that the WEMOS D1 R1 does after being connected to the internet is sending the sensor's data to the android app. Therefore, we have connected our Wi-Fi module to the HC-SR04 level sensor.

WEMOS can work in two different modes: Station mode and access point mode. The mode used in project is access point mode. In access point mode WEMOS does not need to be connected with any local area network rather than the WEMOS itself becomes an access point and provides internet to the devices nearby.

4.4.1.2 INTERFACING WEMOS D1 R1 ESP BOARD WITH HC-SR04 LEVEL SENSOR

There are four pins in a HC-SR0 level sensor.

- VCC
- Gnd
- Echo
- Trigger

Firstly, we connected these four pins with the WEMOS board.

- The Vcc pin of level sensor is connected with the 5V pin of WEMOS D1 R1 Board.
- The Gnd pin of level sensor is connected with the ground pin of WEMOS D1 R1 Board.
- The echo pin of level sensor is connected with D12 (digital input/output) pin of the WEMOS Board.
- The trigger pin of level sensor is connected with the D13 (digital input/output) pin of the WEMOS board.

Since there are only two components in our hardware module so there is only WEMOS and level sensor connection.

4.4.1.3 POWERING UP THE WEMOS D1 BOARD

For providing 5V to the WEMOS board we have used a 5V battery. The 5V pin of WEMOS D1 R1 Board is connected with the positive end of the battery and the gnd pin of the WEMOS is connected to the negative end of the battery.

4.5 ALERTING MECHANISM

The ultrasonic level sensor works on the principle of sending an input wave to the obstacle with the speed of sound that is 343m/sec and frequency of

40 KHz. Once the input wave strikes to an obstacle it sends an output wave back to the sensor.

The echo pin of the sensor sends an input ultrasonic wave at 40 KHz. When it gets garbage in its way then it strikes to it and sends another ultrasonic wave to the output pin (trigger pin) of the sensor.

The level sensor is attached on the lid of the trash bin so that it will accurately determine the level of the garbage.

4.6 HOW MOBILE APP WORKS?

The purpose of mobile app is to measure the shortest path and shows the state of bin that it is filled and needed to be emptied or not. For measuring the shortest path and locating the bin we have used Google Maps instead of OSM (as originally planned) because OSM is hard to be implemented and debug and is not much compatible with devices on the other hand Google Maps is mostly compatible with devices and easily to use and implemented.

4.6.1 WHY GOOGLE MAP?

Google Maps because of their reliability, portability and usability that is it pinpoint the current location, it can be used on most of the devices and is easy to be implemented and used. Update of IDE gives dependency error that shows that OSM are not reliable enough. [13]

4.6.2 FINDING SHORTEST PATH

For finding the shortest path “polyline” is used. Polyline consist of list of points that forms lines which are then used for routing and the data from these can be used for finding shortest path between the destination and source.

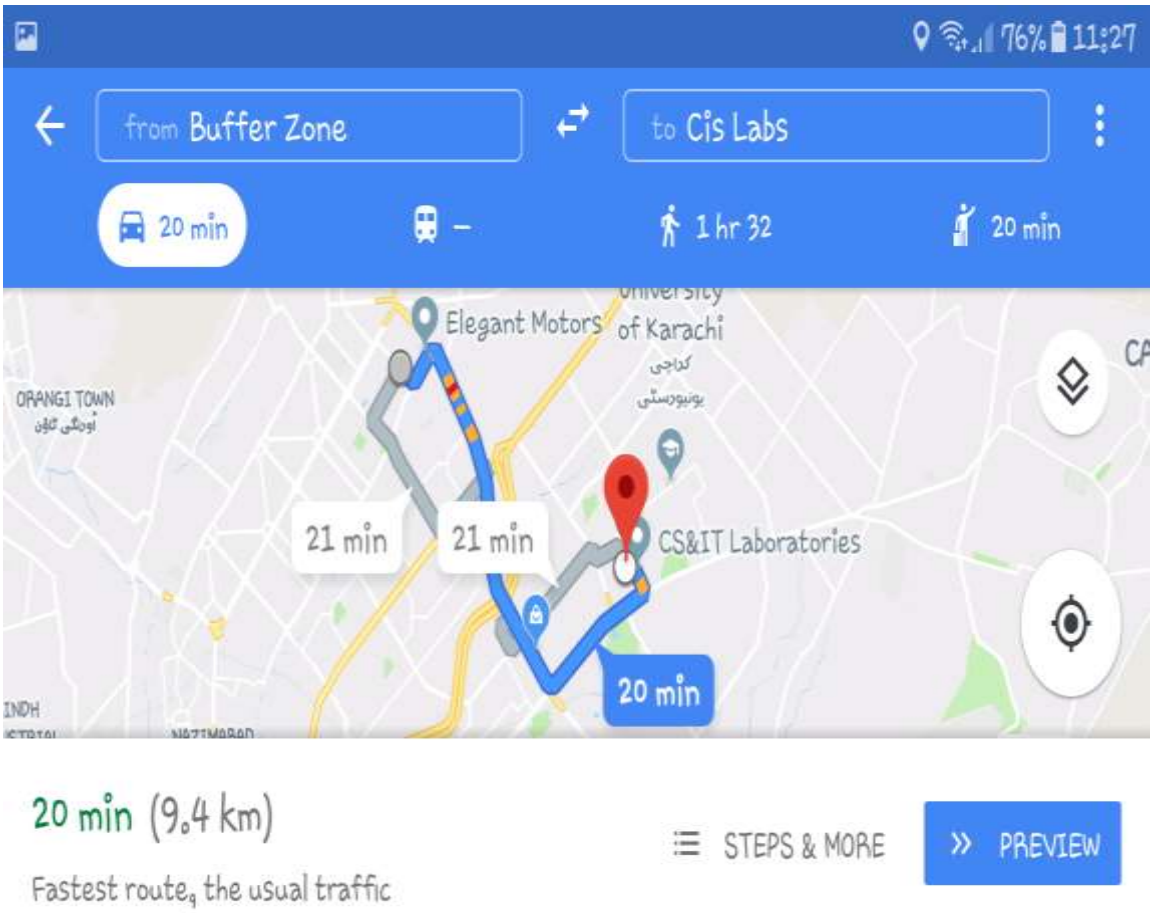

Figure 4.15 Shortest Path between bin and driver is shown by highlighted route

4.6.3 MARKERS

Customized bin marker is used to show the location of bin. The position of bin is static so the marker is located at specified geo-point (location).

Figure 5.16 Marker of garbage bin location

4.6.4 DRIVER'S LOCATION

Drivers location is dynamic and should be updated, for this myLocationEnabled() method is being used. In the screenshot below the driver location is University of Karachi.

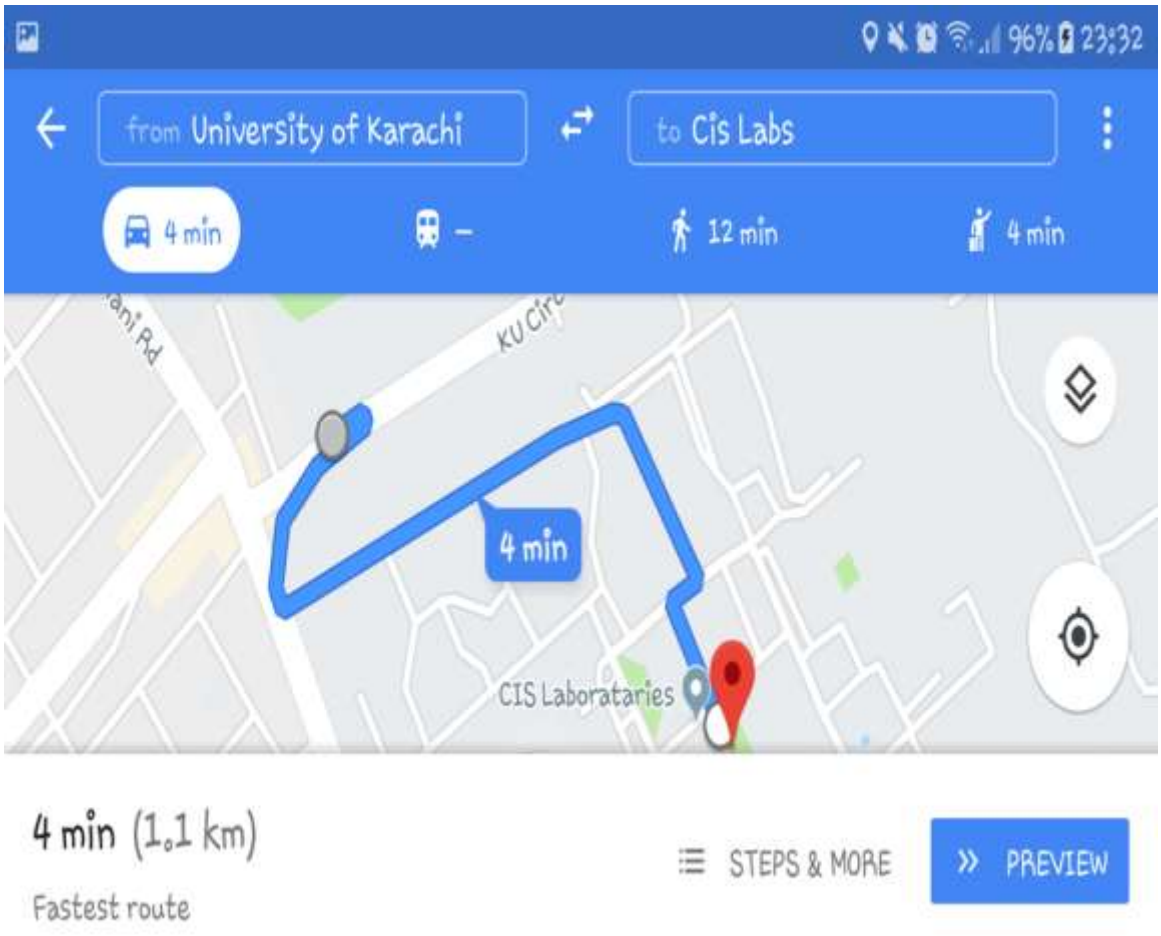

Figure 5.17 Location of driver is University of Karachi

CHAPTER 5

5 RESULTS

5.1 LOCATION OF THE GARBAGE BIN

The location of the bin is currently set to the area outside the CIS lab. The bin is pin pointed by the marker above it.

