CHAPTER 1

INTRODUCTION

In recent years, the landscape of metal detecting robots has evolved significantly, propelled by advancements in robotics, sensing technologies, and artificial intelligence. Today's metal detecting robots exhibit unprecedented levels of sophistication, enabling them to tackle complex tasks in diverse environments with enhanced efficiency and accuracy. Besides, it should be cost-effective as well as portable too. Introduction, aim and objectives, system overview and outlines of thesis will be discussed in this chapter.

1.1 Introduction of IoT Based Metal Detecting Robots

Different technological terms such as Telecommunications, Internet of Things (IoT), and robotics have been considered a vital part of daily activities. Although its advances and limitations, innovative technology can be solved fundamental issues and save lives for many people for political or financial purposes. In the electronic era, speed, flexibility, and automation are major defiance that is enabling researchers to meet the challenges of the society against the quick development of the technologies. Robotics have been becoming dynamically significant for several standard applications such as military, Salvage and Urban Hunt. Due to its human reduction activities in a

severe environment. Effectiveness metal and landmine detections are two vital research areas that still considered more attractive to researchers due to investing technology.

There are a variety of materials including metal and non-metal materials. Non-metal materials include wood, plastic, and other materials that are often used in everyday life. In general, metals are divided into ferrous metals and non-ferrous metals. In everyday life, metal materials are usually used to conduct electricity, cooking utensils, jewelry, even for military purposes, one of which is the material for defense equipment such as mines. In the military world, mines are usually planted below the surface of the ground, so that if mines are pressed heavily, a mass trampled

object will explode. Mines contain explosives that have certain physical and chemical properties.

Using of robots as a tool can work as closely as possible with what humans do. Some robots are designed to have arms, robots that can follow certain colors, robots that can deliver food, robots that can guide parking, robots that are currently developing in connection with the outbreak. Metal detection robots are tools to detect the presence of metal or materials containing metal, this robot will notify the presence of metal around the robot by using light or sound.

These applications are safer and more efficient due to provide a safe route for the soldiers through minefields. Robotics, communication, and data analysis have been advanced with high-speed achieved in landmine detection domain. Data management, analysis, and archiving for the detection, navigating and mapping area will open to more deployed possibilities for furthermore mapping and detection areas. Automation mechanism presents easier and faster scanning process due to it provides the guarantee to more rapid the scanning processing and investigation automatically [1].

This thesis presents a new type of robot that uses a metal detector sensor to detect metallic object passing over the metal detector. The robotic vehicle is controlled using android application for metal detection operation controlled with the help of Wi-Fi technology. This thesis can be widely used because of its simplicity and ability to modify to meet changes of needs. Based on experimental studies, it was found that the

mobile controlled robot can move in any direction as per the desired instruction and the beeper in the metal detector circuit beeps whenever it encounters any metallic object.

The embedded hardware has been developed on ESP32 development board and controlled by an android smartphone. This controller receives the commands from the android phone, takes the data and controls the motors of the robot by the motor driver L298N. The robot can able to move forward, backward, left and right movements. The smartphone is been interfaced to the device by using Wi-Fi. A metal detector sensor was connected to the robot to detect the metal. A beep sound was made when it detected the metal.

1.2 Aim and Objectives

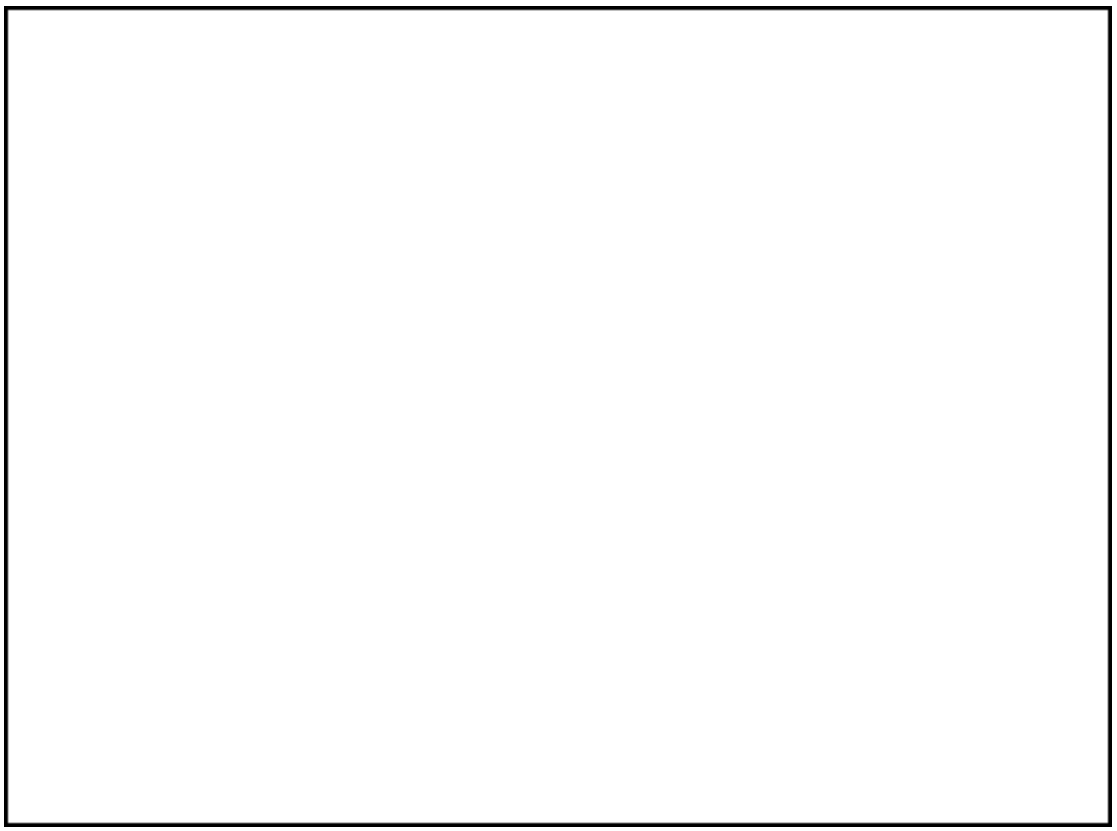
The main aim of this thesis is to detect metal objects on the surface.

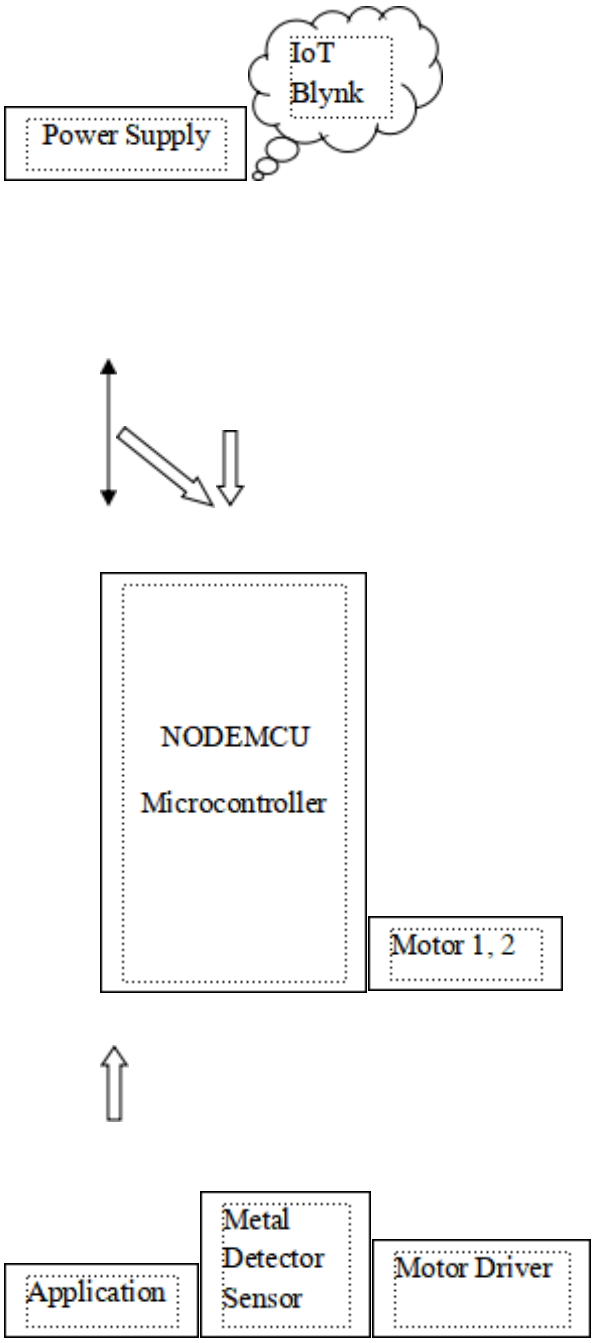
The objectives of this thesis are:

- To create a system capable of accurately detecting metallic object
- To search interesting stuff from where people are not able to reach
- To detect landmines or other metal-based objects on its path
- To improve the life of people with help of technology

1.3 System Overview

First, all of the devices are supplied by the power supply. ESP32 development board is used as a controller in IoT based metal detecting robot with GPS. This controller receives the commands from the android phone, takes the data and controls the motors of the robot by the motor driver L298N. The robot can be able to move forward, backward, left and right movements. The smartphone is interfaced to the device by using Wi-Fi. Figure1.1 shows block diagram of IoT based metal detecting robot with GPS system.




