DESIGN AND DEVELOPMENT OF METAL DETECTING ROBOTIC VEHICLE

MINI PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project report titled "**DESIGN AND DEVELOPMENT OF METAL DETECTING ROBOTIC VEHICLE**", is the bonafide work of "**VIGNESHKUMAR D(420420104058), CHANDRASEKARAN S (420420104301), HEM KUMAR V(420420104306)**who carried out the work under my supervision.

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

ACKNOWLEDGEMENT

It is indeed a great pleasure and proud privilege to acknowledgement the help and support we received from the positive minds around us in making this endeavor a successful one. The spiritual blessing of His Holiness **ARULTHIRU AMMA** and the divine guidance of **THIRUMATHI AMMA** have undoubtedly taken us to the path of victory in completing this project.

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We take enormous pleasure in thanking our respected **PROJECT SUPERVISOR Mr. G. SRINIVASAN , M.E., Assistant Professor** who helped us in crossing obstacles on the path to our glory.

We also thank other staff members,Non-teaching Staff members of the Computer Center ,Parents and Friends who have given their constant support and motivation in all our endeavors.

ABSTRACT

The mechanism of this project is to detect the Metal detection robotic vehicle using IOT TECHNOLOGY. The project demonstrates real life robotic vehicles used to detect land mines or other metal based objects on its path. The vehicle is fitted with a metal detecting system that can sense metals and update sensor response in web application. The system works in conjunction with an ESP32-S Micro-controller to achieve this operation. The buttons are used to send commands to move the vehicle forward, backward, left and right. Two motors at receiving end operate the vehicle as per the commands received. As soon as command is send it send the signal to the web application. At receiving end, a ESP32-S reads the command and starts processing according to the commands. The micro-controller operates the motor to move the vehicle through a motor driver IC. The metal detecting system attached to the system detects any metal underneath it. On detection it automatically sends the signals to web application to notify user about it simultaneously sends message to ESP32-S. Thus, the metal detection system couples with a robotic vehicle allows for operating the robotic vehiclegloballly..

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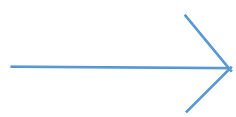
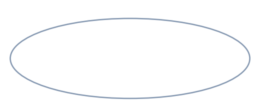
LIST OF SYMBOLS

S.NO	NOTATION NAME	NOTATION	DESCRIPTION
1.	Relation (uses)		Used for additional process communication.
2.	Relation (extends)		Extends relationship is used when one use case is similar to another use case but does a bit more.
3.	Communication		Communication between various use cases.
4.	Control flow		Represents various control flows between the states
5.	Use case		Interaction between the system and external environment.

CHAPTER 1

INTRODUCTION

1.1. BRIEF DESCRIPTION

Robots can be utilized to complete work in perilous zones and can be used to managetroublesome instability levels in such areas. Gradually robots are becoming dynamically vital for standard subject applications, for instance. A variety of small robotic applications are now arising where robots are utilized to complete an assortment of errands. By and large, robots arestill utilized for unsafe work which is dangerous for humans. Metal detecting robot is utilized to search for metal objects covered up in the ground. Electricians also use metal detectors to scan for electrical cables hidden in walls. At airplane terminals, metal finders are utilized to scan travelers for metal protests, for example, cuts and firearms. For searching old combat zones and historical sites, hoping to find treasures, jewelry and old coins, metal detectors are frequently used. In food factories, they are used to check and verify that no metal things have fallen from industrial factories into the food unintentionally.

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CHAPTER 2

LITERATURE SURVEY

A Literature review is a text of a scholarly paper, which includes the current knowledge, including substantive findings, as well as theoretical and methodological contributions to a particular topic. Literature reviews use secondary sources and do not report new or original experimental work. A literature review usually precedes the methodology and results section.

2.1. DESIGN METAL DETECTING ARDUINO REMOTE CONTROL ROBOT VEHICLE CONTROLLED VIA BLUETOOTH

Author: R. Jeyagopi1* , C.K. Chan1 , M.I.N Ma'arof

Year: 2022

Title: "DESIGN METAL DETECTING ARDUINO REMOTE CONTROL ROBOT VEHICLE CONTROLLED VIA BLUETOOTH"

Methodology: To design a metal detecting Arduino remote control robot vehicle controlled via Bluetooth, follow these steps. First, gather the necessary components, including an Arduino board, motor driver module, metal detector sensor, Bluetooth module, robot vehicle chassis, DC motors, wheels, and a power source. Next, connect the components by wiring the motor driver module, metal detector sensor, and Bluetooth module to the Arduino board. Then, write the Arduino code, incorporating functions for controlling the vehicle's movement based on Bluetooth commands and integrating the metal detector sensor for metal detection.

Advantages: The remote-controlled robot vehicle allows you to explore different areas and easily maneuver in various environments. The metal detector sensor integrated into the robot enables the detection of metal objects, which can be useful for treasure hunting, security purposes, or archaeological exploration.

Disadvantages: Bluetooth communication typically has a limited range, usually around 10-30 meters, depending on the specific Bluetooth module used.

2.2. BLUETOOTH CONTROLLED METAL DETECTOR ROBOT

Author: Jesif Ahmed, Ananya Bhattacharyya.

Year: 2020

Title: "BLUETOOTH CONTROLLED METAL DETECTOR ROBOT"

Methodology: This work is divided into two sections- hardware and software. Hardware section contains robot making, metal detector, and control unit. In the hardware section, we explain the working of Arduino and DC motors and how the robot utilizes them to detect the metallic obstacles. In the section of the metal detector, we describe general information about kind of metal detector and working principles. In the section of the control unit, we describe what kind of microcontroller we use. While in the software section, we explain the algorithm that we use in making the android application and metal detector.

Advantages: This provides freedom of movement and convenience in controlling the robot from a distance. With a Bluetooth controlled metal detector robot, you can explore various environments and navigate through different terrains without being limited by wires or cables. This flexibility enhances the mobility and reach of the robot.

Disadvantages: Operating a metal detector robot and maintaining Bluetooth connectivity can consume significant power. Depending on the power capacity of the batteries used, the runtime of the robot may be limited. Regular recharging or battery replacement may be required for sustained operation.