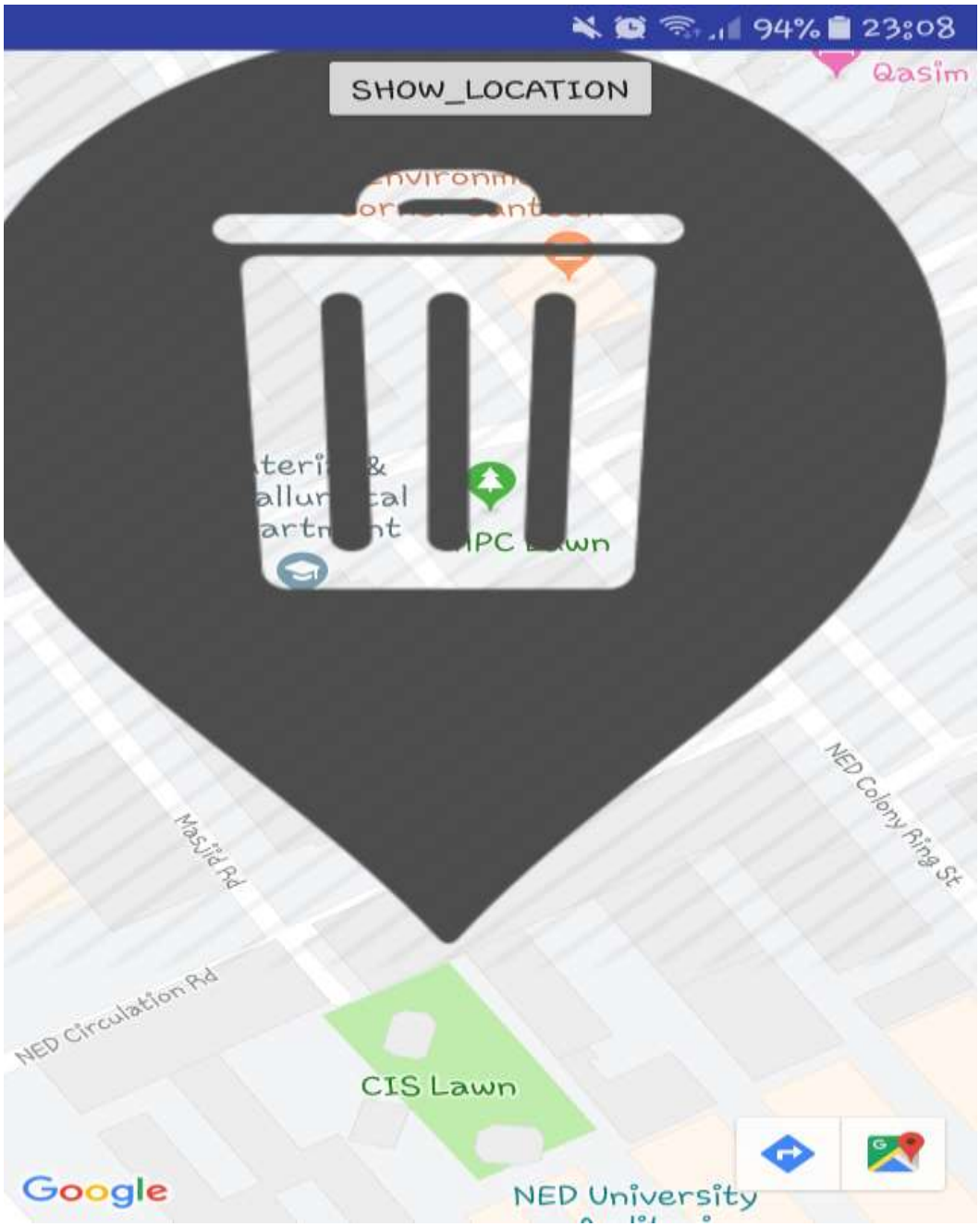

Figure 5.18 Location of the garbage bin

5.2 ACCURACY OF SHORTEST ROUTE TOWARDS THE GARABGE BIN

We have determined the shortest path towards the garbage bin from different locations to observe the accuracy of our system. To determine the accuracy we have experimented this system on ten different locations.

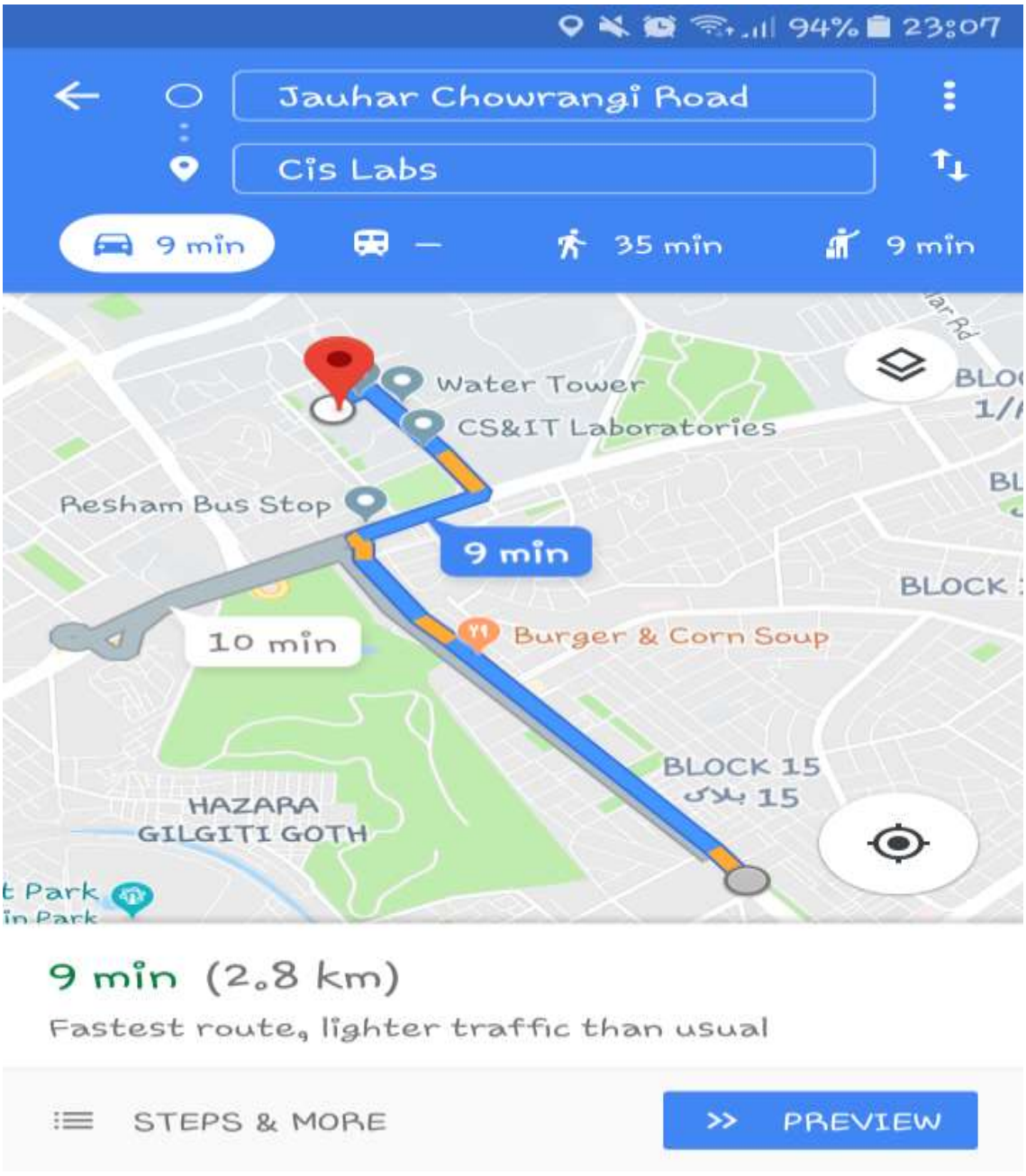

Figure 5.19 Shortest Path of Garbage Bin from Jauhar Chowrangi

In the above screenshot the driver's location is Jauhar Chowrangi and the distance between his location and garbage bin's location is 2.8Km. The route is shown on the map.

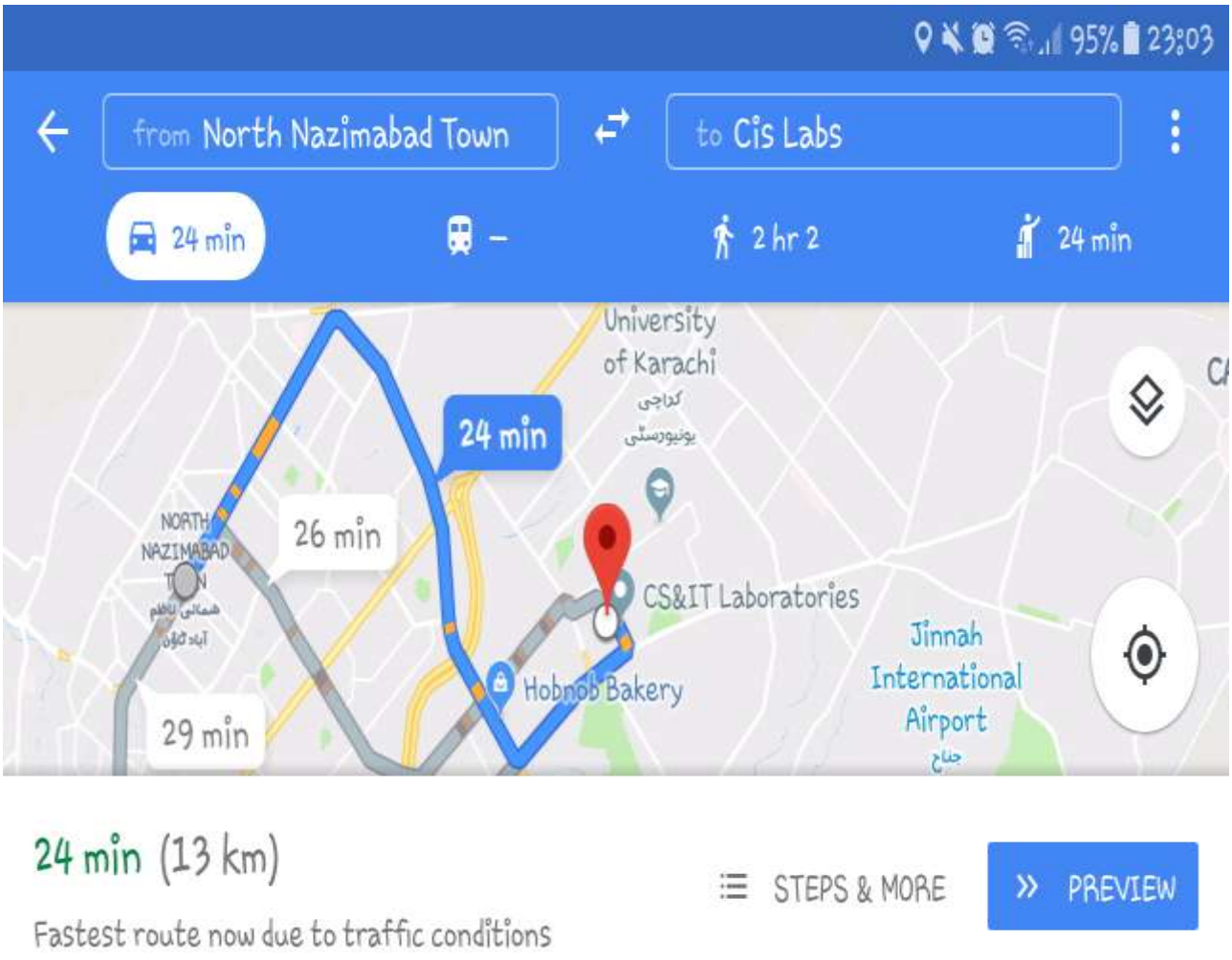

Figure 5.20 Shortest Path of Garbage Bin from North Nazimabad

In the above screenshot the driver's location is North Nazimabad and the distance between his location and garbage bin's location is 13 Km.The route is shown on the map.