IoT
Blynk
Power Supply
NODEMCU
Microcontroller
Motor 1, 2
Application
Metal
Detector
Sensor
Motor Driver

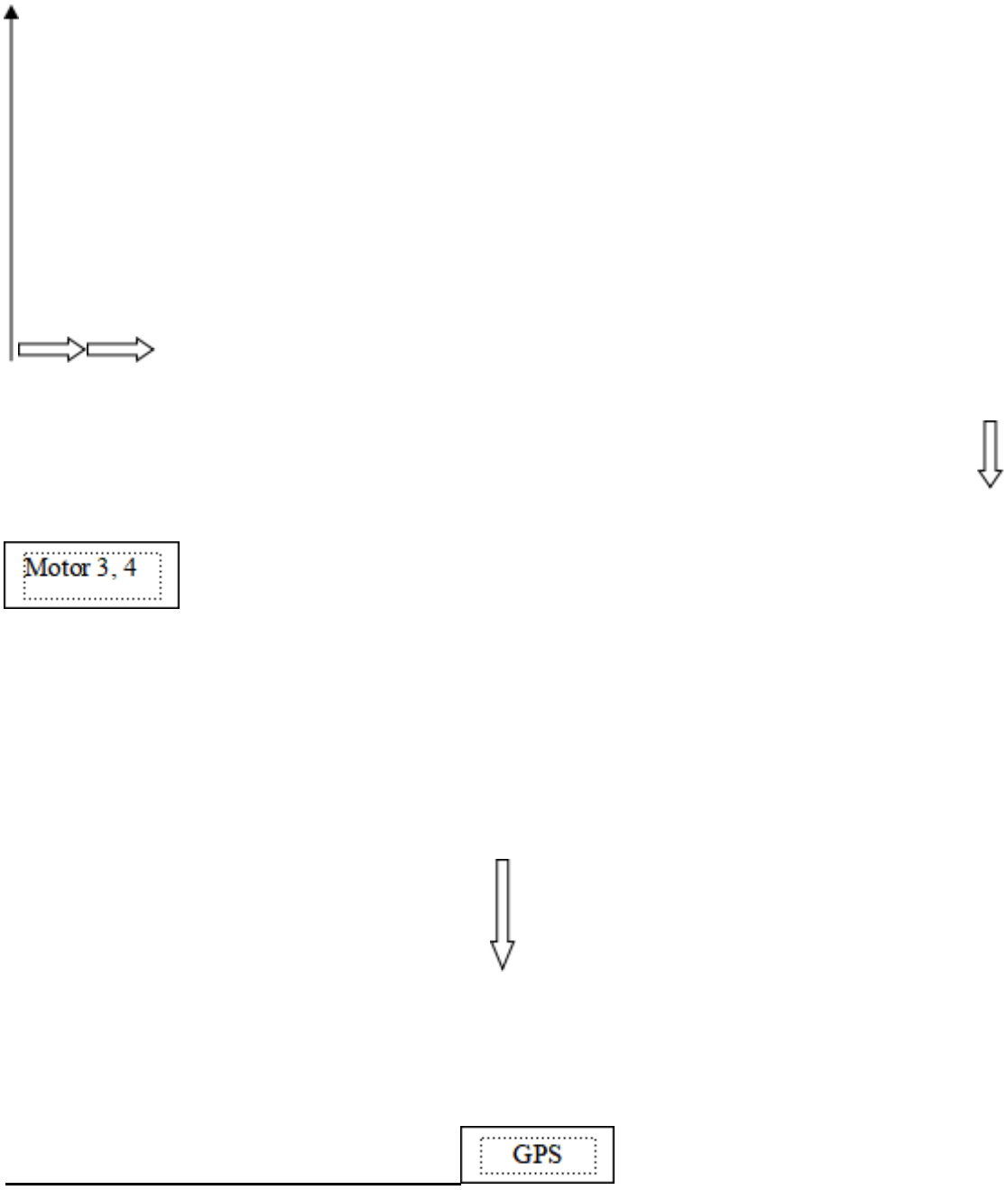


Figure1.1 Block Diagram of IoT Based Metal Detecting Robot with GPS System

A metal detector circuit was connected to robot to detect the metal. A metal detector module senses metal from surrounding. Then, metal detector sensor sends the data to ESP32 development board when metal detector sensor senses the metal from environment.

A beep sound was made when it detected the metal. If ESP32 received the sensors data, it sends received data to Blynk app and A9G GPS sends an E-mail to user with location coordinates. The user can enter these coordinates into Google Maps to view precise location. If metal detector sensor does not detect any metal, metal will be sensed. It is very useful to monitor the detecting metal of a given place and make the information visible anywhere in the world.

1.4 Outlines of Thesis

This thesis composes of five chapters. Chapter one covers IoT based metal detecting robot with GPS such as introduction, aim and objectives of thesis, operation summary of thesis. Chapter two explains background theory and components of the system. Design and implementation of the system are presented in chapter three. Chapter four describes test and results of IoT based metal detecting robot with GPS system. Chapter five concludes discussion, conclusion and further extension of the research.

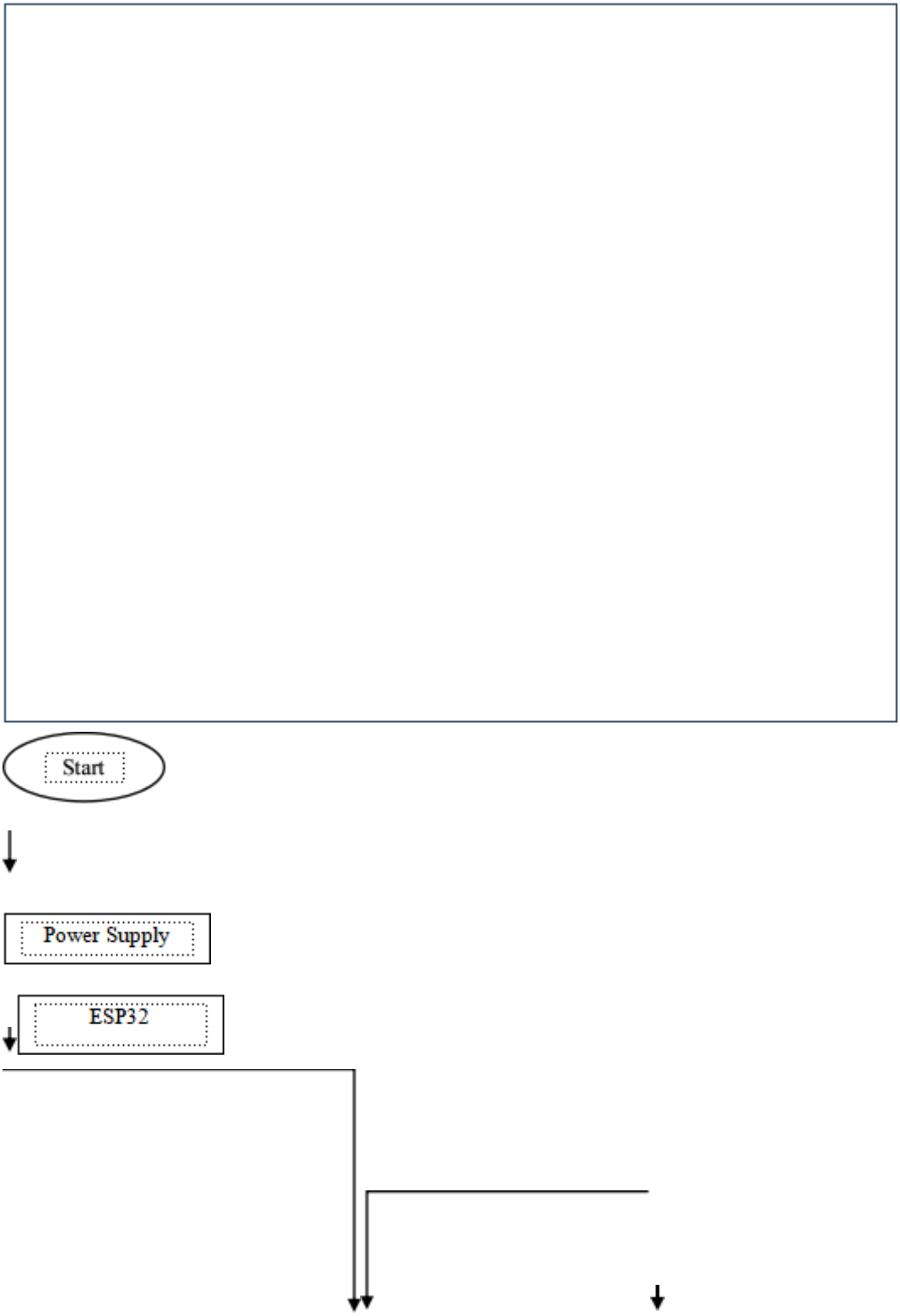
CHAPTER 3

DESIGN AND IMPLEMENTATION OF THE SYSTEM

This chapter describes the implementation of metal detecting robot with GPS system. The hardware implementation of the system and flow chart of metal detecting robot with GPS system are described in this section.

3.1 Operation of Metal Detecting Robot with GPS System

The IoT based metal detecting robot with GPS system is tested by using Arduino IDE and C++ microcontroller library is used to control related module such as an ESP32 development board, metal detector sensor, L298N motor driver shield, LM2596 step down converter, four gear motors, rechargeable battery and A9G GPS. Figure 3.1 shows flowchart of metal detecting robot.