2.3. INTEGRATED IOT BASED DESIGN AND ANDROID OPERATED MULTI-PURPOSE FIELD SURVEILLANCE ROBOT FOR MILITARY USE.

Author: Jebasingh Kirubakaran.S.J1 Anish kumar jha2 , Dheeraj kumar3 , Sadambi Poornachandran Prakash4

Year: 2021

Title:"INTEGRATED IOT BASED DESIGN AND ANDROID OPERATED MULTI-PURPOSE FIELD SURVEILLANCE ROBOT FOR MILITARY USE"

Methodology: The specific requirements of the military application, including surveillance capabilities, environmental adaptability, mobility, and communication requirements.Select the hardware components: Choose the necessary components such as microcontrollers, sensors (e.g., cameras, infrared sensors), communication modules (e.g., Wi-Fi, Bluetooth), and motor control modules suitable for the application.Create a robust and agile chassis design that can withstand various terrains and environments. Consider factors such as weight distribution, stability, and durability.Build an Android application that allows remote control and monitoring of the robot. The application should have a user-friendly interface for controlling the robot's movements, accessing camera feeds, and receiving real-time data.Integrate the IoT capabilities into the robot to enable communication and data exchange with other devices or a central command center. This can involve using cloud platforms, MQTT protocols, or custom-built server-client architectures.Conduct thorough testing of the robot's functionalities, including its mobility, communication, surveillance features, and Android application. Optimize the design and algorithms based on feedback and performance evaluation.

Advantages: The integrated IoT-based design and Android-operated robot can provide advanced surveillance features such as real-time video streaming, remote monitoring, and data analysis, enabling better situational awareness for military personnel. This allows military personnel to operate the robot from a safe distance.Cost-effective solution: The integration of IoT technologies and Android platforms can leverage existing infrastructure and reduce the need for expensive, custom-built solutions. This can result in a cost-effective solution for military field surveillance.

Disadvantages: IoT devices are prone to security vulnerabilities, and military applications require robust security measures to protect against unauthorized access, data breaches, or cyber-attacks. Ensuring the security of the robot's communication, data transmission, and remote control functionalities is critical but can be challenging. In remote or hostile environments where connectivity may be limited or disrupted, the effectiveness of the robot's remote control and surveillance capabilities can be compromised.

CHAPTER 3
SYSTEM ANALYSIS

3.1. EXISTING SYSTEM

The design construction and fabrication of multi-purpose field surveillance robot that can be used for land mine detection, toxic gas sensing and temperature and humidity sensor monitoring in war fields without putting serious manual risks. The land mine detector can detect covered metals, gas sensor can detect toxic gas attacks and the robot can be controlled wirelessly by Android phone. The robot uses Arduino Uno microcontroller to gather sensor information and NodeMCU WiFi to interface the controller and the robot. Based on the input information from Android application, the robot can make moved and climbed on any terrains. The distinguishing feature of our project from traditional ones is that the integrated design of Android phone operation and multiple IoT cloud servers. All robotic sensor information are delivered to cloud servers and viewed through Webpage.

3.2. PROPOSED SYSTEM

Detecting and identifying metallic objects: The primary objective of the metal detecting robotic vehicle is to accurately detect and identify metallic objects buried in various types of terrain. Enabling remote operation: The system should be able to be controlled and monitored remotely, allowing users to operate it from a safe distance. Providing a user-friendly interface: The system should have a user-friendly interface that allows users to easily control and monitor the vehicle's movements and detection results.

CHAPTER 4
SYSTEM REQUIREMENT

4.1 REQUIREMENT ANALYSIS

Requirement analysis determines the requirements of a new system. This project analyzes product and resource requirements, which is required for this successful system. The product requirement includes input and output requirements it gives the want in terms of input to produce the required output. The resource requirements give in brief about the software and hardware that are needed to achieve the required functionality.

4.1.1 FUNCTIONAL REQUIREMENTS

A Functional requirement defines the function of a system or its components. A function is described as the set of inputs, the behavior and the outputs. Functional requirements may be calculations, technical details, data manipulation and other specific functionalities that show how a use case is to be fulfilled. They are supported by non-functionalities requirements, which impose constraints on the design or implementation.

4.1.2 NON-FUNCTIONAL REQUIREMENTS

Non Functional Requirements are requirements that specify criteria that can be used to judge the operations of a system. Rather than specific behaviors, Non-functional requirements are often called qualities of the system.

1. The system should be accurate and efficient.

2. The system should be able to meet all user requirements.

4.1.3. HARDWARE REQUIREMENTS

The most common set of requirements defined by any operating system or software application is the physical computer resources, also known as hardware. A hardware requirements list is often accompanied by a hardware compatibility list, especially in the case of operating systems. The minimal hardware requirements are as follows,

1. Arduino board
2. DC motors
3. Chassis
4. Motor driver
5. ESP8266 WiFi Module
6. Battery
7. Metal detector sensor
8. Other miscellaneous components (wires, resistors, capacitors, etc.)

1. ARDUINO BOARD

The field has evolved due to the convergence of multiple technologies, including ubiquitous computing, commodity sensors, increasingly powerful embedded systems, and machine learning. Traditional fields of embedded systems, wireless sensor networks, control systems, automation (including home and building automation), independently and collectively enable the Internet of things. In the consumer market, IoT technology is most synonymous with products pertaining to the concept of the "smart home", including devices and appliances (such as lighting fixtures, thermostats, home security systems, cameras, and other home appliances) that support one or more common ecosystems, and can be controlled via devices associated with that ecosystem, such as smart phones and smart speakers. IoT is also used in healthcare systems.

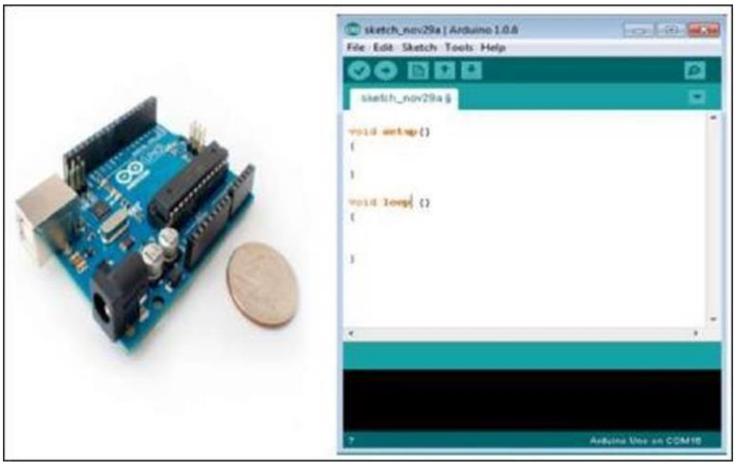


FIGURE 4.1.3.1. ARDUINO BOARD

2 .ESP8266 WIFI MODULE

ESP32S is a low-cost System on Chip (SoC) Microcontroller from Espressif Systems, the developers of the famous ESP8266 SoC. It is a successor to ESP8266 SoC and comes in both single-core and dual-core variations of the Tensilica’s 32-bit Xtensa LX6 Microprocessor with integrated Wi-Fi and Bluetooth.

There are a number of concerns about the risks in the growth of IoT technologies and products,especially in the areas of privacy and security, and consequently, industry and governmental moves to address these concerns have begun, including the development of international and local standards, guidelines, and regulatory frameworks.

This project focuses on designing and developing a robotic vehicle that can sense metals in front of it on its way like detecting land mines.