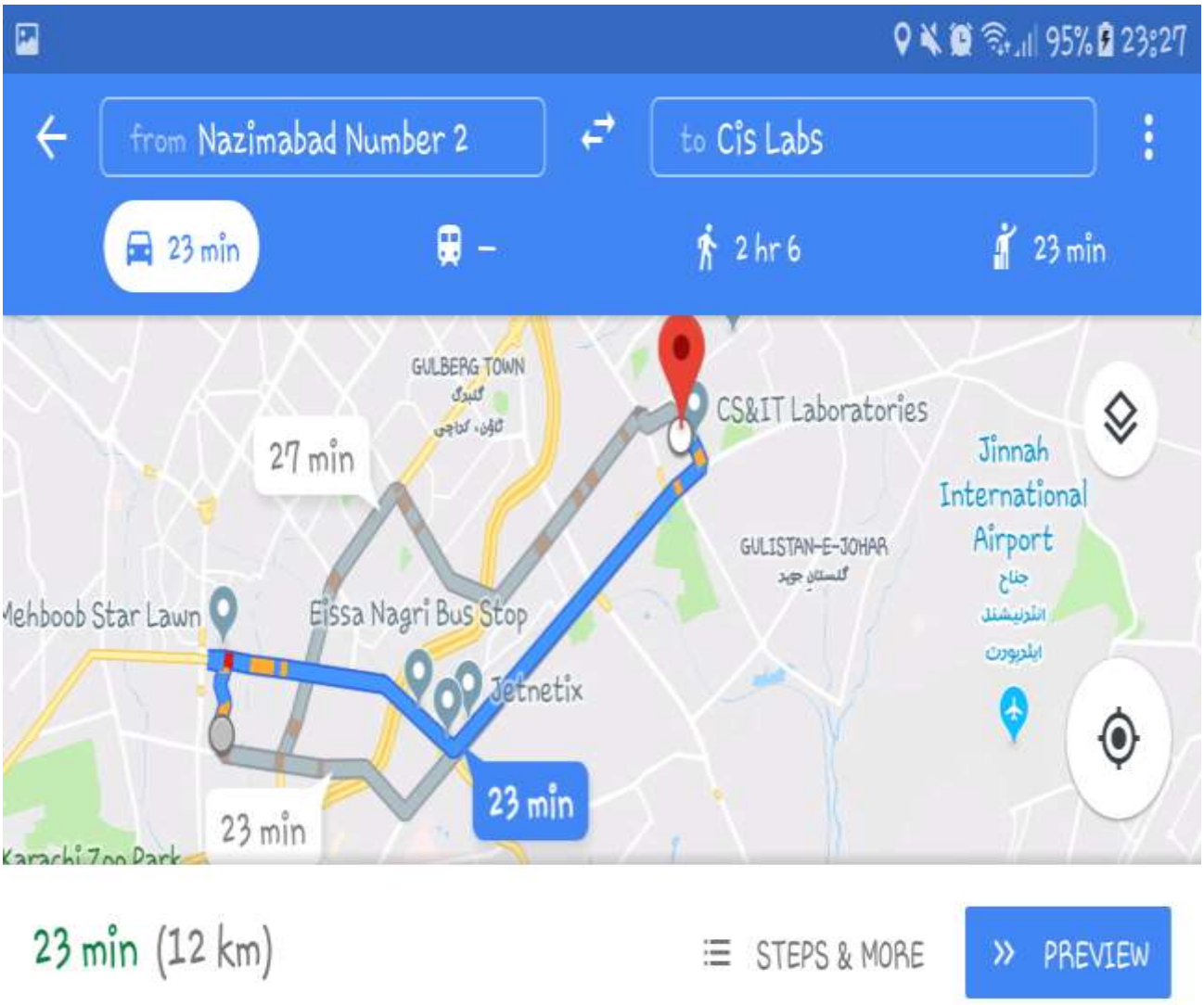

Figure 5.21 Shortest path of garbage bin from Nazimabad Number 2

In the above screenshot the driver's location is Nazimabad Number 2 and the distance between his location and garbage bin's location is 12 Km.

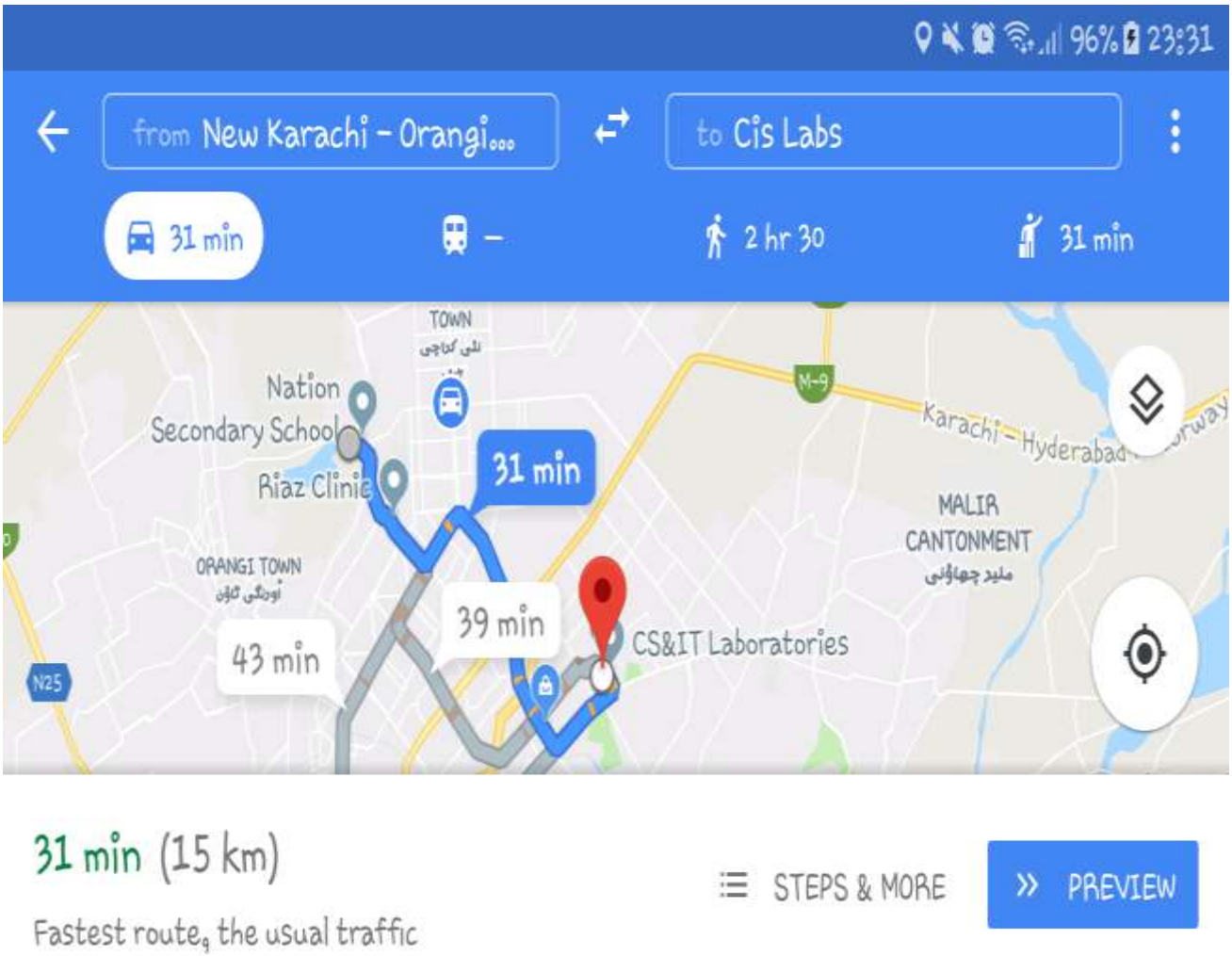

Figure 5.22 Shortest Path of Garbage Bin from New Karachi

In the above screenshot the driver's location is New Karachi and the distance between his location and garbage bin's location is 15Km.

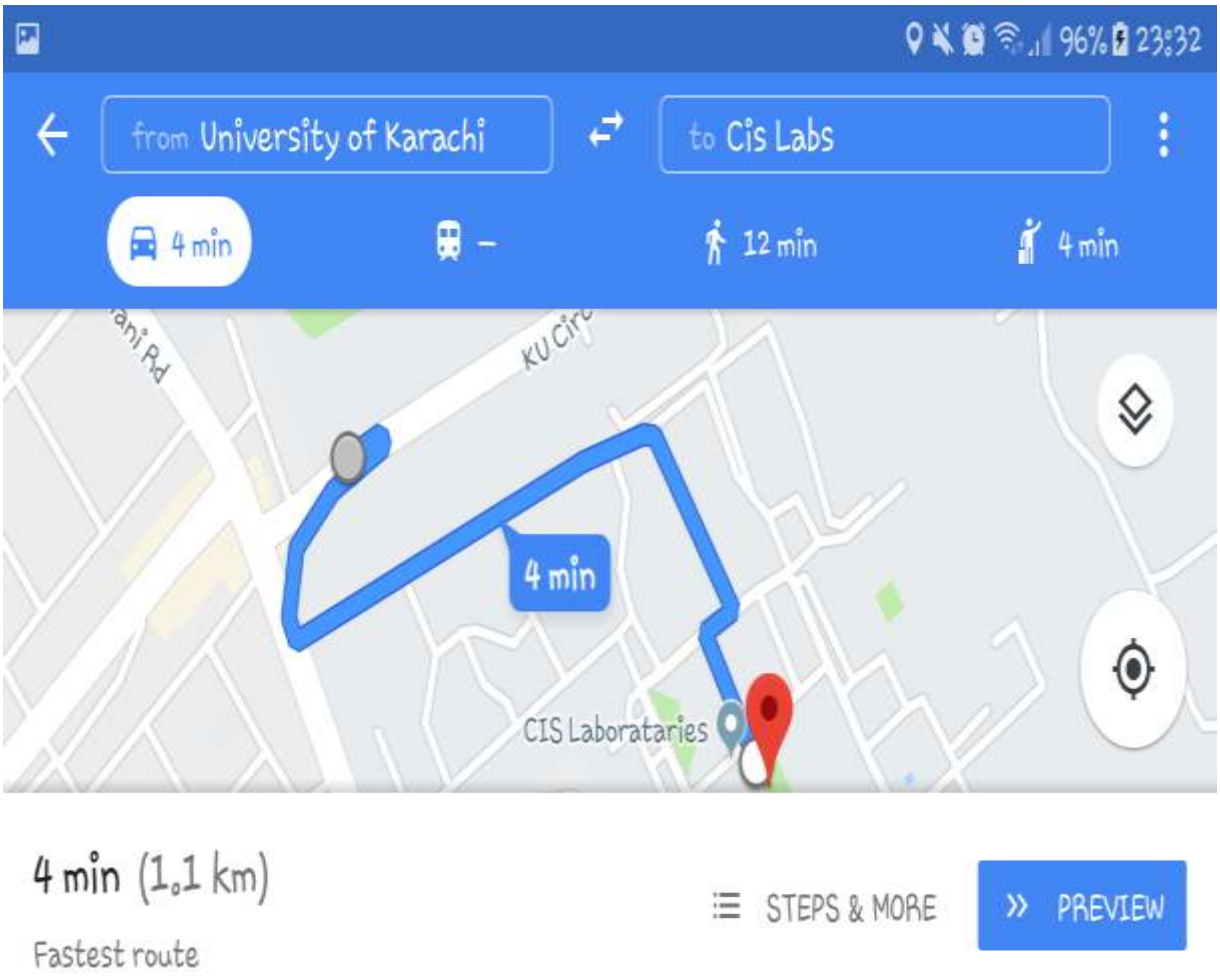

Figure5.23 Shortest Path of Garbage Bin from Karachi University

In the above screenshot the driver's location is Karachi University and the distance between his location and garbage bin's location is 1.1Km. The route is shown on the map.