Start
Power Supply
ESP32

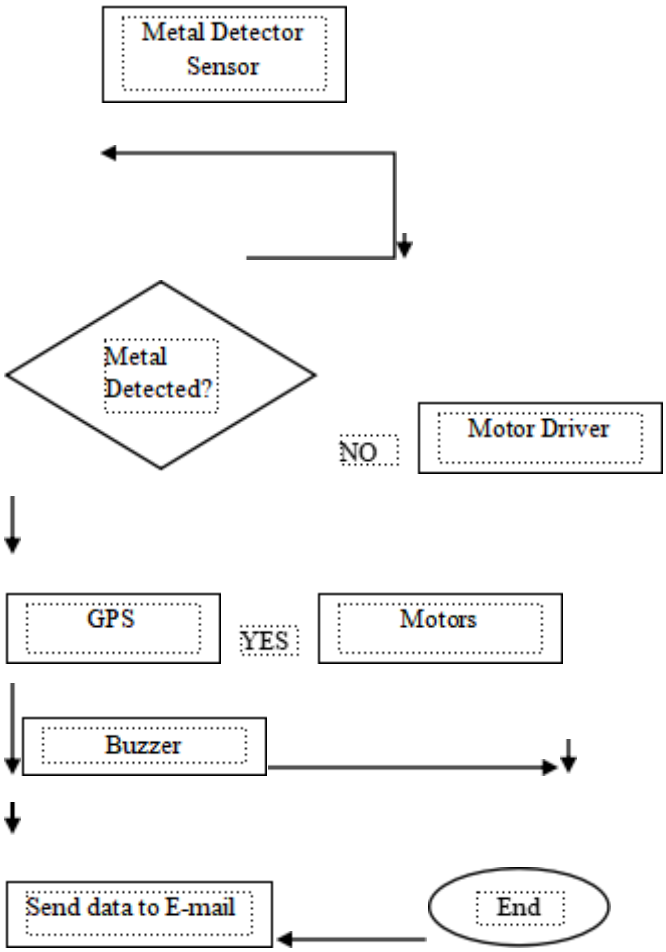


Figure 3.1 Flowchart of Metal Detecting Robot

First, all of the devices are supplied by the power supply. ESP32 development board is used as a controller in IoT based metal detecting robot with GPS. This controller receives the commands from the android phone, takes the data and controls the motors of the robot by the motor driver L298N. The robot can able to move forward, backward, left and right movements. The smartphone is interfaced to the device by using Wi-Fi.

A metal detector circuit was connected to the robot to detect the metal. The metal detector module senses any metal from surrounding. Then, metal detector sensor sends the data to ESP32 development board when metal detector sensor senses the metal from environment.

A beep sound was made when it detected the metal. If ESP32 received the sensors data, it sends received data to Blynk app and A9G GPS sends an E-mail to user with location coordinates. The user can enter these coordinates into Google Maps to view precise location. If metal detector sensor does not detect any metal, metal will be sensed. It is very useful to monitor the detecting metal of a given place and make the information visible anywhere in the world.

3.2 Pin Connection of ESP32 Development Board and Required Components

The pin connection of ESP32 development board and required components are showed in the following.

3.2.1 Connection of ESP32 Developemnt Board and Metal Detector Sensor

A metal detector sensor module is a device that uses electromagnetic induction to detect the presence of metal objects. LC metal detector non-contact metal induction detection module as a metal detector can be used. When it approaches any metal, it makes a sound. Metal detector sensor senses any metal within 3cm.

This is a module specifically designed to detect metal. The module operates by inducing currents in metal objects and responding when it occurs. A nice onboard buzzer signals when it detects something and an onboard potentiometer allows adjustment of sensitivity.

The power cables of the metal detector non-contact metal induction detection module will need soldering in order for the module to function, positive to the outside of the module and negative between the potentiometer and an electrolytic capacitor. The user can connect pins VIN, GND and OUT of the metal detector sensor with digital pins VIN, GND and D4 of ESP32 development board. The hardware pin connection of ESP32 development board and metal detector sensor is shown in Figure 3.2.

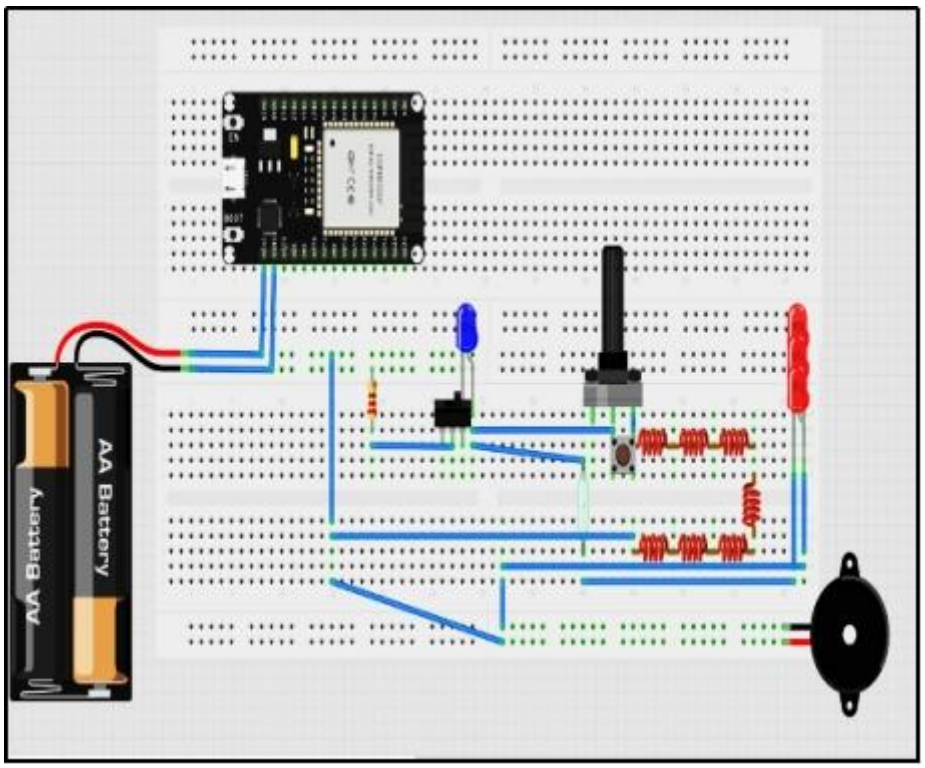


Figure 3.2 Pin Connection of ESP32 Development Board and Metal Detector Sensor

The hardware pin connection of metal detector sensor and ESP32 development board is shown in Table 3.1.

Table 3.1 Pin Connection of ESP32 Development Board and Metal Detector Sensor

No	Metal Detector Sensor	ESP32 Development Board
1	VCC	5V
2	OUT	D4
3	-	-
4	GND	GND

3.2.2 Connection of A9G GPS and ESP32 Development Board

A9G GPS can be used to connect modules such as Arduino and Raspberry Pi to the internet and can be used in a wide range of IoT applications and is ideal for IoT applications for home automation, industrial wireless control, wearable electronics, wireless location sensing devices, wireless location system signals, and other IoT applications.

In this system, A9G GPS and ESP32 development board are used by connecting as the serial communication. A9G GPS is used to track the location of metal. Pins 5V, GND, TX1 and RX1 of A9G GPS are connected to pins VIN, GND, TX2 and RX2 of ESP 32 development board.

The users can available the location of a particular place from Blynk via ESP32 development board and send the data to E-mail. The following Figure 3.3 shows pin connection of ESP32 development board and A9G GPS.

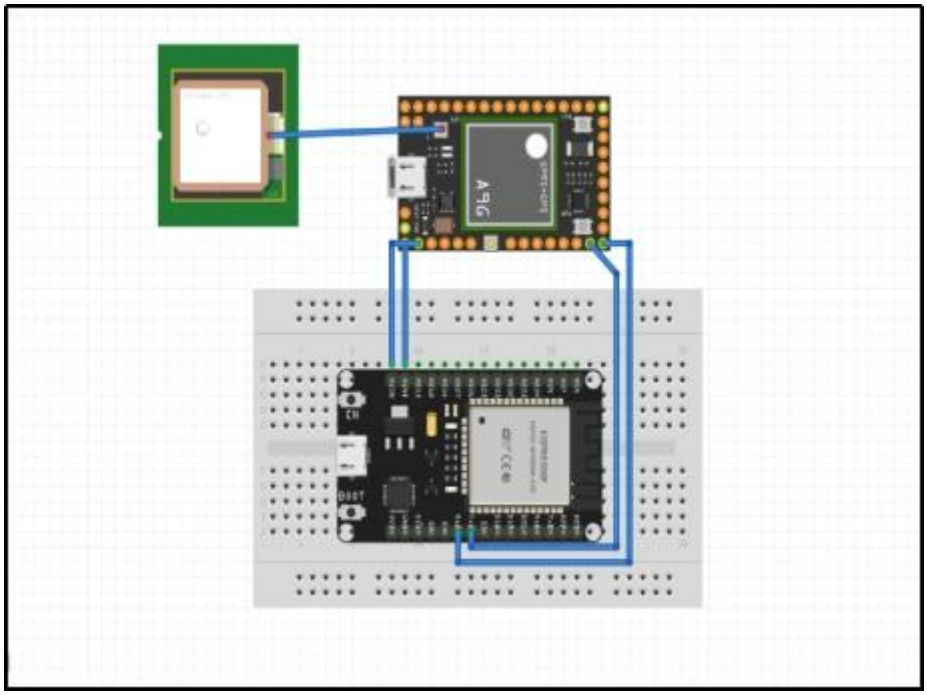


Figure 3.3 Pin Connection of ESP32 Development Board and A9G GPS

The hardware pin connection of A9G GPS and ESP32 development board is shown in Table 3.2.

Table 3.2 Pin Connection of ESP32 Development Board and A9G GPS

No	A9G GPS	ESP32 Development Board
1	VCC	5V
2	TX1	RX2
3	RX1	TX2
4	GND	GND

3.2.3 Connection of Power Supply with LM2596 Step Down Converter

Three 3.7V batteries have been connected in series. To stable or reduce this voltage, LM2596 step down converter is connected with these batteries. Figure 3.4 shows hardware pin connection of power supply with LM2596 step down converter.