The metal detector circuit is mounted on a robotic vehicle and its operation is to detect metals underneath automatically with the help of IOT. Metal detecting sensor will move 180 degrees to detect and the complete robot can move in four directions using 4 buttons(Forward, Backward, Left, Right). If metal gets detected we get a notification that metal got detected and also in which angle this metal is facing with respect to the Robot direction.

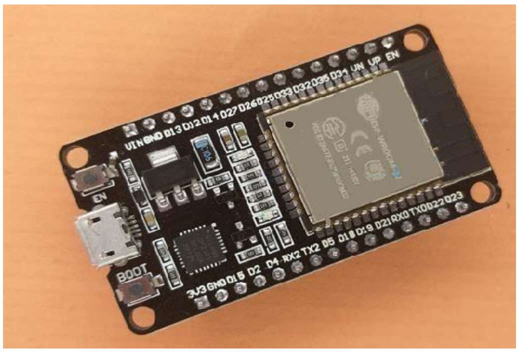


FIGURE4.1.3.2. esp8266

Espressif's ESP8266EX delivers highly integrated Wi-Fi SoC solution to meet users' continuous demands for efficient power usage, compact design and reliable performance in the Internet of Things industry. With the complete and self-contained Wi-Fi networking capabilities, ESP8266EX can perform either as a standalone application or as the slave to a host MCU.

When ESP8266EX hosts the application, it promptly boots up from the flash. The integrated highspeed cache helps to increase the system performance and optimize the system memory. Also, ESP8266EX can be applied to any microcontroller design as a Wi-Fi adaptor through SPI/SDIO or UART interfaces.
ESP8266EX integrates antenna switches, RF balun, power amplifier, low noise receive amplifier, filters and power management modules.

The compact design minimizes the PCB size and requires minimal external circuitries. Besides the Wi-Fi functionalities, ESP8266EX also integrates an enhanced version of Tensilica's L106 Diamond series 32-bit processor and on-chip SRAM. It can be interfaced with external sensors and other devices through the GPIOs. Software Development Kit (SDK) provides sample codes for various applications. Espressif Systems’ Smart Connectivity Platform (ESCP) enables sophisticated features including:

• Fast switch between sleep and wakeup mode for energy-efficient purpose;
• Adaptive radio biasing for low-power operation
• Advance signal processing
• Spur cancellation and RF co-existence mechanisms for common cellular, Bluetooth, DDR, LVDS, LCD interference mitigation

Wi-Fi Key Features

• 802.11 b/g/n support

• 802.11 n support (2.4 GHz), up to 72.2 Mbps

• Defragmentation

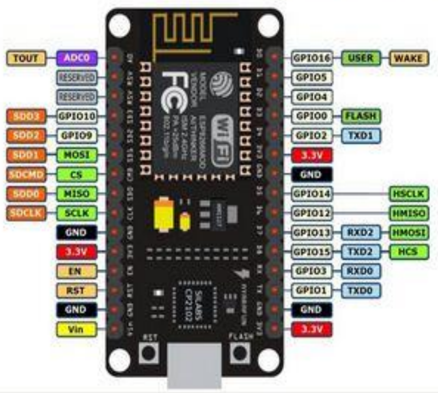
• 2 x virtual Wi-Fi interface

• Automatic beacon monitoring (hardware TSF)

• Support Infrastructure BSS Station mode/SoftAP mode/Promiscuous mode

NodeMCU ESP8266

ESP8266 NodeMCU



NodeMCU ESP8266 Pinout

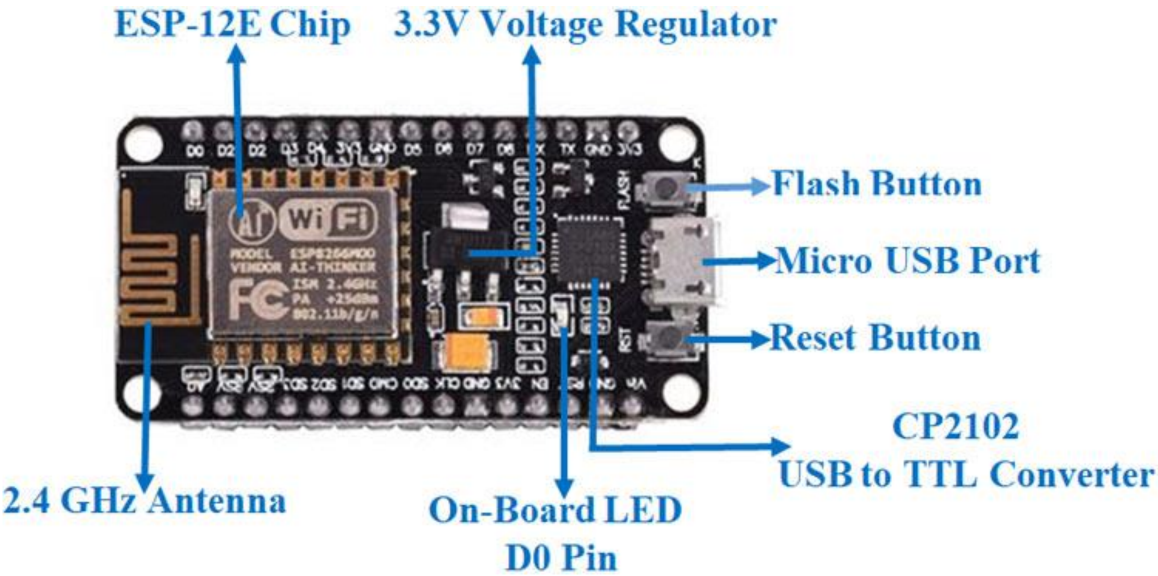
NodeMCU is an open-source Lua based firmware and **development board** specially targeted for IoT based Applications. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module.

NodeMCU ESP8266 Specifications & Features

- Microcontroller: Tensilica 32-bit RISC CPU Xtensa LX106
- Operating Voltage: 3.3V
- Input Voltage: 7-12V
- Digital I/O Pins (DIO): 16
- Analog Input Pins (ADC): 1
- UARTs: 1
- SPIs: 1
- I2Cs: 1
- Flash Memory: 4 MB
- SRAM: 64 KB
- Clock Speed: 80 MHz
- USB-TTL based on CP2102 is included onboard, Enabling Plug n Play
- PCB Antenna
- Small Sized module to fit smartly inside your IoT projects

The **NodeMCU ESP8266 development board** comes with the ESP-12E module containing the ESP8266 chip having Tensilica Xtensa 32-bit LX106 RISC microprocessor. This microprocessor supports RTOS and operates at 80MHz to 160 MHz adjustable clock frequency. NodeMCU has 128 KB RAM and 4MB of Flash memory to store data and programs. Its high processing power with in-built Wi-Fi / Bluetooth and Deep Sleep Operating features make it ideal for IoT projects.

NodeMCU can be powered using a Micro USB jack and VIN pin (External Supply Pin). It supports UART, SPI, and I2C interface.