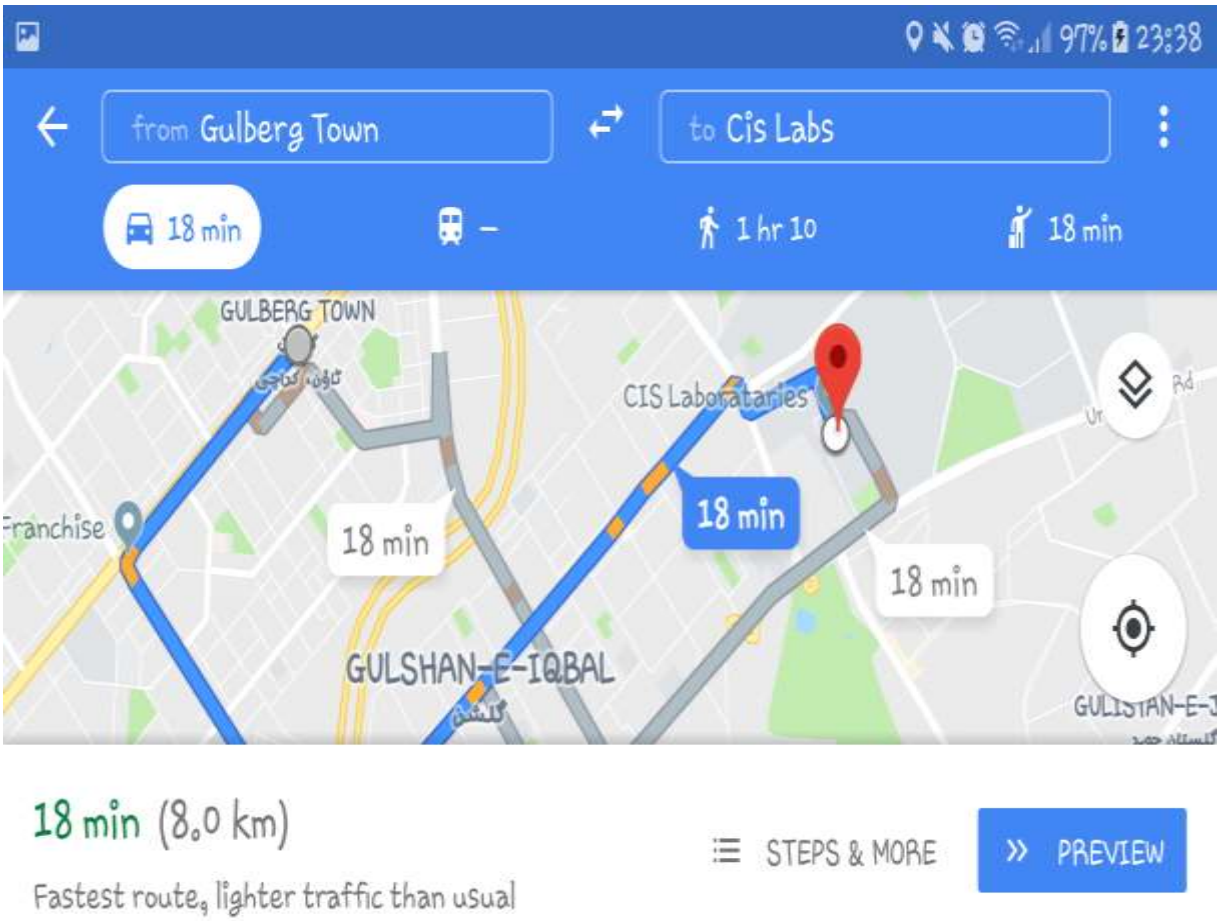

Figure 5.24 Shortest Path of Garbage Bin from Gulberg Town

In the above screenshot the driver's location is Gulberg Town and the distance between his location and garbage bin's location is 8Km.

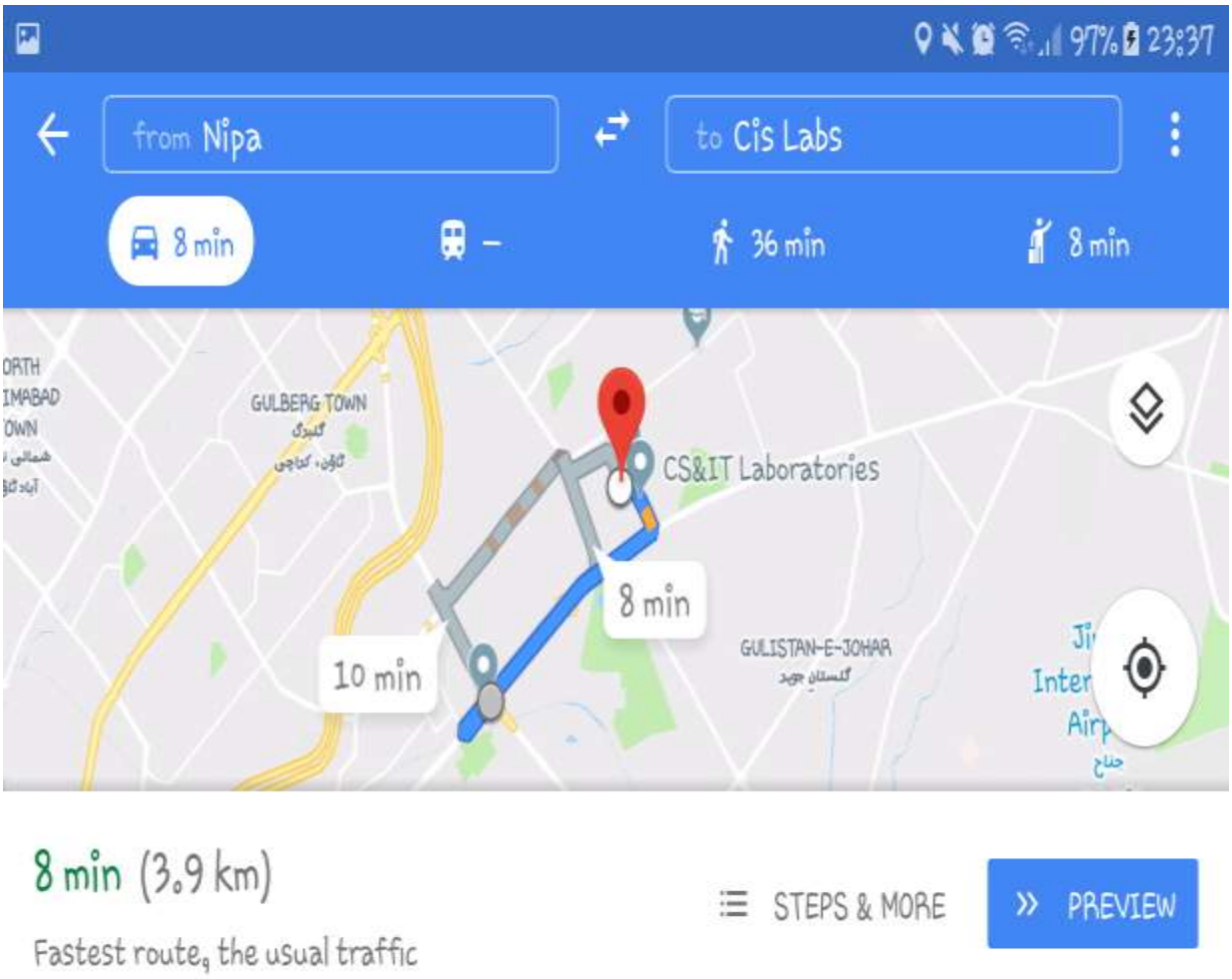

Figure 5.25 Shortest Path of Garbage Bin from Nipa

In the above screenshot the driver's location is Nipa and the distance between his location and garbage bin's location is 3.9Km.

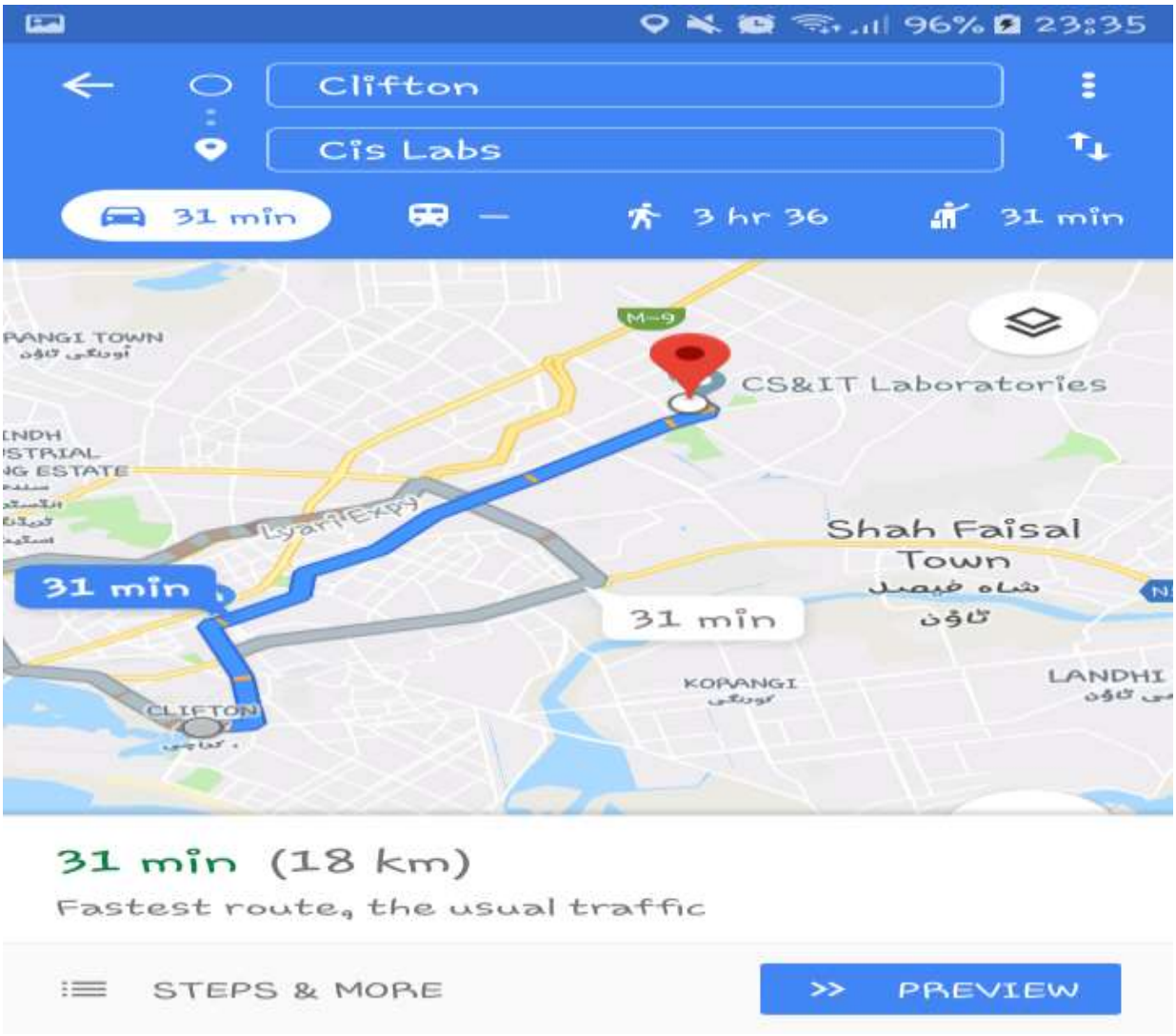

Figure 5.26 Shortest Path of Garbage Bin from Clifton

In the above screenshot the driver's location is Clifton and the distance between his location and garbage bin's location is 18Km.