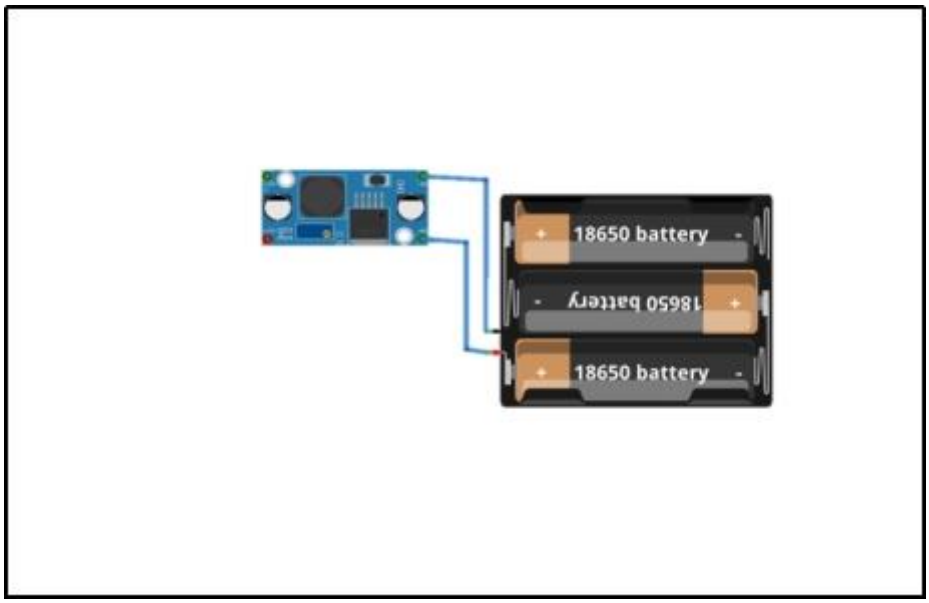


Figure 3.4 Pin Connection of Power Supply with LM2596 Step Down Converter

The hardware pin connection of power supply with LM2596 step down converter is shown in Table 3.3.

Table 3.3 Pin Connection of Power Supply with LM2596 Step Down Converter

No	Power Supply	LM2596 Step Down Converter
1	+	IN (+)
2	-	IN (-)

3.2.4 Connection of L298N Motor Driver Shield with Four Gear Motors

In order to drive four gear motors, L298N motor driver shield is used in this system. The L298N motor driver shield is a dual H-Bridge motor driver which allows speed and direction control of two DC motors at the same time. The module can drive DC motors that have voltages between 5V and 35V, with a peak current up to 2A.

It uses a L298N PWM system, which can control voltage using square wave pulses. The wider the pulses, the faster the motor will rotate. However, the exact pulse width will vary depending on the type of motor. The hardware pin connection of L298N motor driver shield with four gear motors is shown in Figure 3.5.

LM2596 step down converter is used to reduce the voltages of power supply. This module has a multi-turn trim pot (potentiometer) to adjust the LM2596's output voltage. Since the trim pot has 25 turns of adjustment, the output of the module to exactly the voltage can be easily adjusted. Four excellent DC gear motors that can rotate at 200 RPM and operate between 3 and 6 V, is perfect for robotics thesis.

In this system, all of the devices are supplied by the power supply. LM2596 DC-DC step down converter is used to reduce the voltage of power supply. VIN and GND of power supply are connected to IN (+) and IN (-) of LM2596 step down converter.

OUT (+) and OUT (-) of LM2596 step down converter are connected to 12V and GND of L298N motor driver shield. L298N motor driver shield is used to drive

four gear motors and provide 5V to ESP32 development board. OUT1, OUT2, OUT3 and OUT4 of L2596 step down converter are connected to four gear motors.

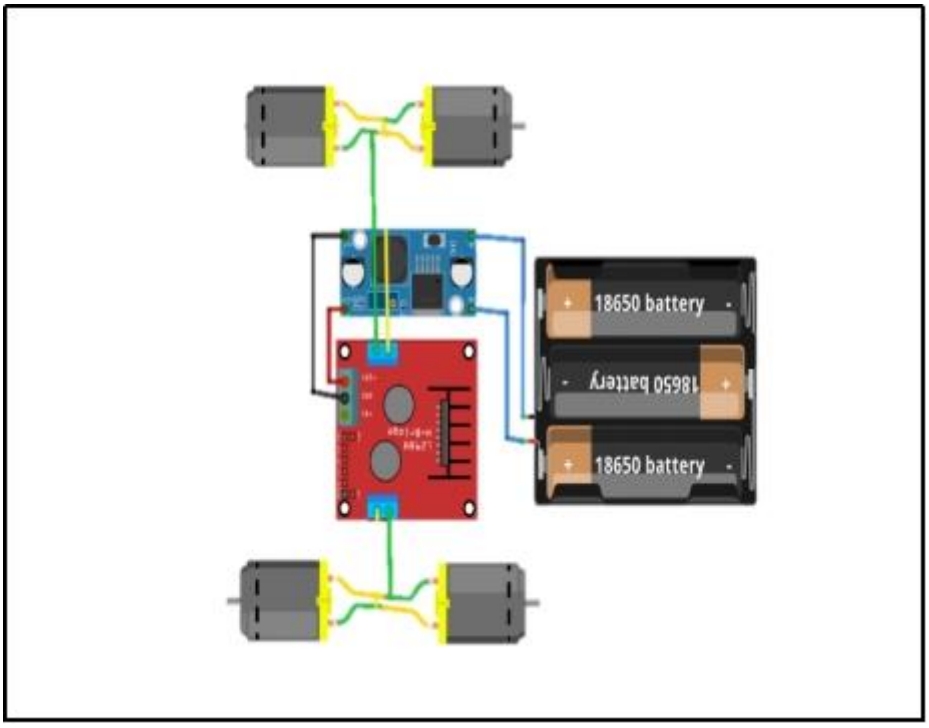


Figure 3.5 Pin Connection of L298N Motor Driver Shield with Four Gear Motors

The hardware pin connection of L298N motor driver shield with four gear motors is shown in Table 3.4.

Table 3.4 Pin Connection of L298N Motor Driver Shield with Four Gear Motors

No	Power Supply	LM 2596 Step Down Converter	L298N Motor Driver Shield	Four Gear Motor
1	+	IN (+)	-	-
2	-	IN (-)	-	-

3	-	OUT (+)	12V	-
4	-	OUT (-)	GND	-
5	-	-	OUT1	IN1
6	-	-	OUT2	IN2
7	-	-	OUT3	IN3
8	-	-	OUT4	IN4

Pins VIN, GND, D19, D18, D13 and D12 of ESP32 development board are connected to pins 5V, IN1, IN2, IN3, IN4 of L298N motor driver shield. The pin connection of four gear motors with ESP32 development board is shown in Figure 3.6.

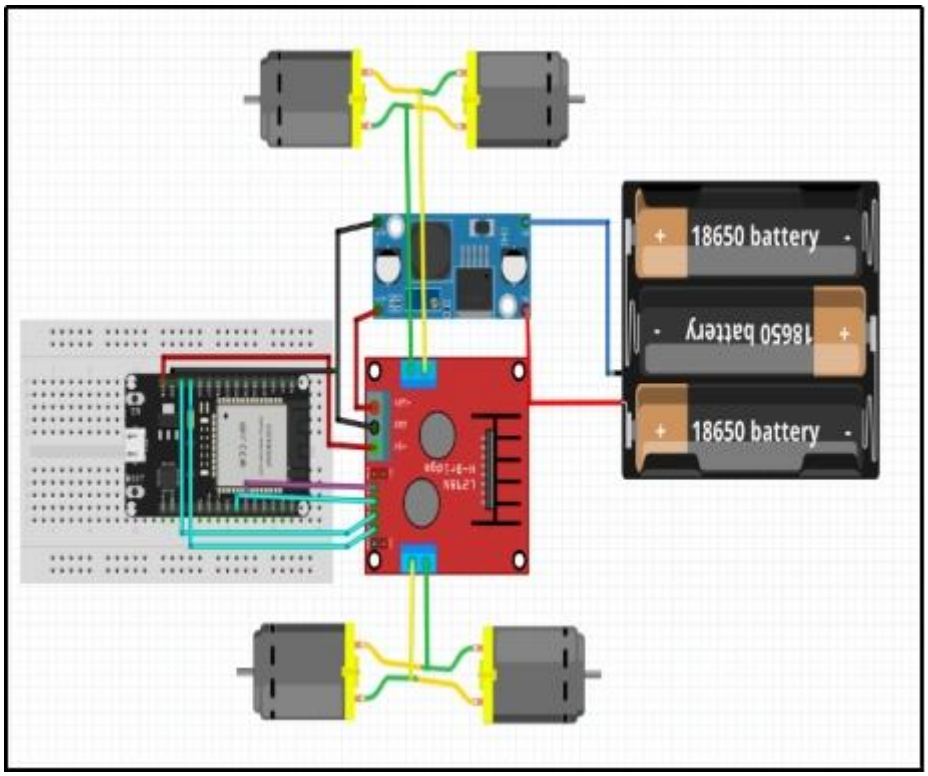


Figure 3.6 Pin Connection of Four Gear Motors with ESP32 Development Board

The pin connection of four gear motors with ESP32 development board is shown in Table 3.5.

Table 3.5 Pin Connection of Four Gear Motors with ESP32 Development Board

No	ESP32 Development Board	L298N Motor Driver Shield	LM2596 Step Down Converter	Four Gear Motor
1	VIN	5V	-	-
2	OUT	12V	OUT (+)	-
3	D19	IN1	-	-
4	D18	IN2	-	-
5	D13	IN3	-	-
6	D12	IN4	-	-
7	-	OUT1	-	IN1
8	-	OUT2	-	IN2
9	-	OUT3	-	IN3
10	-	OUT4	-	IN4
11	GND	GND	OUT (-)	-

3.2.5 Overall Pin Connections of Metal Detecting Robot

In this system, all of the devices are supplied by the power supply. LM2596 DC-DC step down converter is used to reduce the voltage of power supply. VIN and GND of power supply are connected to IN (+) and IN (-) of LM2596 step down converter. OUT (+) and OUT (-) of LM2596 step down converter are connected to 12V and GND of L298N motor driver shield.