Programming NodeMCU ESP8266 with Arduino IDE

The NodeMCU Development Board can be easily programmed with Arduino IDE since it is easy to use.

Programming NodeMCU with the Arduino IDE will hardly take 5-10 minutes. All you need is the Arduino IDE, a USB cable and the NodeMCU board itself. You can check this Getting Started Tutorial for NodeMCU to prepare your Arduino IDE for NodeMCU.

UPLOADING FIRST PROGRAM

Once Arduino IDE is installed on the computer, connect the board with the computer using the USB cable. Now open the Arduino IDE and choose the correct board by selecting **Tools>Boards>NodeMCU1.0** (ESP-12E Module), and choose the correct Port by selecting **Tools>Port**. To get it started with the NodeMCU board and blink the built-in LED, load the example code by selecting **Files>Examples>Basics>Blink**. Once the example code is loaded into your IDE, click on the 'upload' button given on the top bar. Once the upload is finished, you should see the built-in LED of the board blinking.

Applications

- Prototyping of IoT devices
- Low power battery operated applications
- Network projects
- Projects requiring multiple I/O interfaces with Wi-Fi and Bluetooth functionalities

3. L293 MOTOR DRIVER AND H-BRIDGES

The most common method to drive DC motors in two directions under control of a computer is with an H-bridge motor driver. H-bridges can be built from scratch with bi-polar junction transistors (BJT) or with field effect transistors (FET), or can be purchased as an integrated unit in a single integrated circuit package such as the L293. The L293 is simplest and inexpensive for low current motors, For high current motors, it is less expensive to build your own H-bridge from scratch.

ITP Physical Computing has a terrific tutorial on using an Arduino and an L293 to control a bi-directional motor.

The Twin Cities Robotics Club has an *excellent* tutorial on H-bridges, and complete detail on how to build your own $5.00 H-bridge good for several amps. From the same source is a detailed tech note on PWM speed control of a motor using an H-bridge and a PIC microcontroller

The L293 is an integrated circuit motor driver that can be used for simultaneous, bi-directional control of two small motors. Small means small. The L293 is limited to 600 mA, but in reality can only handle much small currents unless you have done some serious heat sinking to keep the case temperature down. Unsure about whether the L293 will work with your motor? Hook up the circuit and run your motor while keeping your finger on the chip. If it gets too hot to touch, you can't use it with your motor

2. DC MOTOR:

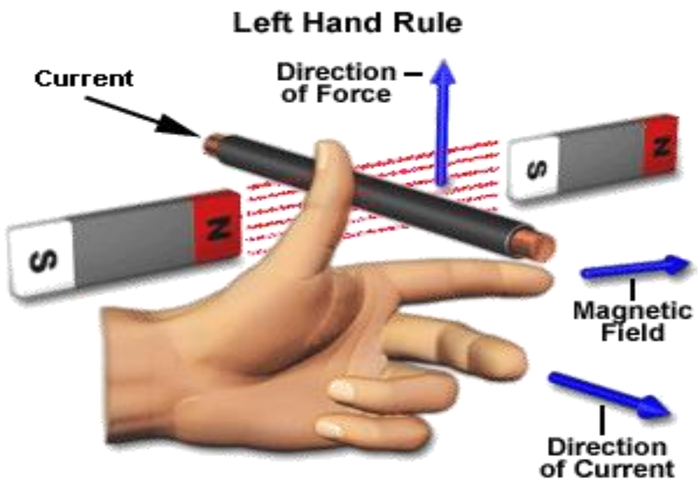
A DC motor in simple words is a device that converts direct current (electrical energy) into mechanical energy. It’s of vital importance for the industry today, and is equally important for engineers to look into the **working principle of DC motor** in details that has been discussed in this article. In order to understand the **operating principle of dc motor** we need to first look into its constructional feature.

The very basic construction of a dc motor contains a current carrying armature which is connected to the supply through commentator segments and brushes and placed within the north south poles of a permanent or an electro-magnet as shown in the diagram below.

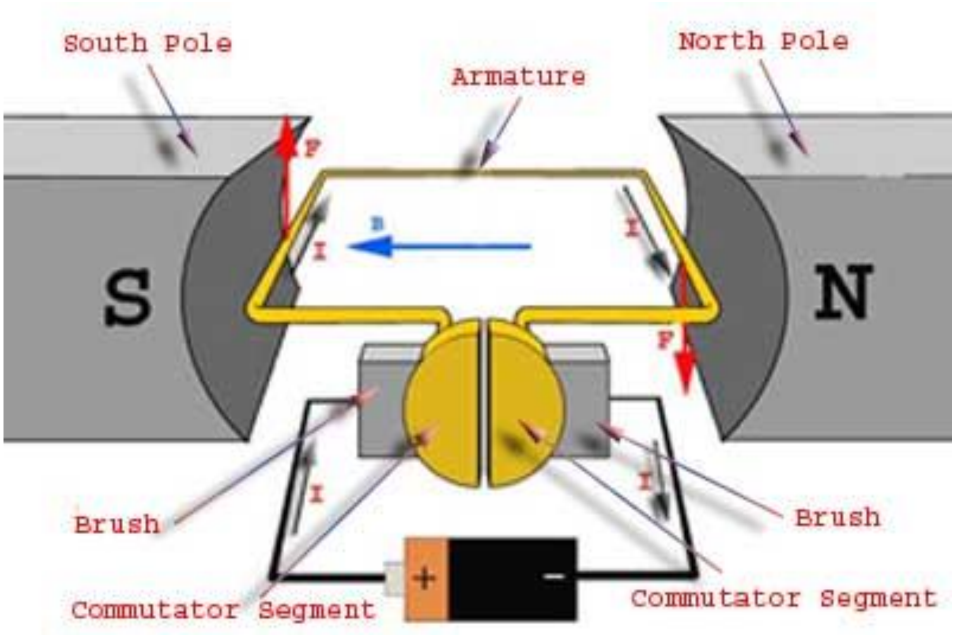
Now to go into the details of the **operating principle of DC motor** it's important that we have a clear understanding of Fleming's left hand rule to determine the direction of force acting on the armature conductors of dc motor.