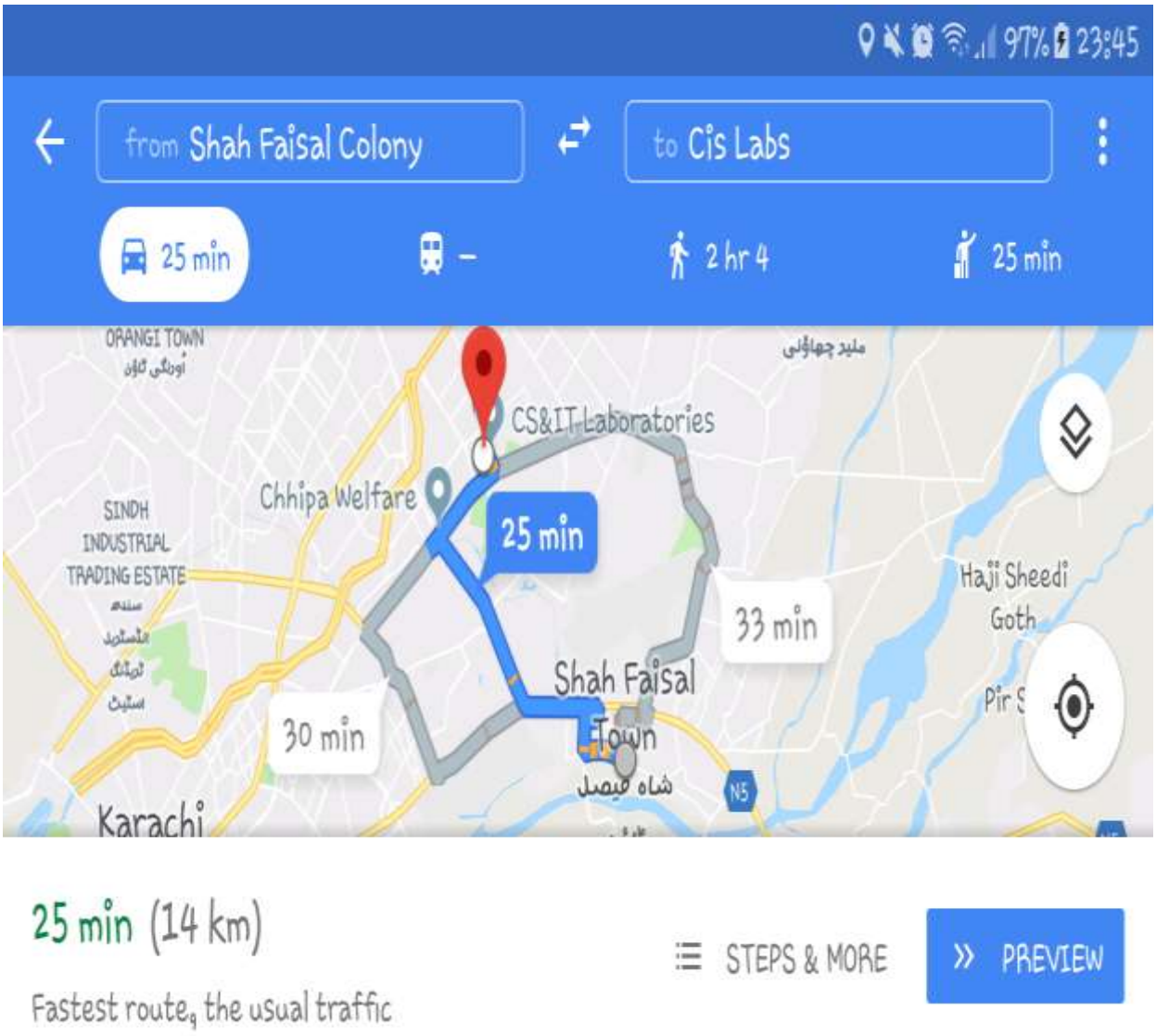

Figure 5.27 Shortest Path of Garbage Bin from Shah Faisal Colony

In the above screenshot the driver's location is Shah Faisal Colony and the distance between his location and garbage bin's location is 14Km.

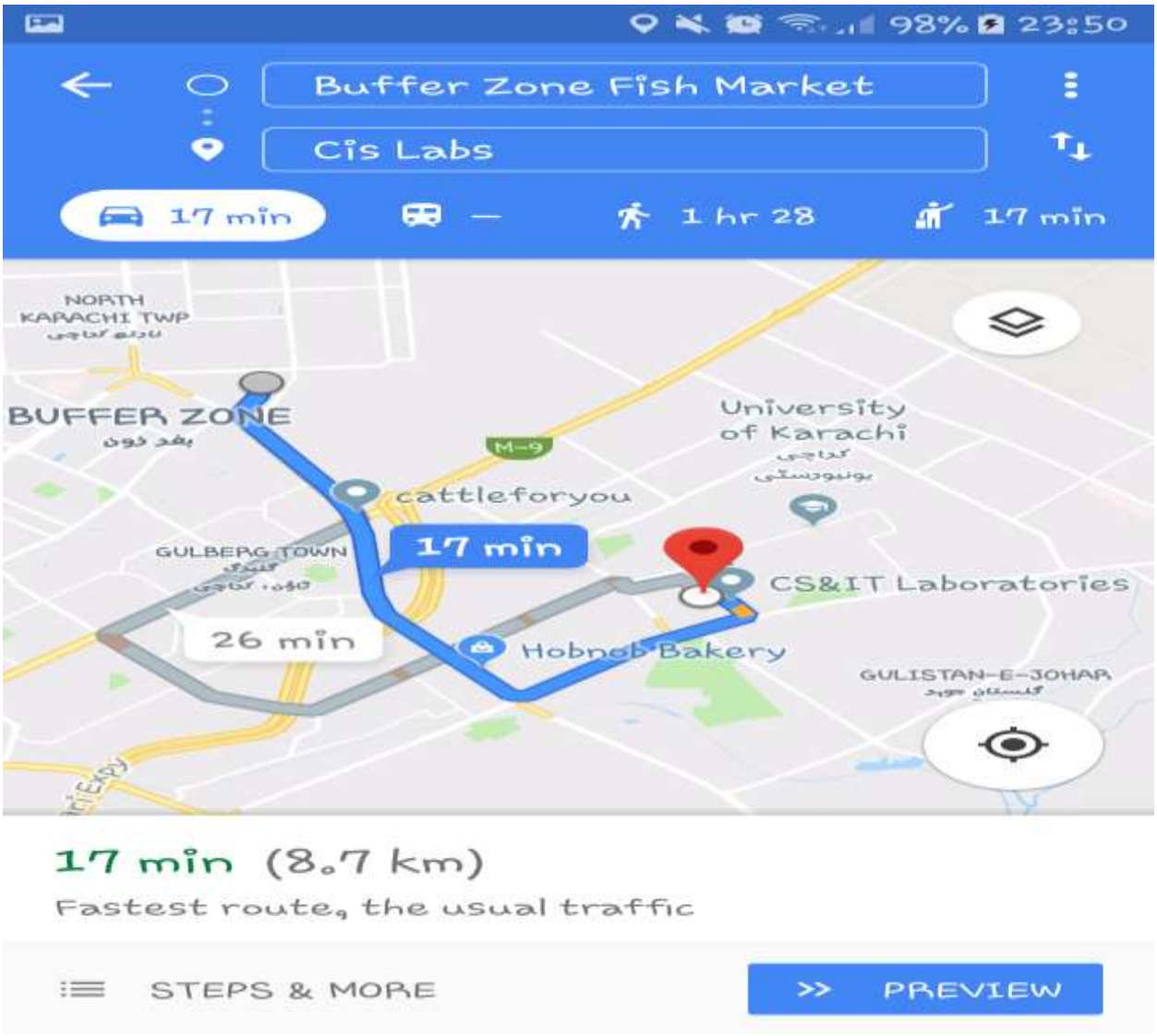

Figure 5.28 Shortest Path of Garbage Bin from Buffer Zone

In the above screenshot the driver's location is Buffer Zone and the distance between his location and garbage bin's location is 8.7Km.

5.3 LEVEL OF GARBAGE

Figure 5.29 Top View of Garbage Bin

On the lid of the bin the ultrasonic level sensor is attached for the detection of garbage level.

Figure 5.30 Side View of Garbage Bin

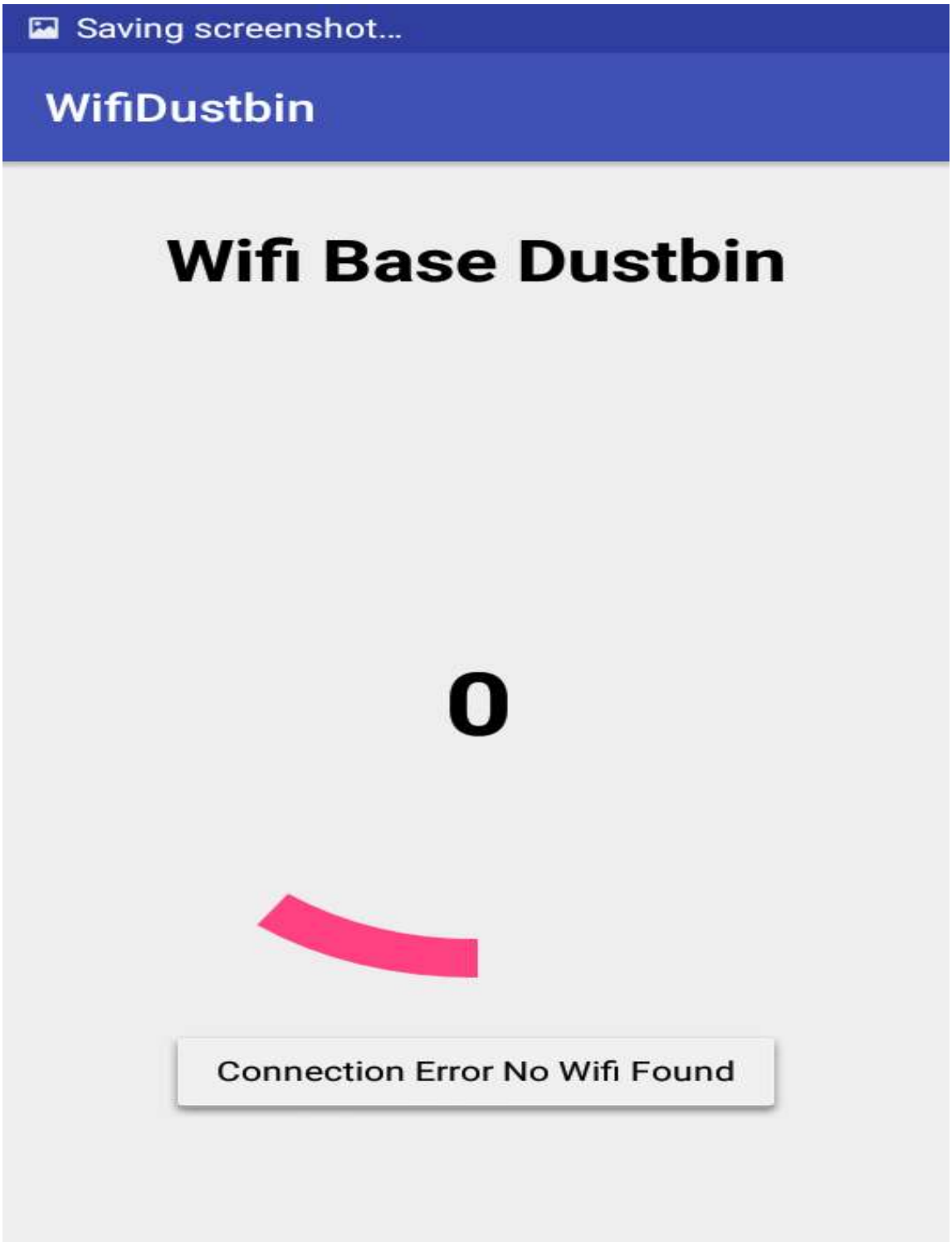

Figure 31 When Internet is Not Connected with the Application

When the app is not connected to the WEMOS it will not display any result.