L298N motor driver shield is used to drive four gear motors and provide 5V to ESP32 development board. OUT1, OUT2, OUT3 and OUT4 of L2596 motor driver shield are connected to four gear motors. Pins VIN, GND, D19, D18, D13 and D12 of ESP32 development board are connected to pins 5V, IN1, IN2, IN3, IN4 of L298N motor driver shield. ESP32 development board is used as a microcontroller. corresponding program is uploaded into the ESP32 development board. Metal detector sensor is used to detect any metal of the environment. The user can connect pins VIN, GND and OUT of the metal detector sensor with digital pins VIN, GND and D4 of ESP32 development board.

A9G GPS is used to track the location of metal. Pins 5V, GND, TX1 and RX1 of A9G GPS are connected to pins VIN, GND, TX2 and RX2 of ESP 32 development board. The users can available the location of place via ESP32 development board and send the data to E-mail with coordinates.

The user can enter coordinates into Google Maps to view the precise location. Figure 3.7 shows overall pin connection of metal detecting robot.

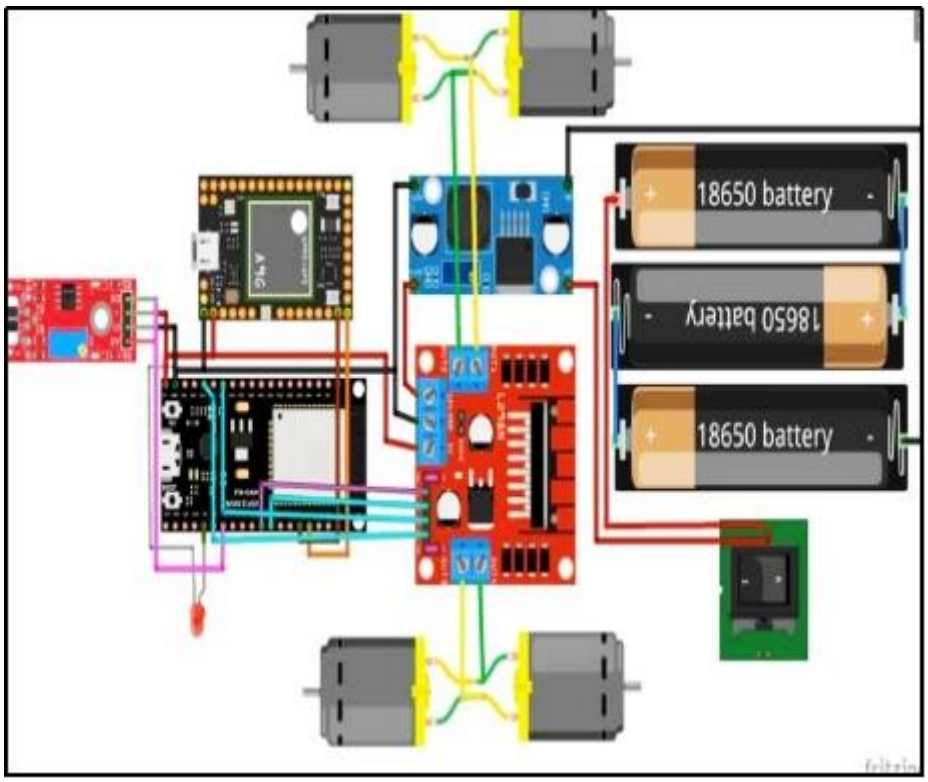


Figure 3.7 Overall Pin Connection of Metal Detecting Robot

3.3 Hardware Implementation

Each hardware implementation of IoT based metal detecting robot with GPS system is showed in the following. Each section provides a comprehensive explanation of various components and steps required to build the robot.

3.3.1 Hardware Implementation of Four Gear Motors

To build a metal detecting robot, the first step involves installing the four gear motors as shown in Figure 3.8. The gear motors are crucial for driving the wheels and allowing the robot to move efficiently.

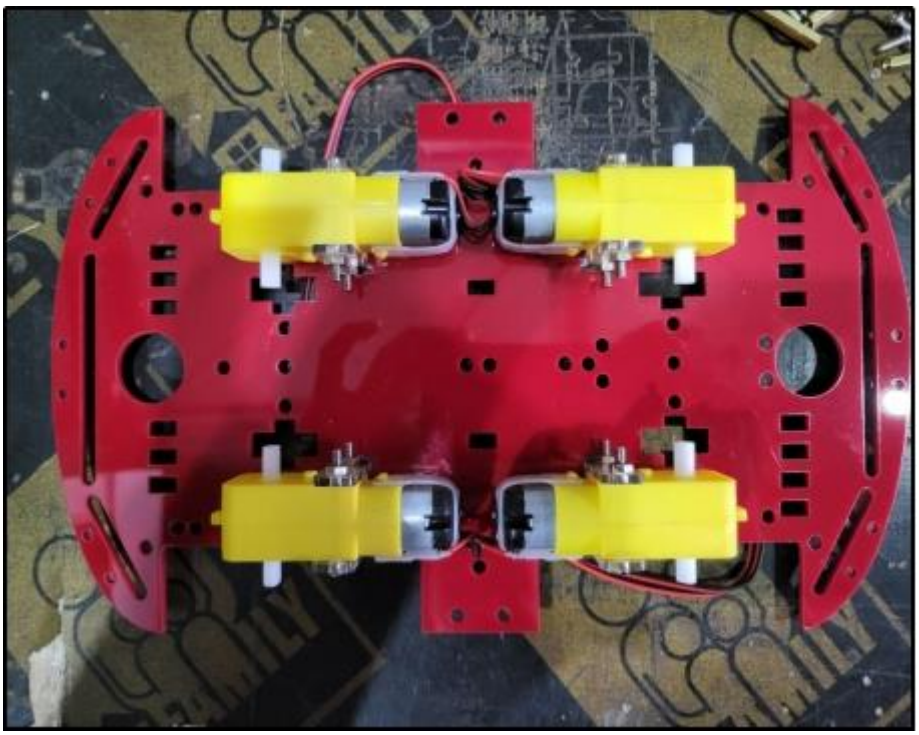


Figure 3.8 Implementation of Four Gear Motors

3.3.2 Hardware Implementation of L298N Motor Driver Shield with Four Gear Wheels

In Figure 3.9 shows a set up with four gear motors and four wheels. Three batteries that have 3.7V are connected in series.

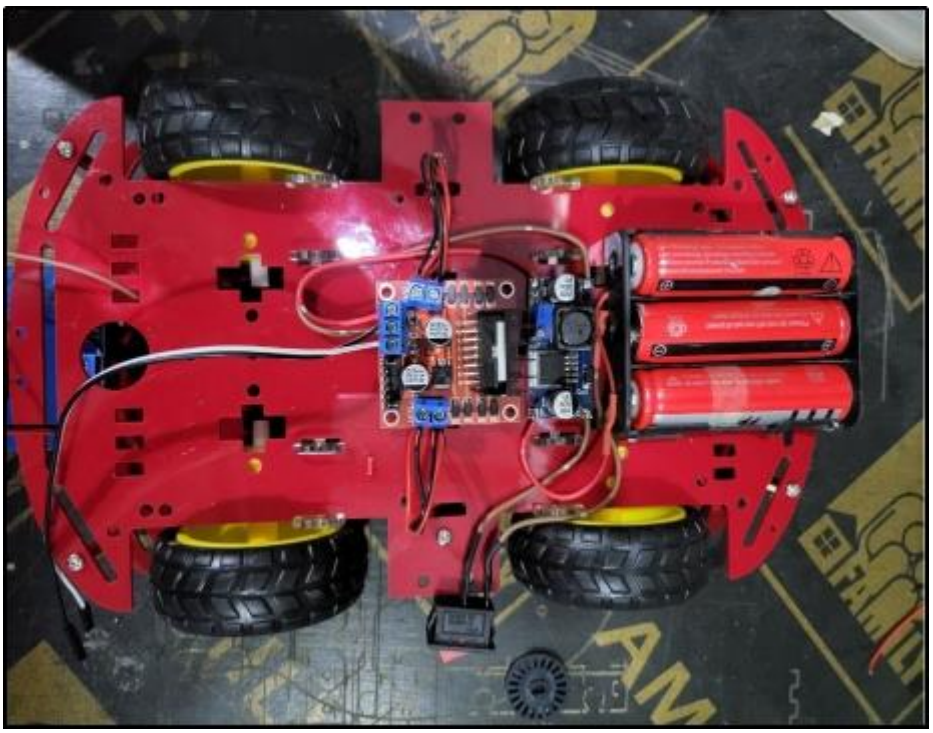


Figure 3.9 Implementation of Four Gear Motors with Wheels

And then LM2596 step down converter reduces the volage of power supply and connects with L298N motor driver shield to provide 5V to ESP32 development board and A9G (GPS).

Figure 3.10 shows how all of the components are assembled together.