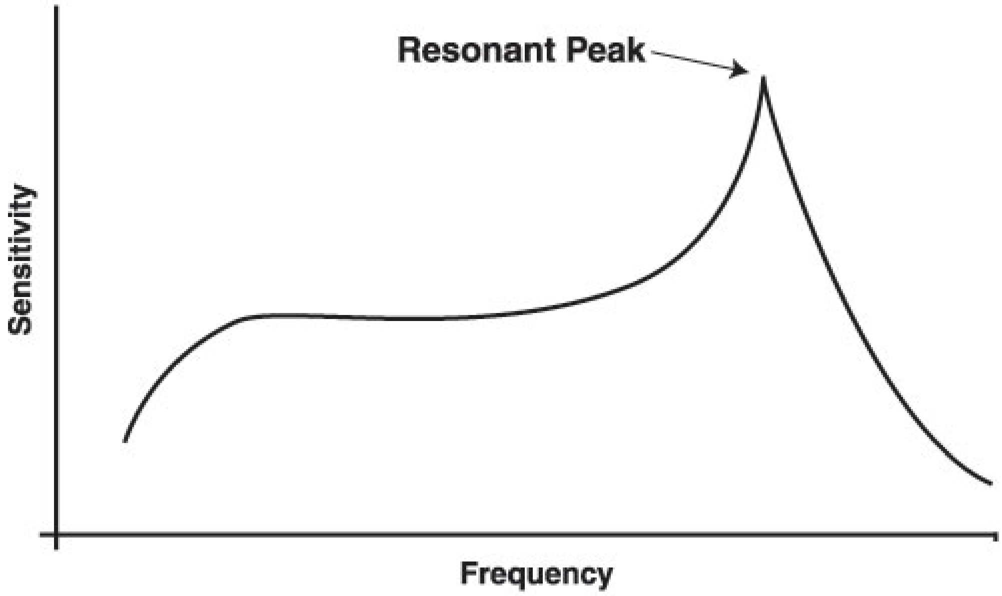
FLEMING left hand role says that if we extend the index finger, middle finger and thumb of our left hand in such a way that the current carrying conductor
is placed in a magnetic field (represented by the index finger) is perpendicular to the direction of current (represented by the middle finger).

Then the conductor experiences a force in the direction (represented by the thumb) mutually perpendicular to both the direction of field and the current in the conductor.



For clear understanding the **principle of DC motor** we have to determine the magnitude of the force, by considering the diagram below.


South Pole
North Pole
Armature
S
N
F
I
B
Brush
Brush
Commutator Segment
Commutator Segment
+
-


Resonant Peak
Sensitivity
Frequency

4.1.4. SOFTWARE REQUIREMENTS

Software requirements deal with defining resource requirements and prerequisites that need to be installed on a computer to provide the functioning of an application. These requirements need to be installed separately before the software is installed.

The software requirements for a metal detecting robotic vehicle typically include an integrated development environment (IDE) such as Arduino IDE or similar software for programming and uploading code to the microcontroller or controller board. This allows developers to write, compile, and upload the firmware or software that controls the robot's behavior and interfaces with the hardware components. Additionally, the software requirements may involve libraries or software frameworks specific to the hardware components used in the robot, such as motor control libraries or sensor libraries, to simplify programming and enhance functionality.

The minimal software requirements are as follows,

1. Programming Language: C
2. IDE: Arduino
3. Operating System: Windows 11

CHAPTER 5

SYSTEM DESIGN

5.1 PROBLEM STATEMENT

To Design and develop a metal detecting robotic vehicle capable of autonomously detecting and identifying buried metallic objects in various types of terrain, including soil, sand, and gravel.

The robotic vehicle should be equipped with a reliable metal detection sensor, an efficient power source, and a user-friendly interface for controlling and monitoring its movements and detection results.

The system should be able to detect and differentiate between various types of metals, such as iron, aluminum, and gold, and accurately display their location and depth on a digital map.

5.2. CONNECTION DIAGRAM

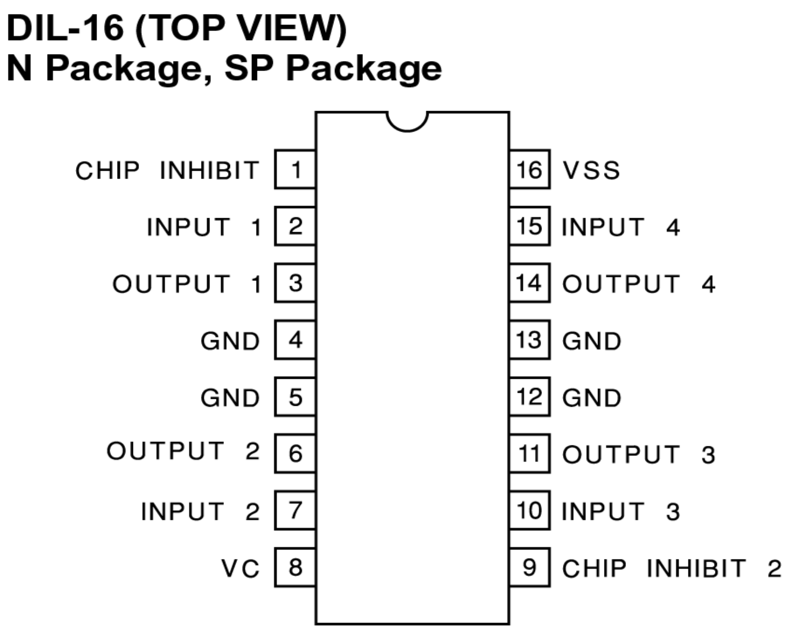


FIGURE 5.3. CONNECTIONN DIAGRAM

The L293D is a 16 pin IC, with eight pins, on each side, dedicated to the controlling of a motor. There are 2 INPUT pins, 2 OUTPUT pins and 1 ENABLE pin for each motor. L293D consist of two H-bridge. H-bridge is the simplest circuit for controlling a low current rated motor.

Pin No. - Pin Characteristics

- 1 - Enable 1-2, when this is HIGH the left part of the IC will work and when it is low the left part won't work.
- 2 - INPUT 1, when this pin is HIGH the current will flow though output 1
- 3 - OUTPUT 1, this pin should be connected to one of the terminal of motor
- 4,5 - GND, ground pins
- 6 - OUTPUT 2, this pin should be connected to one of the terminal of motor
- 7 - INPUT 2, when this pin is HIGH the current will flow though output 2
- 8 - VCC2, this is the voltage which will be supplied to the motor.
- 16 - VCC1, this is the power source to the IC. So, this pin should be supplied with 5 V
- 15 - INPUT 4, when this pin is HIGH the current will flow though output 4
- 14 - OUTPUT 4, this pin should be connected to one of the terminal of motor
- 13,12 - GND, ground pins
- 11 - OUTPUT 3, this pin should be connected to one of the terminal of motor
- 10 - INPUT 3, when this pin is HIGH the current will flow though output 3