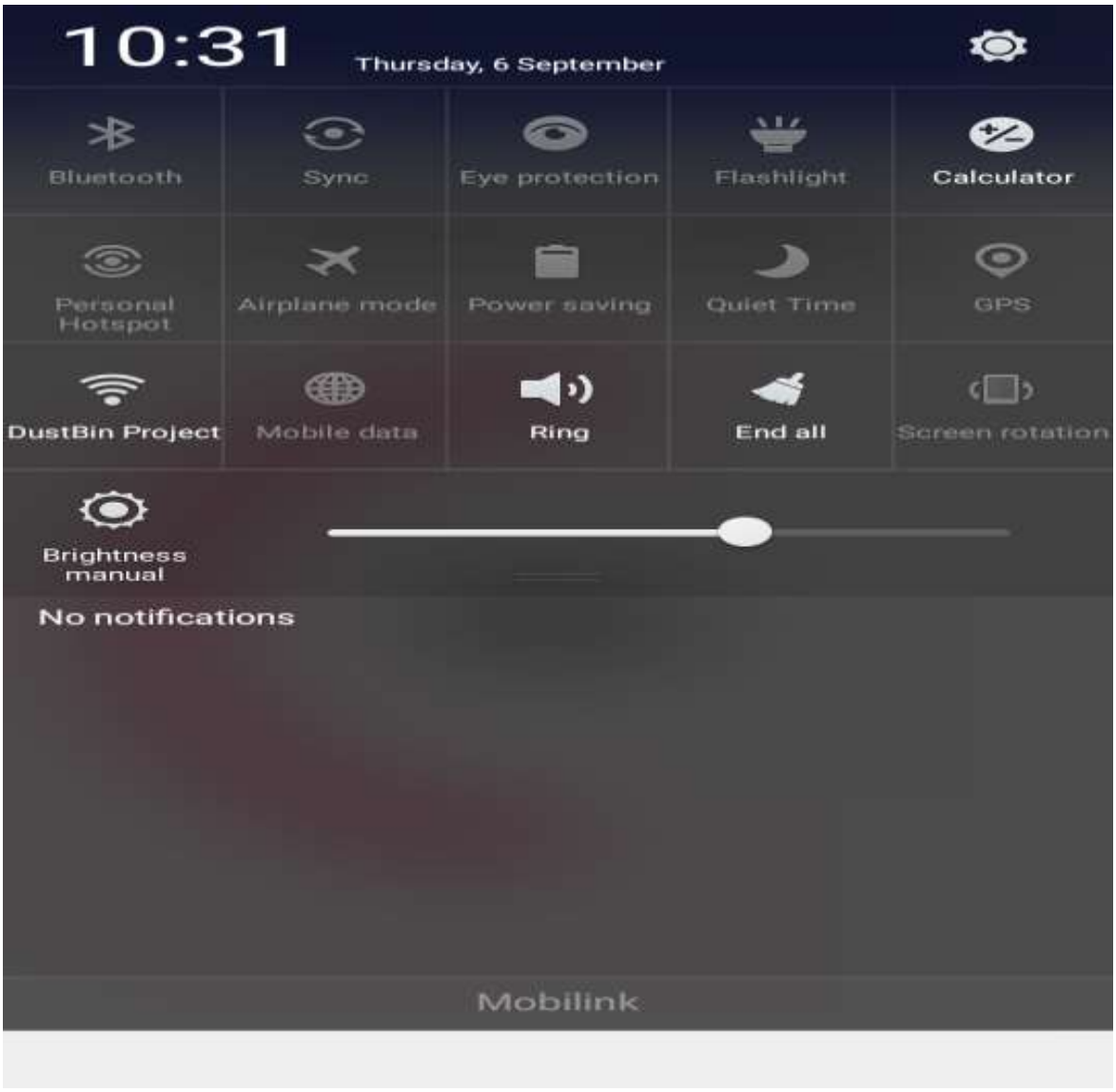

Figure 5.32 Display of Wi-Fi Connectivity with the Mobile

The Wi-Fi status is displayed on the device on which it is being run.

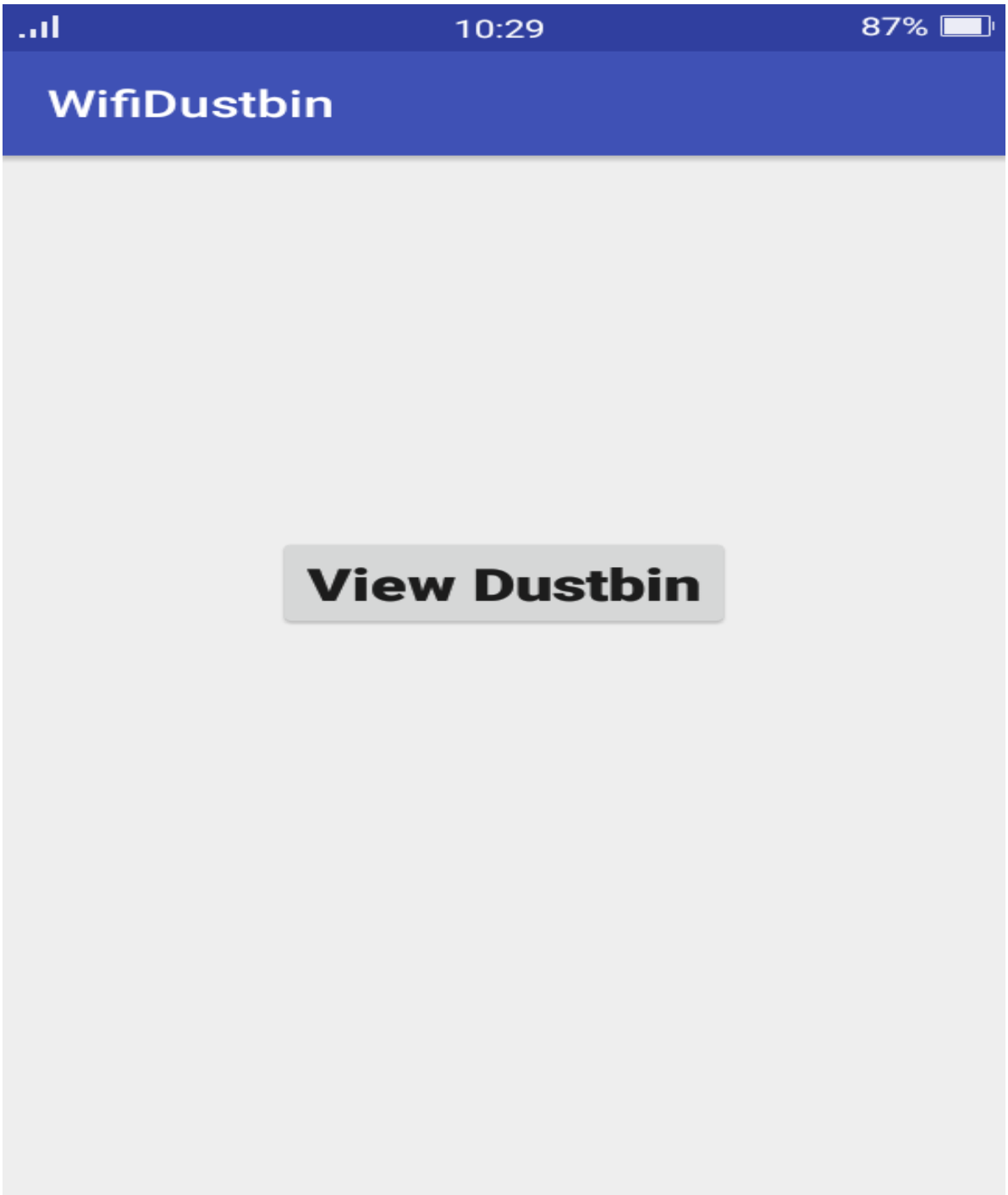

Figure 5.33 Interface of Application

The above figure shows the main page of the mobile application in which there is an option for garbage level (View Dustbin).