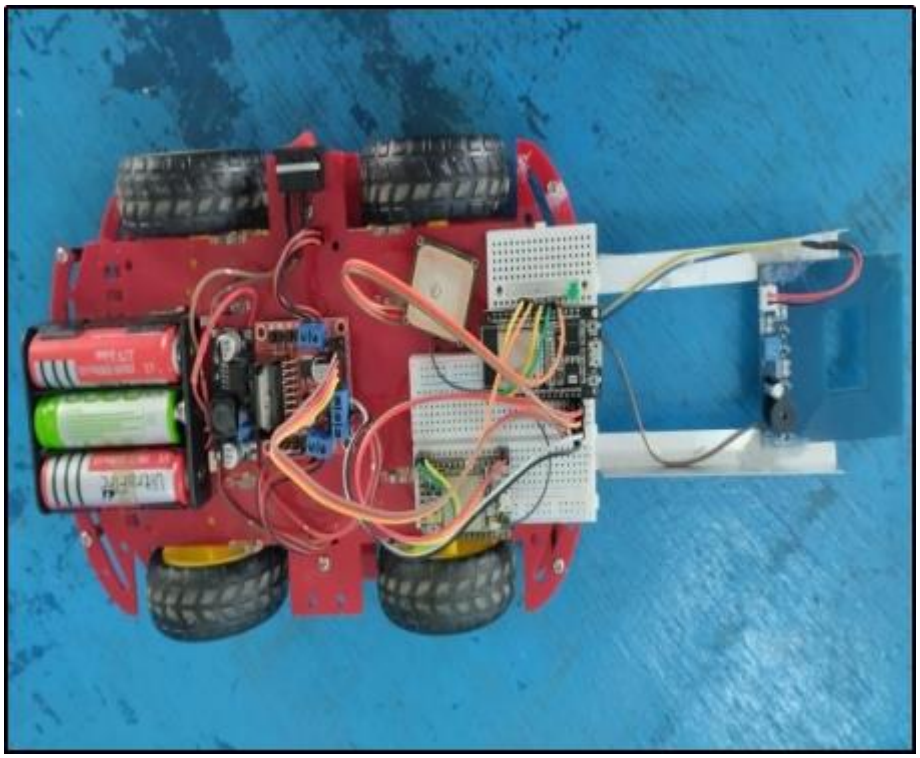


Figure 3.10 Implementation of All Components

3.3.3 Overall Hardware Installation of Metal Detecting Robot

In this system, 12V Rechargeable battery is used for supply of all devices. LM2596 step down converter is used to reduce the voltage of power supply. L298N motor driver shield is used to drive four gear motors. 5V of L298N motor driver shield is applied to supply ESP32 development board and A9G GPS. ESP32 development board is used as a main microcontroller.

Arduino IDE and C++ microcontroller library is used to control related module such as an ESP32 development board, metal detector sensor, L298N motor driver shield, LM2596 step down converter, four gear motors, rechargeable battery and A9G GPS.A9G GPS is used to track location of metal. Metal detector sensor is used to detect

the metal everywhere. Metal detector sensor can sense metal within 3cm. To move forward, backward, left and right, robot can be controlled from Blynk (web application).

When the metal is detected, the indicator LED of Blynk becomes active and get location of metal using GPS via ESP 32 development board. Location with coordinates of metal is showed on E-mail of user. The user can enter these coordinates into Google Maps to view precise location.

3.4 Summary

In this chapter, the steps for the system operation are described briefly. The required pins set up of IoT based metal detection robot with GPS system are also described. And sketch of the pin configuration of ESP32 development board and requirements are explained in this chapter. Test and results of IoT based metal detection robot with GPS system will be discussed in next chapter.

CHAPTER 4

TEST AND RESULTS

This chapter emphasizes the test and results of IoT based metal detecting robot with GPS system. This chapter includes the test and final results of the system.

4.1 Test and Results of Metal Detector Sensor with ESP32 Development Board

Firstly, ESP32 development board is connected to metal detector sensor for detecting metal system. The USB plug of ESP32 development board is connected to the computer's USB.

And then upload the program to ESP32 development board, the metal detector sensor starts to sense metal from environment which is less than three centimeters. When it detects any metal, it makes a sound.

The test of the metal detector sensor with ESP32 development board is shown in Figure 4.1.

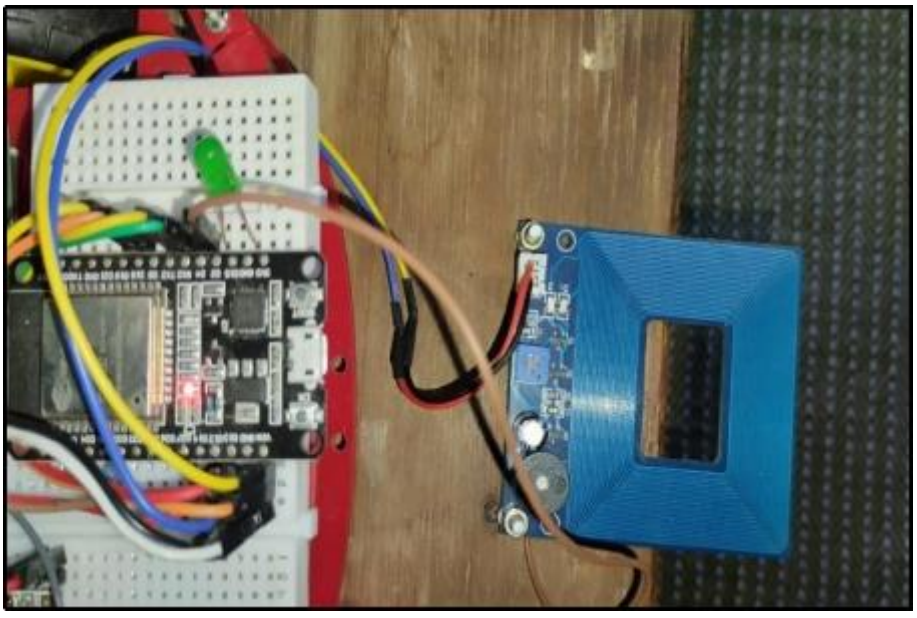


Figure 4.1 Test of Metal Detector Sensor with ESP32 Development Board

The result of metal detector sensor detected metal from environment is shown in Figure 4.2.

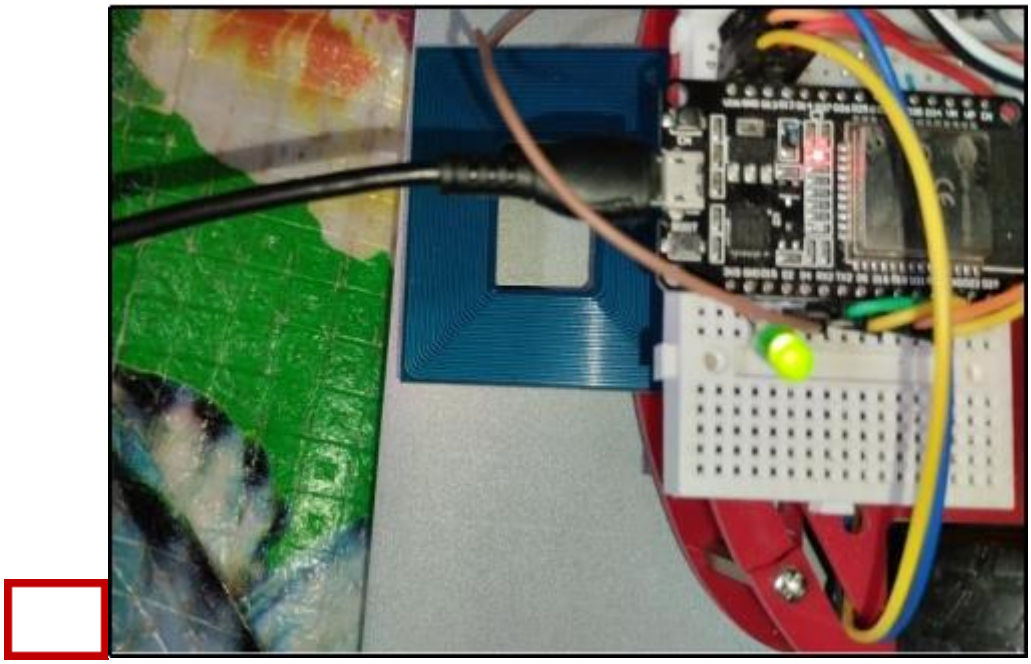


Figure 4.2 Result of Metal Detector Sensor with ESP32 Development Board

Figure 4.3 shows the results of indicator LED on the Blynk app, LED will be lighted up when the metal is detected.

Figure 4.3 Result of Indicator LED on Blynk App will be Lighted up

4.2 Test and Results of A9G GPS with ESP32 Development Board

Initially the pins of ESP32 development board and A9G GPS are connected respectively. And then uploaded a program to the ESP32 development board. A9G GPS start to track the location of metal. If the metal is detected to metal detector sensor, A9G GPS tracks the location and then send data to user's E-mail. The data on E-mail is searched on Google. The user can be found location of metal on Google Maps. The test of A9G GPS with ESP32 development board is shown in Figure 4.4.

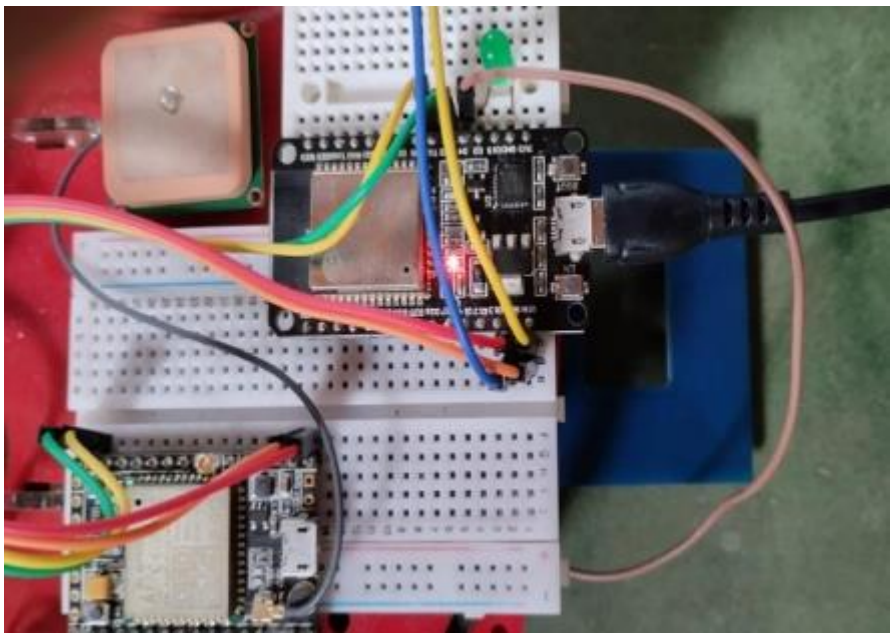


Figure 4.4 Test of A9G GPS with ESP32 Development Board

The result of tracking location of metal that metal detector sensor detected metal from environment is shown in Figure 4.5.