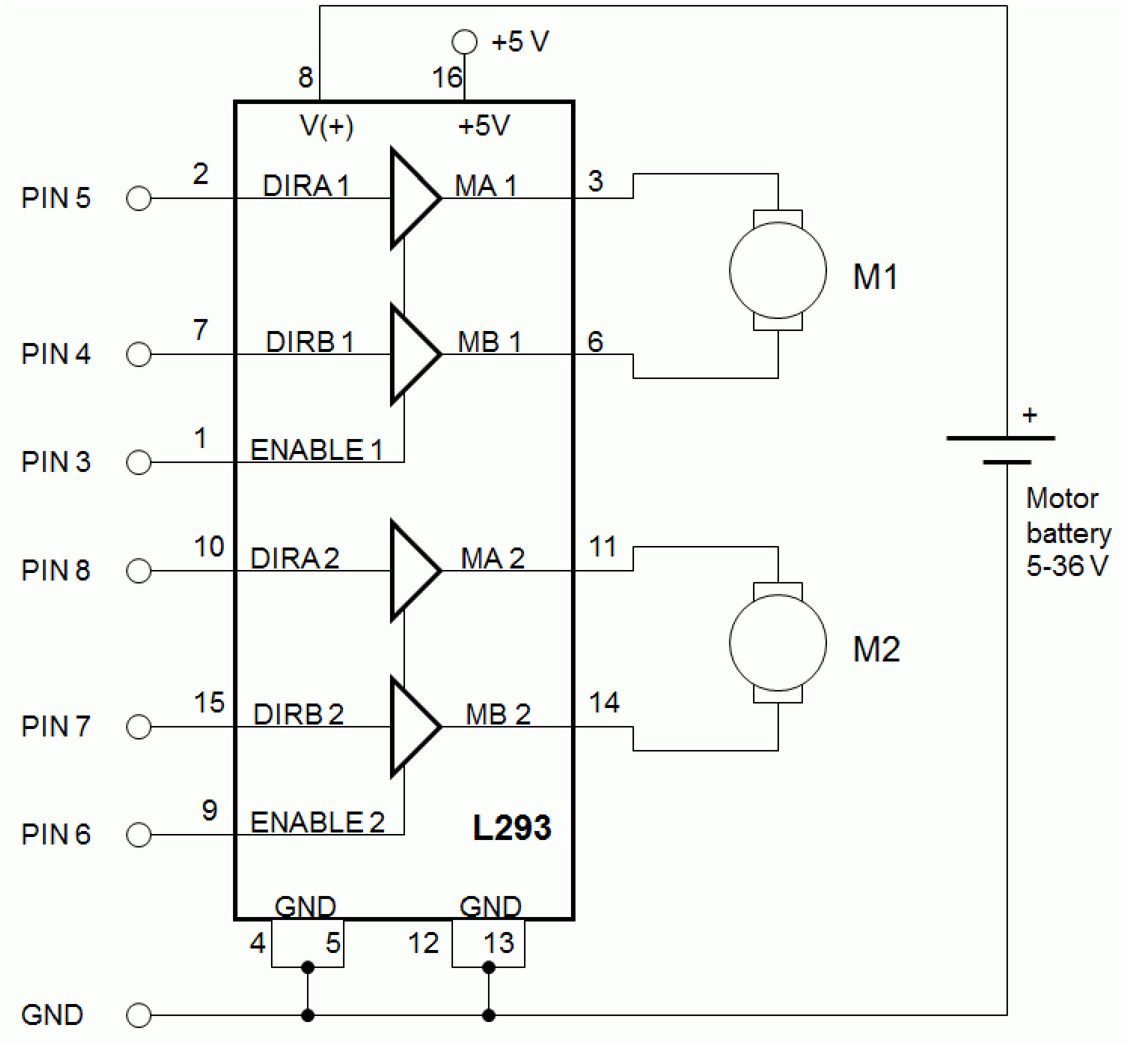


Fig5.4. Circuit Diagram

5.3. FLOW DIAGRAM

A flow diagram is a graphical representation of the "flow" data through an information system, modeling its process aspects. It is often used as a preliminary step to create an overview of the system without going into great detail, which can later be elaborate. It can also be used for the visualization of data processing.

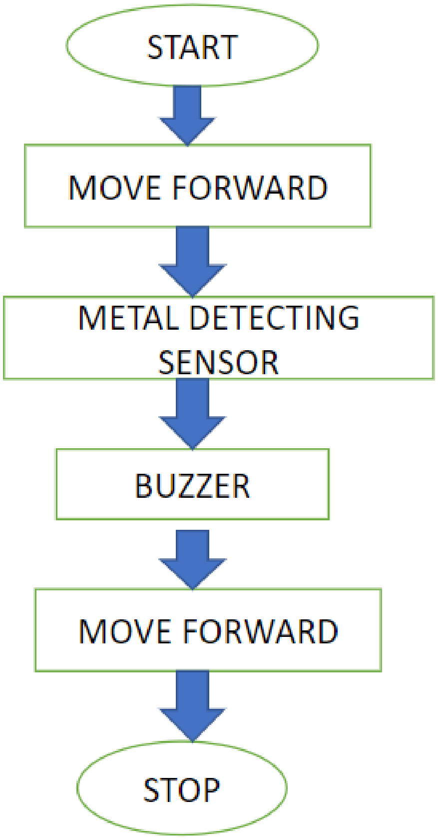


FIGURE 5.4. FLOW DIAGRAM

5.4. LIST OF MODULES

5.4.1. SELECTING PATH FOR THE ROBOTIC VECHICLE

We select the notorious path which consist of metal or so we suspect .We come to this conclusion by inspecting and having first hand knowledge of the pathways. Assign priorities to different objectives or constraints to determine the optimal path, such as avoiding collisions over maximizing speed or selecting the shortest path over energy efficiency.

The goals of the mission or task assigned to the robotic vehicle also influence path selection. Whether it's delivering a package, exploring an unknown area, or performing specific actions, the chosen path should align with the mission objectives.

In conclusion, selecting a path for a robotic vehicle involves a comprehensive analysis of various factors. By considering obstacles, terrain, safety, efficiency, mapping, sensors, goals, adaptability, and prioritization, the vehicle can chart a course that ensures successful navigation while accomplishing its intended mission.

5.4.2. NAVIGATING THE ROBOTIC VECHICLE

For the selected path we navigate the robotic vehicle by giving instructions like moving forward, backward, right , left via the app interface blynk application. During navigation, the robotic vehicle constantly reassesses its surroundings and updates its path if needed. If unexpected obstacles are detected or changes occur in the environment, the vehicle can dynamically adjust its path to avoid collisions and navigate safely.

Once the path is determined, control algorithms come into play to guide the vehicle's movement. These algorithms convert the desired path into appropriate control commands, adjusting the vehicle's speed, direction, and steering angle.

Overall, navigating a robotic vehicle requires a combination of perception, mapping, localization, path planning, and control algorithms. By leveraging sensor data and intelligent decision-making, the vehicle can autonomously navigate its environment, ensuring efficient and reliable movement towards its destination.

5.4.3. DETECTING METAL COMPONENT

While traversing the path if any metal components are found by the sensor, metal detector sensor a beep alarming sound is raised. Integration with mapping and localization technologies further enhances the capabilities of metal-detecting robotic vehicles. By creating detailed maps of the environment and accurately localizing the vehicle's position within it, these vehicles can systematically scan areas, ensuring comprehensive metal component detection.

Overall, metal-detecting robotic vehicles offer a powerful solution for efficient and reliable metal component detection. With their advanced sensors, intelligent algorithms, and autonomous capabilities, these vehicles can navigate complex environments while accurately identifying and locating metal components, providing valuable support across industries such as construction, mining, security, and archaeological exploration.