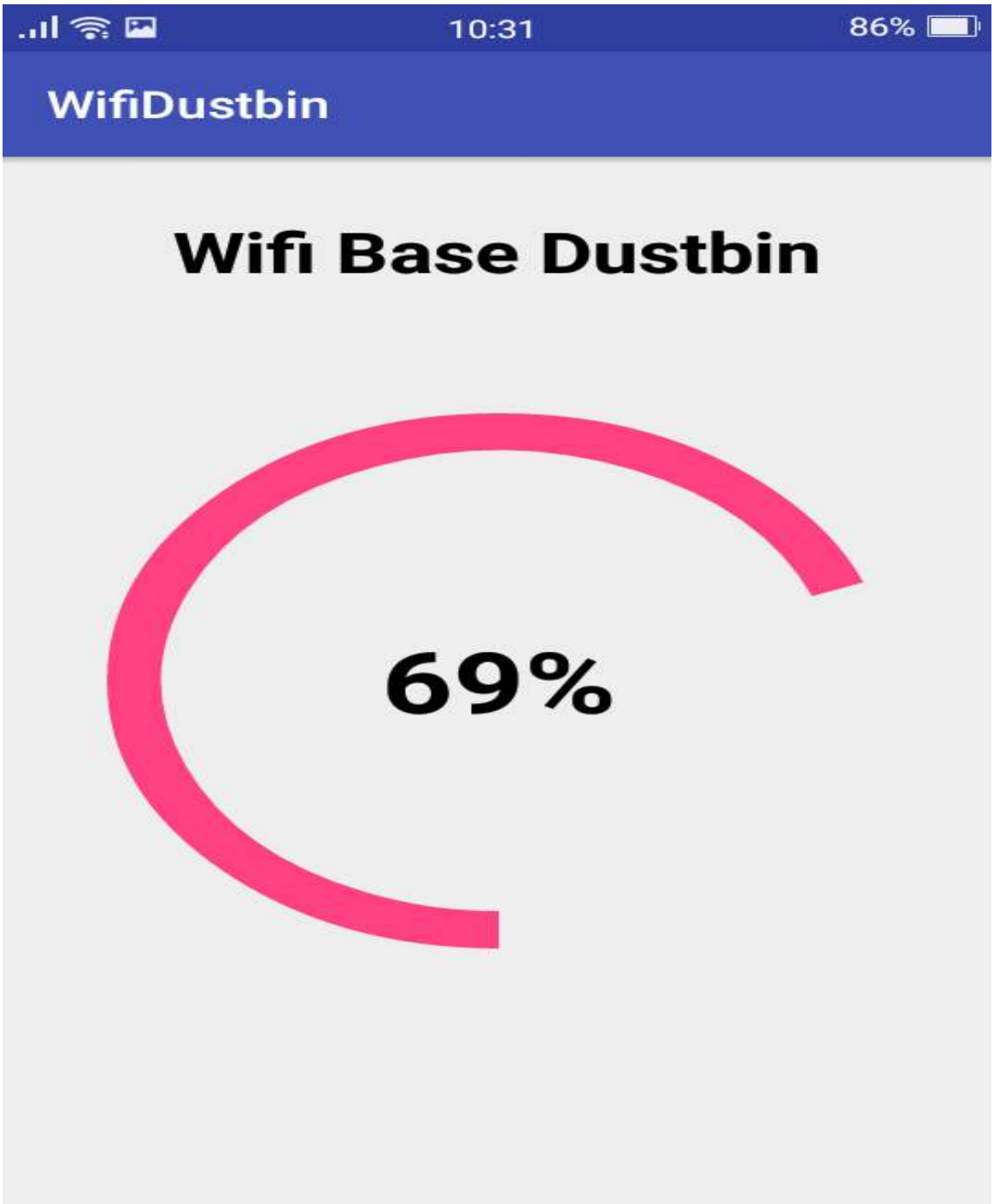

Figure 5.34 Display of Garbage Level

The bin is 69% filled with the garbage.

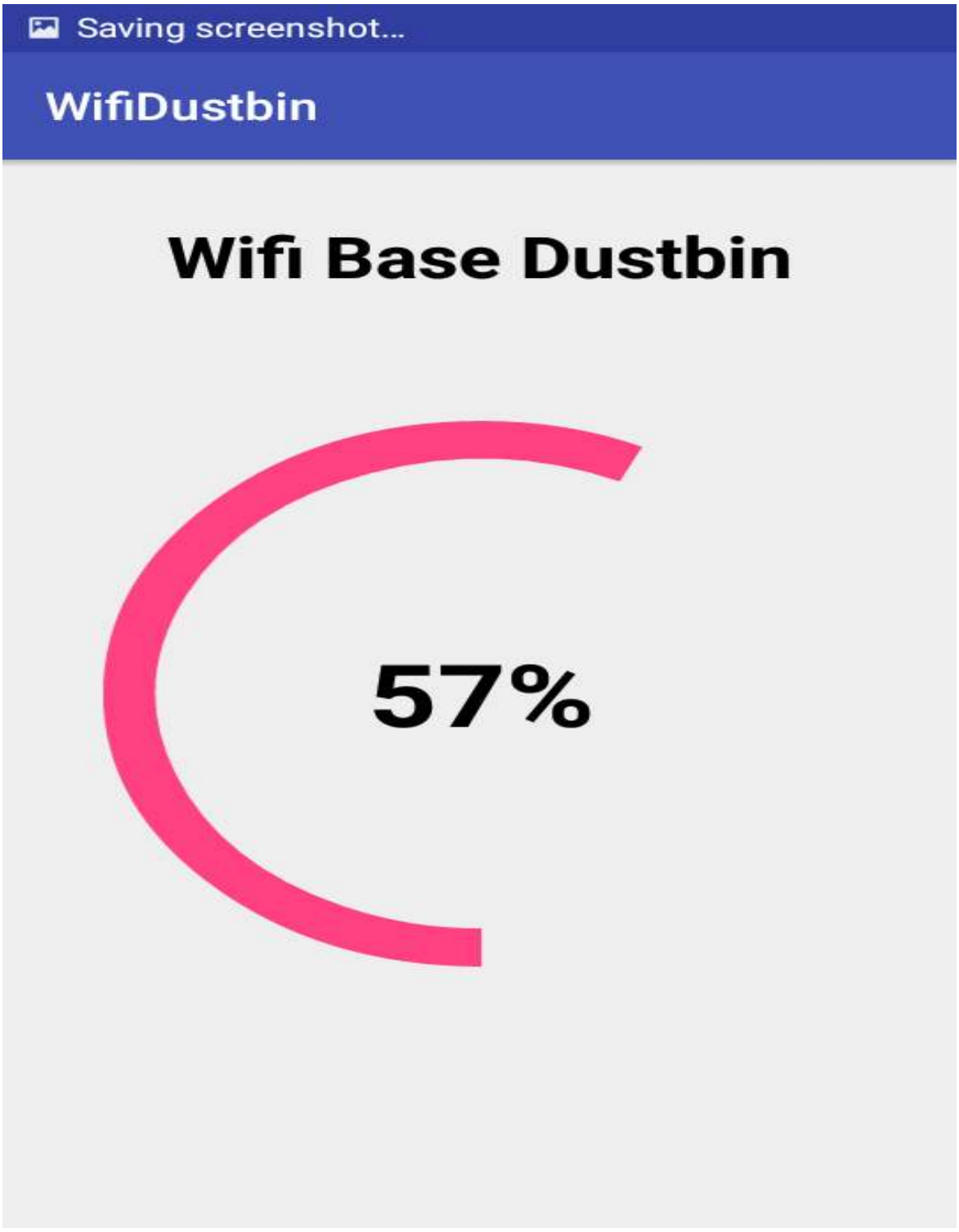

Figure 5.35 Display of Another level of Garbage

The bin is 57% filled with the garbage.

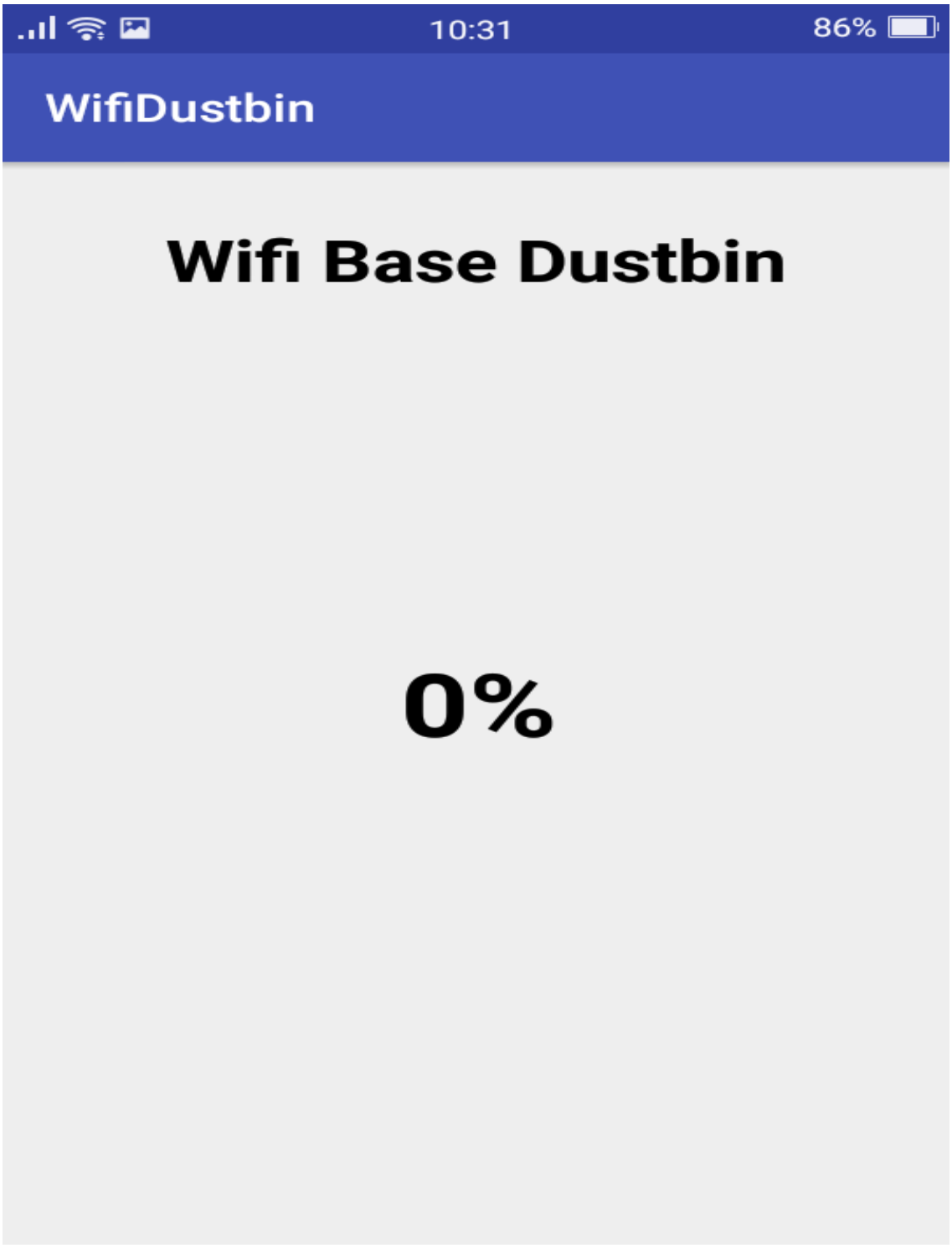

Figure 5.36 When Garbage Bin is Empty

When the bin is empty the app will show 0% status of garbage level.

CHAPTER 6

6 CHALLENGES AND OBSTACLES FACED DURING PROJECT

6.1 DIFFICULTIES WITH ESP8266-01

Our first plan was to use ESP8266-01 for our project but while using ESP8266-01 Wi-Fi module we came across a number of difficulties. Due to these problems we decided to use another way to make internet accessible to our hardware module.

These problems are discussed below:

- **SUPPLYING 3.3.V TO ESP8266-01**

a. USING VOLTAGE DIVIDER METHOD

The biggest problem with ESP8266-01 is to provide 3.3V to the module. ESP8266 is a very sensitive Wi-Fi module and it becomes unstable on voltage greater than 3.3V. For providing 3.3 V to the ESP8266-01 we used different methods.