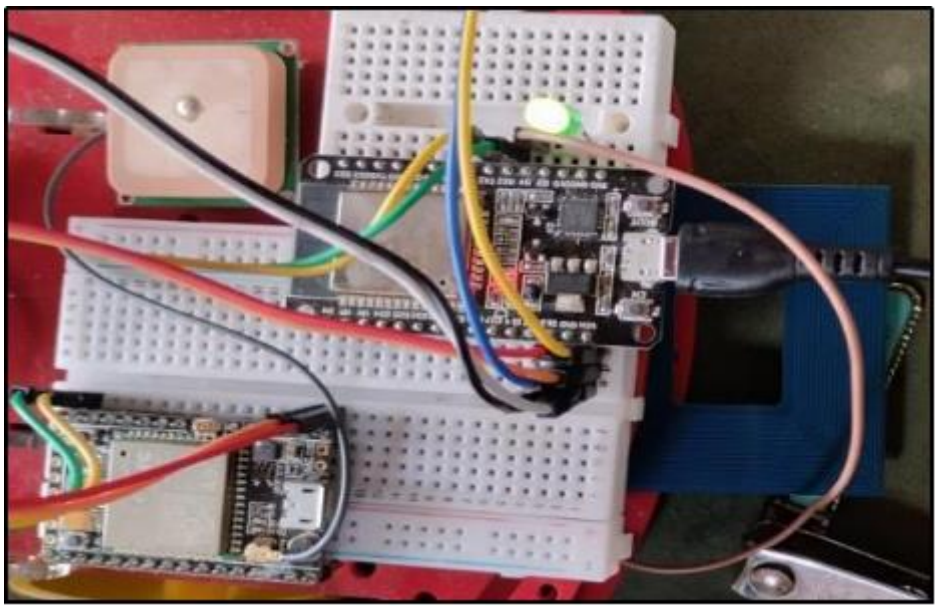


Figure 4.5 Result of Tracking Location of Metal

When the metal is detected, A9G GPS sends an E-mail to user with location coordinates. The user can enter these coordinates into Google Maps to view precise location. Figure 4.6 shows the results of sending the data of metal to user's E-mail.

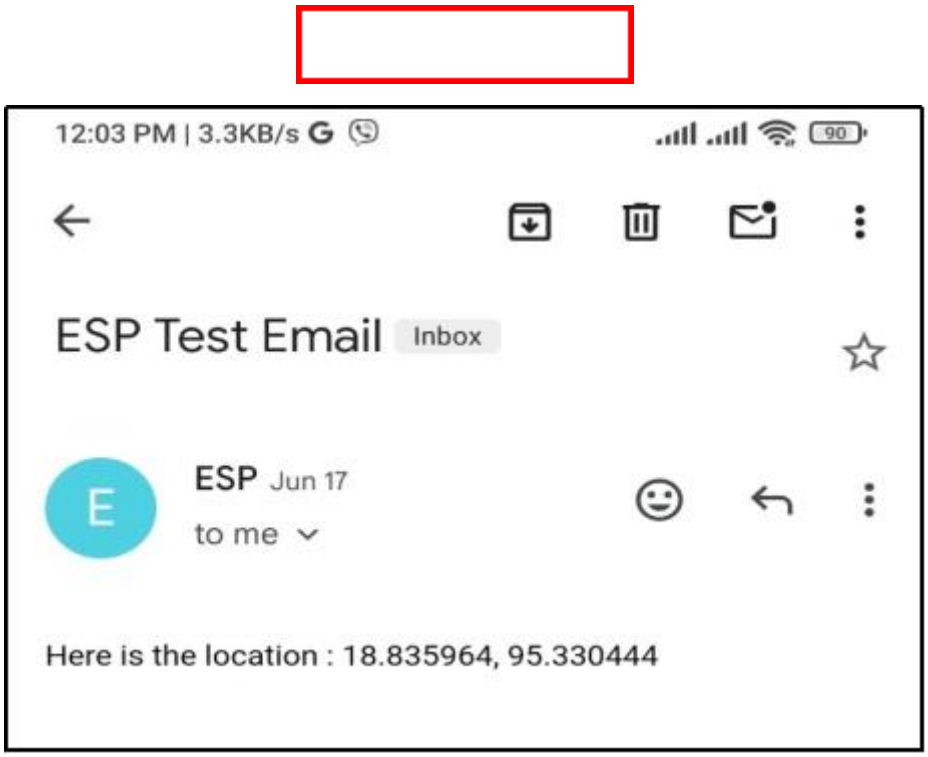


Figure 4.6 Result of Sending Data of Metal to user's E-mail

In Figure 4.7, the extract location of the metal is shown as a result on Google Maps.

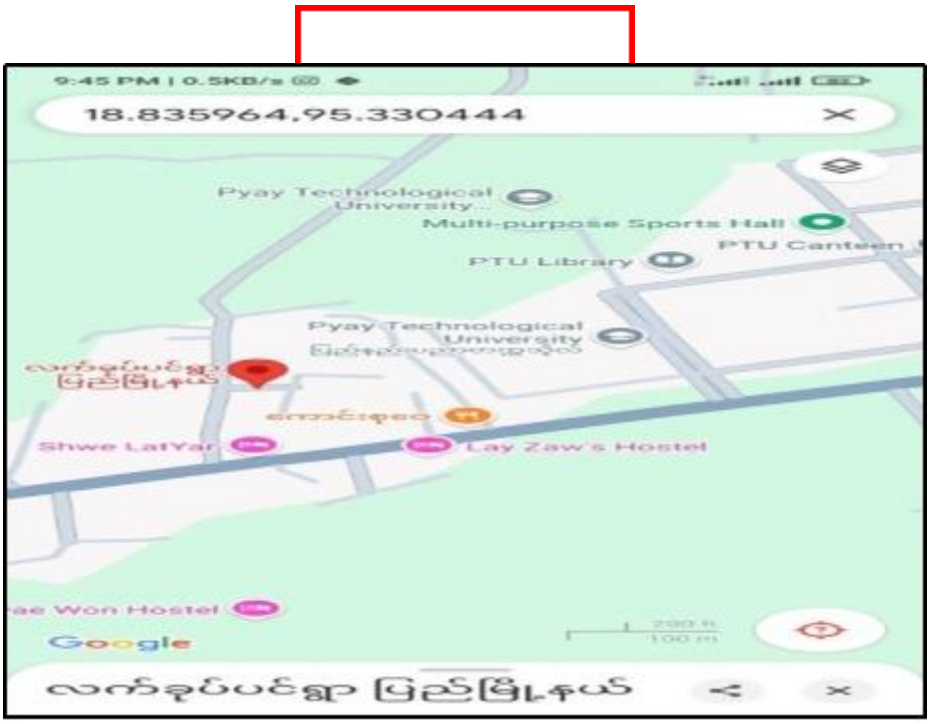


Figure 4.7 Result of Extract Location of Metal on Google Maps

4.3 Test and Results of L298N Motor Driver Shield and LM2596 Step Down Converter

The embedded hardware has been developed on ESP32 development board and controlled by an android smartphone. This controller receives the commands from Blynk (web application), takes the data and controls the motors of the robot by the motor driver L298N. The robot can able to move forward, backward, left and right movements. Test and result of L298N motor driver shield with ESP32 development board when the forward button in the Blynk app is pressed as shown in Figure 4.8.

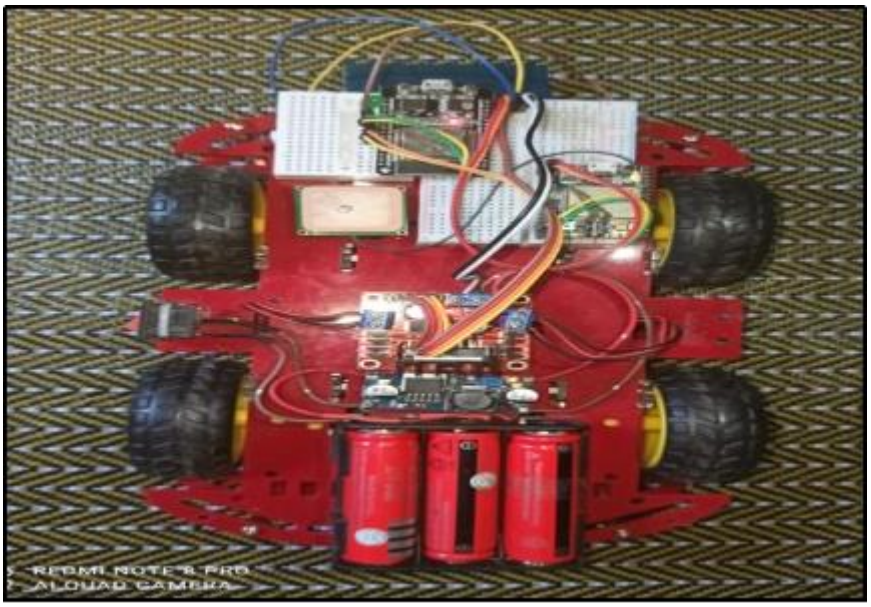


Figure 4.8 Test and Result of Car “forward”