5.4.4. CALCULATING THE RANGE OF METAL

Once the metal component found we measur the range of the component in the Blunk app interface which displays the range value of the metal component. The robotic vehicle's navigation and mapping capabilities also play a crucial role in range calculation. By accurately determining its own position within the environment and having a detailed map, the vehicle can calculate the distance between its sensors and the metal component based on their respective coordinates.

Overall, by combining time-of-flight measurements, signal strength analysis, triangulation, and mapping information, a metal-detecting robotic vehicle can accurately calculate the range of a detected metal component. These range calculations provide valuable information for various applications, such as object positioning, obstacle detection, or spatial analysis in industries like manufacturing, construction, or archaeological exploration.

CHAPTER 6
IMPLEMENTATION OF MODULES

SOURCE CODE

```
const byte npulse = 01;
const bool sound = true;
const bool debug = true;

const byte pin_pulse=A0;
const byte pin_cap  =A1;
const byte pin_LED1 =12;
const byte pin_LED2 =11;
const byte pin_tone =10;

void setup() {
  if (debug) Serial.begin(9600);
  pinMode(pin_pulse, OUTPUT);
  digitalWrite(pin_pulse, LOW);
  pinMode(pin_cap, INPUT);
  pinMode(pin_LED1, OUTPUT);
  digitalWrite(pin_LED1, LOW);
  pinMode(pin_LED2, OUTPUT);
  digitalWrite(pin_LED2, LOW);
  if(sound)pinMode(pin_tone, OUTPUT);
  if(sound)digitalWrite(pin_tone, LOW);
}

const int nmeas=256;  //measurements to take
long int sumsum=0; //running sum of 64 sums
```

```
long int skip=0;   //number of skipped sums
long int diff=0;        //difference between sum and avgsum
long int flash_period=0;//period (in ms)
long unsigned int prev_flash=0; //time stamp of previous flash

void loop() {


  int minval=1023;
  int maxval=0;
   //perform measurement
  long unsigned int sum=0;
  for (int imeas=0; imeas<nmeas+2; imeas++){
    //reset the capacitor
    pinMode(pin_cap,OUTPUT);
    digitalWrite(pin_cap,LOW);
    delayMicroseconds(20);
    pinMode(pin_cap,INPUT);
    //apply pulses
    for (int ipulse = 0; ipulse < npulse; ipulse++) {
      digitalWrite(pin_pulse,HIGH); //takes 3.5 microseconds
      delayMicroseconds(3);
      digitalWrite(pin_pulse,LOW);  //takes 3.5 microseconds
      delayMicroseconds(3);
    }
    //read the charge on the capacitor
    int val = analogRead(pin_cap); //takes 13x8=104 microseconds
    minval = min(val,minval);
    maxval = max(val,maxval);
    sum+=val;
```

```
//determine if LEDs should be on or off
   long unsigned int timestamp=millis();
   byte ledstat=0;
   if (timestamp<prev_flash+10){
     if (diff>0)ledstat=1;
     if (diff<0)ledstat=2;
   }
   if (timestamp>prev_flash+flash_period){
     if (diff>0)ledstat=1;
     if (diff<0)ledstat=2;
     prev_flash=timestamp;
   }
   if (flash_period>1000)ledstat=0;

   //switch the LEDs to this setting
   if (ledstat==0){
     digitalWrite(pin_LED1,LOW);
     digitalWrite(pin_LED2,LOW);
     if(sound)noTone(pin_tone);
   }
   if (ledstat==1){
     digitalWrite(pin_LED1,HIGH);
     digitalWrite(pin_LED2,LOW);
     if(sound)tone(pin_tone,2000);
   }
```

CHAPTER 7

SNAPSHOTS

7.1 SELECTING PATH FOR THE ROBOTIC VECHICLE

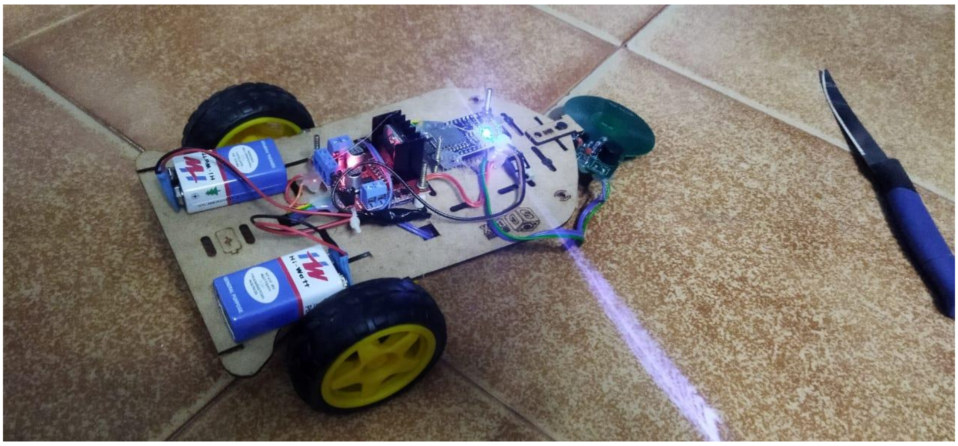


Fig7.1. Metal detecting robotic vehicle kit

7.2 NAVIGATING THE ROBOTIC VECHICLE

Fig 7.2. Finding metals

7.3 DETECTING METAL COMPONENT

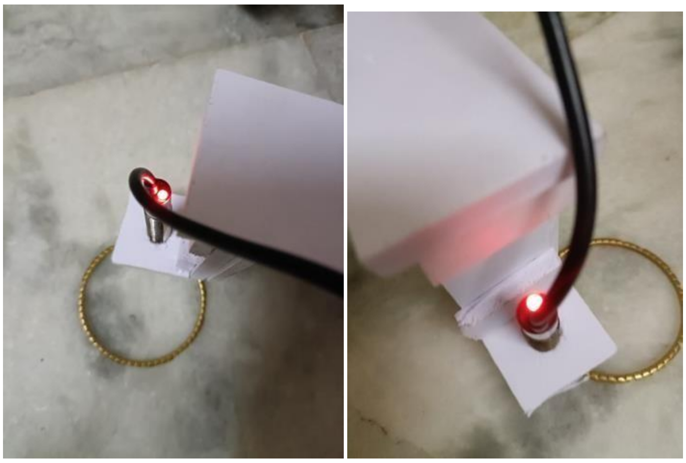


Fig 7.3 Metal detected

7.4 CALCULATING THE RANGE OF METAL

Calculating the range of metal using the Blynk application can provide valuable insights into its capabilities and potential applications. Blynk is a powerful IoT platform that allows users to create customized mobile applications and connect them to various hardware devices. With Blynk, you can gather data from sensors attached to the metal and perform calculations to determine its range.