Firstly, we used a simple voltage divider method that decreases a large value of input voltage to a smaller one. The circuit that we implemented for providing 3.3.V to the Wi-Fi module is shown below:

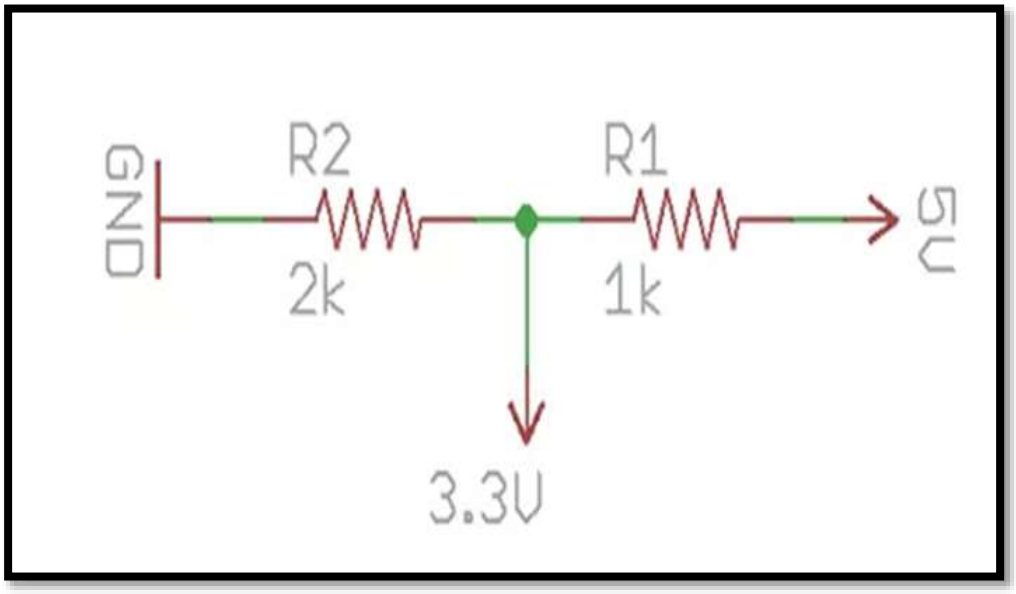

Figure 6.37 Voltage Divider for ESP8266

Implementing this circuit did not result in providing 3.3V to the ESP module. The voltage provided after implementing this circuit was greater than 3.3V and therefore our ESP8266 did not give us any response. [12]

b. USING VOLTAGE REGULATOR ICs

The second method that we used for supplying exact 3.3V to the ESP module is by voltage regulator ICs. The first voltage regulator IC that we wanted to use for ESP8266 was LM-1117 voltage regulating IC but it was not available anywhere so we started finding other voltage regulator ICs and then we decided to use AMS-1117 voltage regulator.

Its circuit is given below:

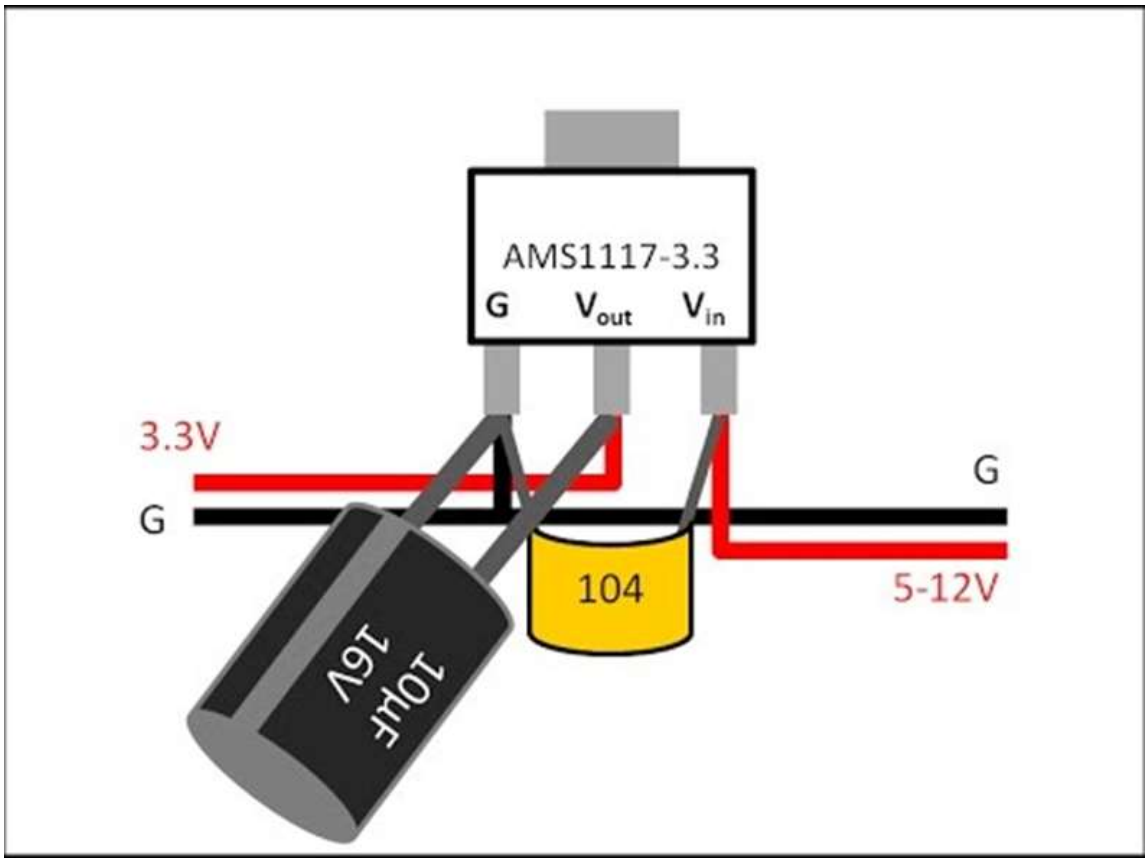

Figure 6.38 Voltage Regulator AMS-1117 for ESP8266

But this method was also not successful for supplying 3.3V to the ESP8266 module.

- **UNABLE TO COMMUNICATE WITH ARDUINO BOARD**

We tried to make our ESP8266 communicate with the Arduino board. For this we runs several AT commands but it was of no use.

We uploaded our code into ESP8266 for its station mode configuration but the serial mode did not respond to any of the AT command. We also tried using different baud rate for serial monitor but it did not make any difference in the output.

- **REPROGRAMMING OF ESP8266**

We were unable to reprogram our ESP module. ESP8266 did not upload any new program in its memory once it has already a program in it.

- **WHY WE USE WEMOS D1 R1 BOARD?**

Due to the above mentioned problems and issues, our ESP module did not work and we were unable to make our Arduino board communicate with the Wi-Fi module and send the sensor data to the android app.

Therefore, we decided to use WEMOS D1 R1 ESP board for our project.

6.2 WEMOS D1 R1 ESP BOARD

Firstly, we were using ESP8266 module and we did a lot of research before using it but after shifting on WEMOS D1 R1 board we had to learn every basic thing about it. We were not fully informed about it so we had to start from scratch using WEMOS board.

Due to the learning of WEMOS board and its specifications a lot of time was required to us for start working on it. We managed time in a way that our one member learn about the basic factors of WEMOS board and the other started its implementation in our project. In this way we tried to save both our time for project completion as well as its research.

6.3 USING ARDUINO IDE FOR OUR PROJECT

As we started working on this project, the first thing we realized is that we have to get full knowledge about its usage and working. Before this project, we have never worked on Arduino IDE. Therefore a large time period was required to us for getting familiar with Arduino IDE environment.

6.3.1 INSTALLING REQUIRED BOARD FOR PROJECT

Before compiling and updating Arduino code on Arduino IDE we have to install the required board and its library that we are using in our project. If the required board is not installed and we upload the Arduino code on another Arduino board then it will not work and will cause different errors.

6.3.2 SERIAL PORT ISSUE

Another problem is to select the right serial port for the Arduino board. When the Arduino board is connected to the laptop or computer, one important thing is to select the correct serial port from the Tools Menu. There are several serial ports options that are available once the Arduino board is connected.

If the serial port is not selected correctly then the Arduino board and Arduino IDE will not communicate and we will not get the desired output and we will get an error like this: serial port COM1 not found.

6.3.3 DEBUGGING ISSUE

During this project we have to debug our code several times due to which we faced many problems.

6.4 GOOGLE MAP

- ✦ App crashes often due to smallest bugs and there is no explanation for it.
- ✦ If the java version is not updated app becomes very slow.
- ✦ The best route is taken according to the traffic but it does not take road blocks, procession and protests that are common nowadays.

CHAPTER 7

7 FUTURE ADVANCEMENTS

7.1 FUTURE WORKs

As the problem of garbage cleaning is gaining attention of many researchers and scientists therefore a lot of work is being done in this domain. However, there are many upgrades and innovations that can be done in current garbage monitoring and cleaning systems.

Some new advancements regarding our garbage collection systems is discussed below:

7.1.1 CAPABILITY TO DIFFERENTIATE BETWEEN DIFFERENT TYPES OF GARBAGE

A method that will differentiate between different garbage in the bin e.g. dry garbage or wet garbage and collecting them separately in a bin. Also, there can be a way to collect the spilled garbage from the bins and putting it back in the garbage bins.

7.1.2 REAL TIME CLOCK DISPLAY

There can be an innovation in our system for the garbage cleaning authorities to monitor the garbage cleaning situation in the city. It will consist of an android app or a simple web page that will display the real time at which the garbage bin is filled and the time at which garbage is collected from the bins.

Through this system the garbage collecting person will work more efficiently because he knows that the authorities are continuously checking the time at which garbage is being collected.

7.1.3 INSTALLING CAMERA SENSORS WITH THE BINS

One advancement that can be done in our system is to employ camera sensors with the smart garbage bins. With the help of video processing the garbage cleaning authorities can keep an eye on the cleanliness situation of the roads and the area.

This will also help to identify the person who will not throw the garbage in the bins properly and the authorities in this way can punish such people who make their area dirty.

7.1.4 COST REDUCTION

Reducing the total cost of the system so that the garbage cleaning authorities can easily employ this system in their respective areas.

7.1.5 MULTIPLE GARBAGE BINS

Making our system able to deal with multiple garbage bins. Due to less time we have implemented this system for only one garbage bin.

7.1.6 MORE DETAILS ABOUT THE GARBAGE BINS

Making such advancement that will give more detailed information about the bin e.g. the weight of the garbage bin, height of the garbage bin.

7.1.7 FUEL CONSUMPTION OF THE GARBAGE COLLECTING TRUCK

To provide another option in the android mobile application that will inform the garbage collecting person about his fuel consumption.

The fuel consumption will be the amount of the fuel consumed to travel towards the garbage bins. The app will tell about different paths available for

reaching towards the garbage bin but at the same time it will tell that which path is the best for less fuel consumption of the garbage collecting truck.

CONCLUSION

We have designed a system that will help in the process of garbage cleaning and monitoring in an effective way. We tried to contribute our efforts in making our city clean. Although the system is yet not employed on a large scale but many future advancements can be done on our prototype to make it work more efficiently.

Our system will detect the level of the garbage in the bins and will notify the driver about it and also the shortest path towards the garbage bin.

APPENDIX

Overview

- Internet of Things (IOT)

Motivation

- Efficient technique
- Ensure clean environment
- Innovative garbage cleaning method

Objectives

- Cost-effective
- User-friendly

Literature Review

- Smart dustbins
- IOT based systems
- Garbage cleaning solutions
- Smart city
- Waste monitoring
- GSM technology
- Web Servers
- GPS technology

Hardware Architecture

- WEMOS
- Ultrasonic technology
- ESP8266
- Easy to use

Software Architecture

- Arduino IDE
- Android Studio
- Board selection
- Serial monitor setting
- ESP8266 libraries
- Arduino functions

Methodology

- Trash bins
- HC-SR04
- ESP8266 WEMOS
- Android Application
- Data retrieval
- Wi-Fi connection
- Google map
- Vero board
- Jumper Wires

Challenges

- Cost-effectiveness
- Shortest path finding

Debugging errors

Future Advancements

Better performance and accuracy

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