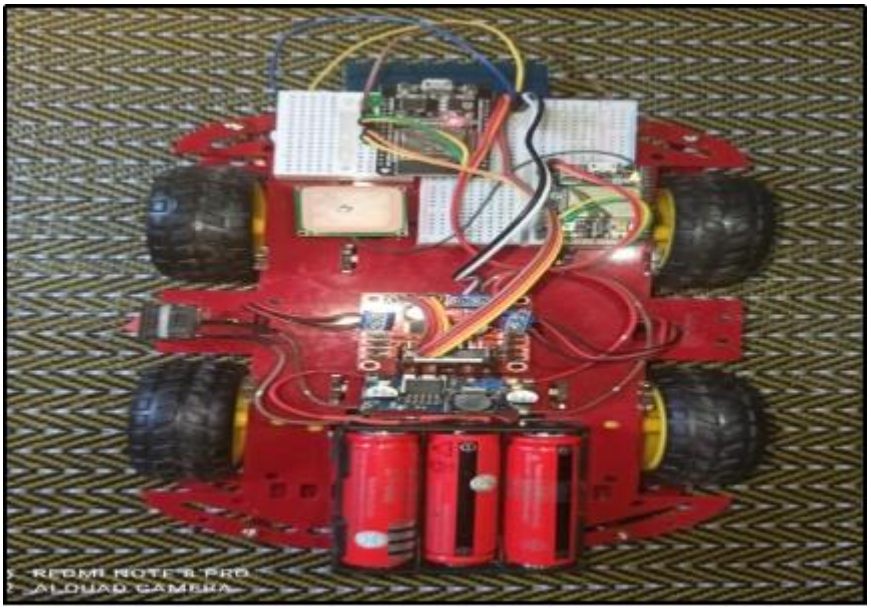


Figure 4.9 Test and Result of Car “backward”

Test and result of L298N motor driver shield with ESP32 development board when the backward button in the Blynk app is pressed as shown in Figure 4.9.

.

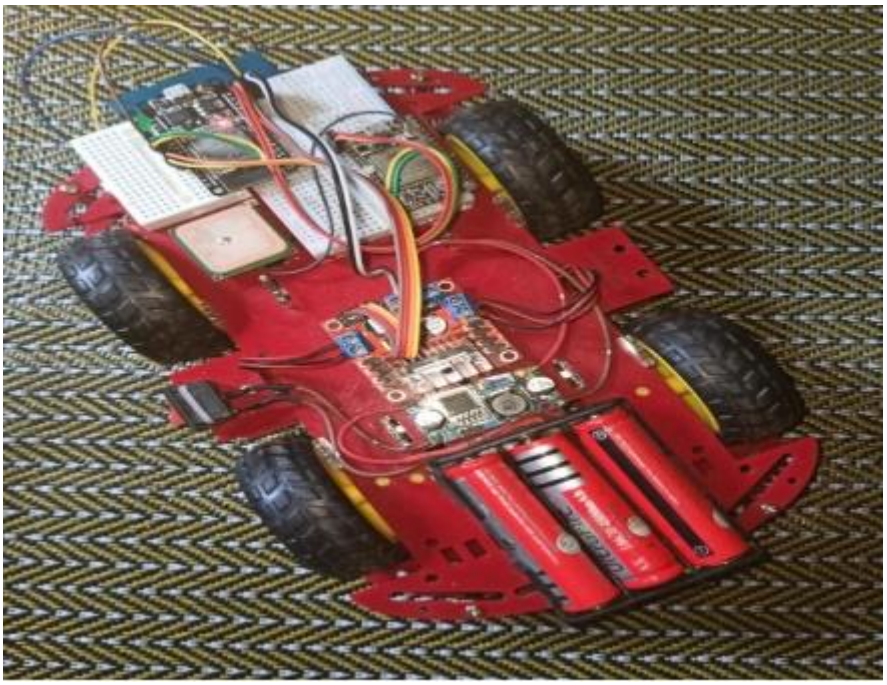


Figure 4.10 Test and Result of Car “left”

Test and result of L298N motor driver shield with ESP32 development board when the left button in the Blynk app is pressed as shown in Figure 4.10.

Figure 4.11 Test and Result of Car “right”

Test and result of L298N motor driver shield with ESP32 development board when the right button in the Blynk app is pressed as shown in Figure 4.11.

4.4 Test and Results of the Overall System

First, all of the devices are supplied by the power supply. ESP32 development board is used as a controller in IoT based metal detecting robot with GPS system. This controller receives the commands from the android phone, takes the data and controls the motors of the robot by the motor driver L298N. The robot can able to move forward, backward, left and right movements. The smartphone is been interfaced to the device by using Wi-Fi.

A metal detector circuit was connected to the robot to detect the metal. Then, metal detector sensor sends the data to ESP32 development board when metal detector

sensor senses the metal from environment. A beep sound was made when it detected the metal. If ESP32 development board received the data of sensor, it sends received data to Blynk app and location with coordinates to E-mail.

The user can enter these coordinates into Google Maps to view precise location. It is very useful to monitor the detecting metal of a given place and make the information visible anywhere in the world. The following Figure 4.12 shows the results of IoT based metal detecting robot with GPS system.

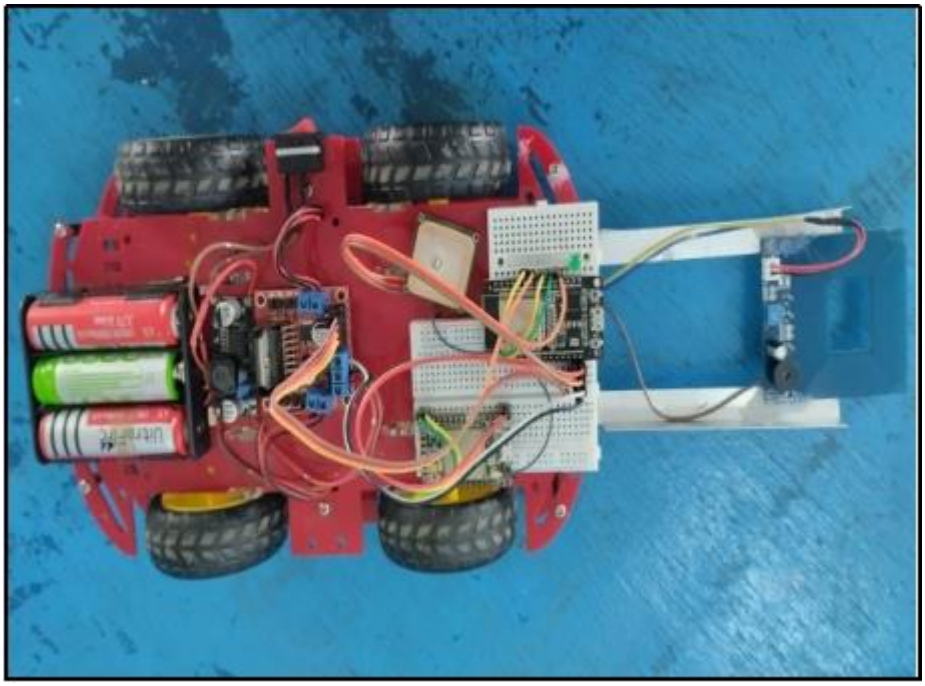


Figure 4.12 Result of IoT Based Metal Detection Robot with GPS System

4.5 Summary

In this chapter describes the test and results of IoT based metal detecting robot with GPS system. Moreover, hardware testing results has been discussed in this chapter.

And, results of IoT based metal detecting robot are described in detail. The necessary figures are also expressed clearly. Discussions, conclusion, and further extension of IoT based metal detecting robot with GPS system are described in the next chapter.

CHAPTER 5

DISCUSSSION, CONCLUSION AND FURTHER EXTENSION

This chapter describes discussion, conclusion and further extension of IoT based metal detecting robot with GPS system.

5.1 Discussion

When the author tried to create IoT based metal detecting robot with GPS system by using Arduino IDE software, the author faced the problem that matching of the software with the window of personal computer (PC) and hardware components. So, the author can fix this error by learning YouTube video and PDF file via google.

If A9G GPS does not get enough power supply, it cannot track the location of metal. In addition, all hardware components cannot work if power supply is not the same. Finally, design and implementation of IoT based metal detecting robot with GPS system has been achieved in this thesis.

5.2 Conclusion

In this thesis, IoT based metal detecting robot with GPS system has been created. The main goal of thesis is to design a robotic vehicle which can sense metals near to robotic vehicle on its track, and this robot is controlled by an android application This robot was designed and implementation with ESP32 microcontroller for its operation. It is moved in different direction with the help of buttons which is done with the help of web application (Blynk App).

This thesis comprises of a metal detector sensor which is interfaced to the control unit that produces a buzzer sound to the user when metal object is close to it. The metal detector sensor can also work at a constant speed. The radio frequency transmission is not blocked by common materials. This means, it can penetrate most solids and pass-through walls, control of the device can be maintained at a range of up to three centimeters, the robot is not sensitive to the light and it is not much sensitive to the environmental changes and weather conditions. This thesis is successfully detecting the metal, it can be mainly used in defense applications. Whenever the metal explosive is detected, it gives an alarm and also sends the relevant information to the higher official using Internet of Things (IoT). An android application is developed to control the robot vehicle from the side of user. After detecting the location information, the system will send an E-mail to user with the location coordinates. The user can then enter these coordinates into Google Maps to view the precise location. So, the user can find it out as early as possible mean while the robot checks for another area.

5.3 Further Extension

In future, users will be attaching an IR camera to sense the images of the detected place. The users also work on minimizing the order range of the coordinates that are sent by GPS by 10-15cm. The user modifies this thesis will be able to make the save path humans to reach mine and deactivate it.