Overall, using the Blynk application to calculate the range of metal provides a convenient and efficient way to gather data from sensors, perform calculations, and visualize the results. By leveraging the power of IoT and mobile applications, you can gain valuable insights into the metal's capabilities and make informed decisions for various industrial or scientific applications.

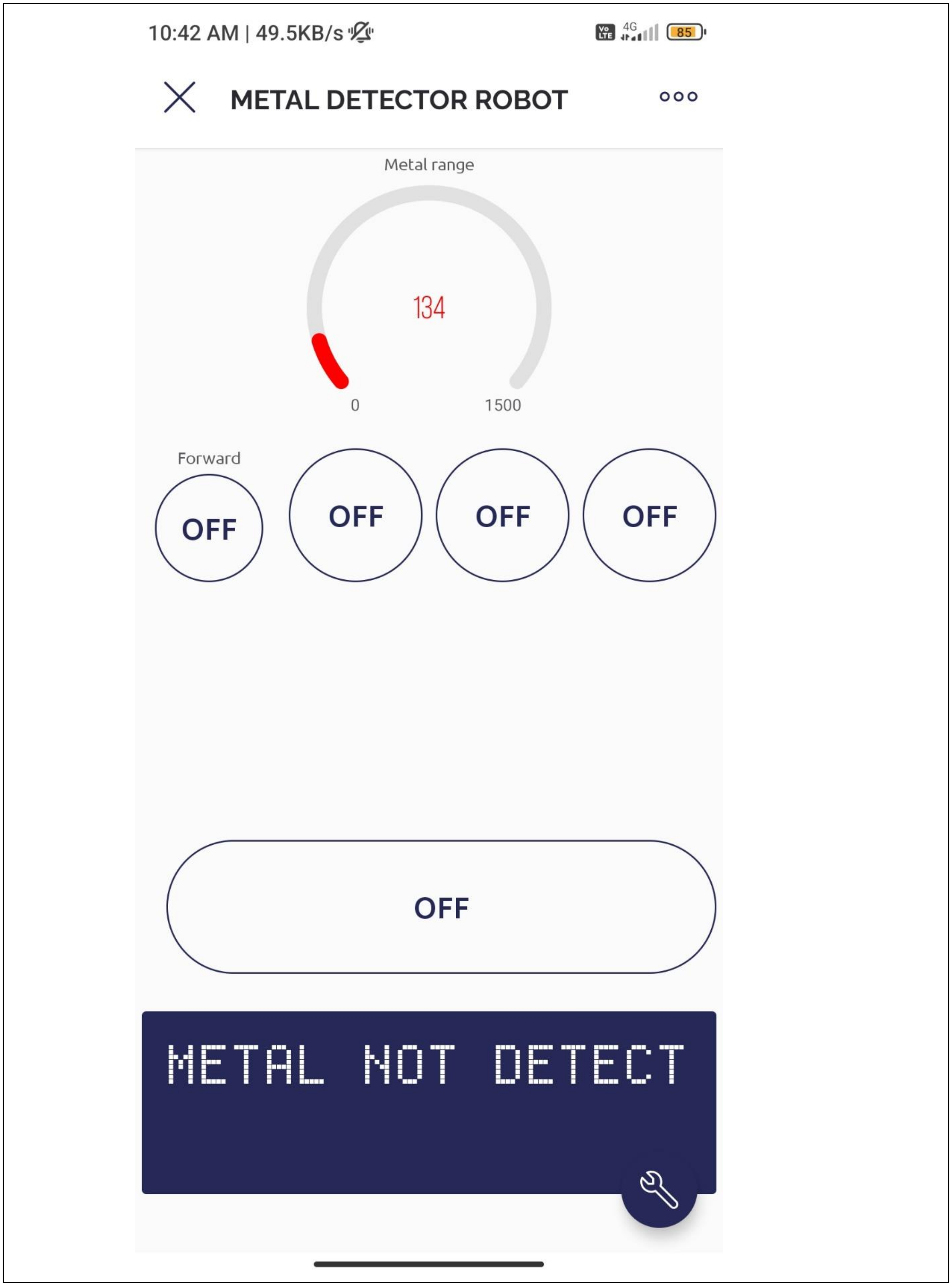


Fig 7.4 By Using Mobile App We Find The Metal Range

CHAPTER 8

SOFTWARE TESTING

8.1. TESTING OBJECTIVE

Testing is a set of activities that can be planned in advance and conducted systematically. For this reason a template for software testing, a set of steps into which specific test case design techniques and testing methods can be defined for software processes. Testing often account for more efforts tan any other software engineering activity. If it is conducted haphazardly, time is undetected. It would therefore seem reasonable to establish a systematic strategy for testing software.

8.2. TEST CASE DESIGN

UNIT TESTING

Primary goal of unit testing is to find the smallest piece of testable software in the application, isolate it from the remainder of the code, and determine whether it behaves exactly as you expect. Each unit is tested separately before integrating them into the modules to test the interfaces between modules. Unit testing has proven its value in that a large percentage of defects are identified during its use.

INTEGRATION TESTING

Testing is done for each module. After testing all the modules, the modules are integrated and testing of the final system is done with the test data, specially designed to show that the system will operate successfully in all its aspects conditions. Thus, the system testing is a confirmation that all is correct and an opportunity to show the user that the system works,

VALIDATION TESTING

The final step involves Validation testing, which determines whether the software functions as the user expected. The end-user rather than the system Developer conducts this test most software developers as a process called “Alpha and Beta were testing” to uncover that only the end user seems able to find. The compilation of the entire project is based on the full satisfaction of the end user.

INTERFACE TESTING

The Interface Testing is performed to verify the interfaces between sub modules while performing integration of sub modules aiding master modules recursively. Integration testing is also essential, where all components and interfaces are tested together to ensure seamless operation. Testing scenarios, test cases, and documentation of observed issues or deviations are important during the interface testing process. Regular and thorough interface testing ensures the proper functioning and reliability of the metal detecting robotic vehicle.

MODULE TESTING

Module testing is a process of testing the system , module by module. It includes the various inputs given, outputs produced and their correctness. By testing in this method, it would be very clear of all the bugs that have occurred. Each module is tested with a variety of test cases and scenarios to ensure that they meet the required specifications and perform as intended. The integration of the tested modules is then performed to ensure their seamless interaction and compatibility within the metal detecting robotic vehicle. Module testing allows for early identification and resolution of issues, ensuring the overall functionality, reliability, and performance of the robotic vehicle.

CONCLUSION

The robot was designed and implemented with an ESP32S microcontroller for its operation. Itis moved in different directions with the help of buttons which is done with the help of web application (Blynk App). It is verified to be highly beneficial for security and industrial purposes. The robot can detect objects within a very good radius which is a highly beneficial characteristic; it 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 100m, therobot is not sensitive to the light and it is not much sensitive to the environmental changes and weather conditions.

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