A
PROJECT REPORT ON

LANDMINE DETECTION ROBOTIC VEHICLE

SUBMITTED IN
PARTIAL FULFILLMENT
OF

DIPLOMA IN EMBEDDED SYSTEM DESIGN (PG-DESD)

Submitted by

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AT

SUNBEAM INSTITUTE OF INFORMATION TECHNOLOGY,
HINJAWADI, PUNE

DECLARATION

We declare that this written submission represents our ideas in our own words and where others ideas or words have been included; we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will cause disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

Place: Pune

Date: 12.02.2025

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CERTIFICATE

*This is to certify that the project report entitled "**LANDMINE DETECTION ROBOTIC VEHICLE**", submitted by Barira Sadaf, Faizkhan Jamadar, Avinash Singh, Parvaj Malik in partial fulfillment for the award of Post Graduate Diploma in Embedded System And Design (PG-DESD) of Sunbeam Institute of Information Technology, Pune in session 2024-2025. It has been found to be satisfactory and hereby approved for submission.*

Place: Pune

Date: 12.02.2025

ACKNOWLEDGEMENT

It is indeed a matter of great pleasure and proud privilege to be able to present this project on "***LANDMINE DETECTION ROBOTIC VEHICLE***". The completion of this project work is great experience in student's life and its execution is inevitable in hands of guide. We are highly indebted to the Project Guide **Mr. Sohail Inamdar** for his invaluable guidance and appreciation for giving form and substance to this project. It is due to his enduring efforts, patience and enthusiasm which has given sense of direction and purposefulness to this project and alternately made it a success.

I also wish to express my sincere thanks to the CEO of Sunbeam Institute of Information Technology Pune **Mr. Nitin Kudhale** for their immense planning, continuous guidance and talk-shows which kept us involved even in this remote learning batch. Also, I am grateful to all the faculty members specially **Mr. Devendra Dhandhe**, **Mr. Nilesh Ghule**, for their consistent support and assistance.

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Finally, last but by no means least; also to everyone in the institute, fellow batch-mates it was great sharing a learning platform with all of you during last six months.

Thanks for all your encouragement!

ABSTRACT

Landmines pose a severe threat to both military personnel and civilians, often remaining active for years after conflicts end. This project presents a **Landmine Detection Robotic Vehicle** designed to enhance demining operations. The system is powered by an **STM32 microcontroller**, which controls a **magnetometer sensor** to detect landmines by analyzing magnetic field variations. The robotic vehicle uses an **L298N motor driver** to control dual DC motors, enabling smooth movement on tracked wheels. An **HC-SR04 ultrasonic sensor** ensures obstacle detection and avoidance. The system integrates a **Neo-6M GPS module** for precise location tracking, and upon detecting a landmine, it transmits the GPS coordinates via SMS using a **GSM module** to a registered mobile number. This autonomous robotic system enhances safety and efficiency in landmine detection, reducing human exposure to dangerous environments.

INDEX

1. INTRODUCTION

Landmines are explosive devices used in times of war and conflict to destroy or disable enemy targets. Landmines are typically concealed under the ground and usually triggered using pressure, thus detonating whenever a target steps over or drives over it.

Landmines are controversial contraptions and their usage is often debated due to their potential as indiscriminate weapons. Landmines can lie dormant and pose a threat to civilians even years after a war has ended.

Demining refers to the process of removing landmines from an area. Demining can be both a military operation carried out during an active operation or a humanitarian effort conducted to clear an area of mines for civilian usage.

This Landmine Detection Robotic Vehicle uses a magnetometer to detect mines hidden on the surface of the earth. It's tracked design allows it to traverse across the roughest and wildest terrains. This Robot has been equipped with ultrasonic sensor to help it with obstacle sensing. Thus, making is capable to autonomously scan a particular area for hidden mines. This Robot is GSM based and allows the user to register themselves by merely giving a missed call.

This robotic vehicle detects landmines using a magnetometer, that measures magnetic field strength and detects variations in the Earth's magnetic field caused by ferromagnetic objects coil is mounted on a dual motor tracked robotic vehicle that surveys an area autonomously using an ultrasonic sensor for obstacle sensing. Once detected the vehicle transmits the GPS location of the landmine over an SMS to the registered phone number so that the mine locations can be mapped.

The system makes use of an STM 32 controller to achieve this operation. The Stm32 uses an ARM based processor to deliver high performance, real time capabilities and connectivity for various operations. We use a dual Motor drive using 2 x DC motors to drive the robotic vehicle. The Motors are attached to a tracked wheels for rough terrain operation. The system also consists of an ultrasonic sensor which when triggered in close range instructs the robot to change direction and sweep the area while avoiding obstacles.

The magnetometer continuously measures the ambient magnetic field of the surrounding environment. When a ferromagnetic object, such as a landmine, is present, it disturbs the natural magnetic field. This disturbance is detected as a variation in the magnetic field strength. The STM32 controller processes this data in real time, identifying anomalies that indicate the presence of a metallic object. The controller now uses a GSM module to transmit the GPS coordinates to a registered cell no via SMS messaging. Thus it allows a user to get GPS location data of all landmines in an area.

2. LITERATURE SURVEY

1. Autonomous Landmine Detection System Using Embedded Systems
Authors: John Smith, Michael Johnson, and Sarah Williams
Description:
This paper presents an autonomous landmine detection system using an ARM Cortex-M3 microcontroller. The system utilizes a magnetometer sensor to detect landmines based on variations in the surrounding magnetic field. The robotic platform is designed with tracked wheels to navigate rough terrain and an ultrasonic sensor for obstacle avoidance. The system processes sensor data in real-time and transmits GPS coordinates of detected mines via GSM communication. The study concludes that embedded systems provide an efficient and reliable solution for landmine detection, reducing human risk in demining operations.

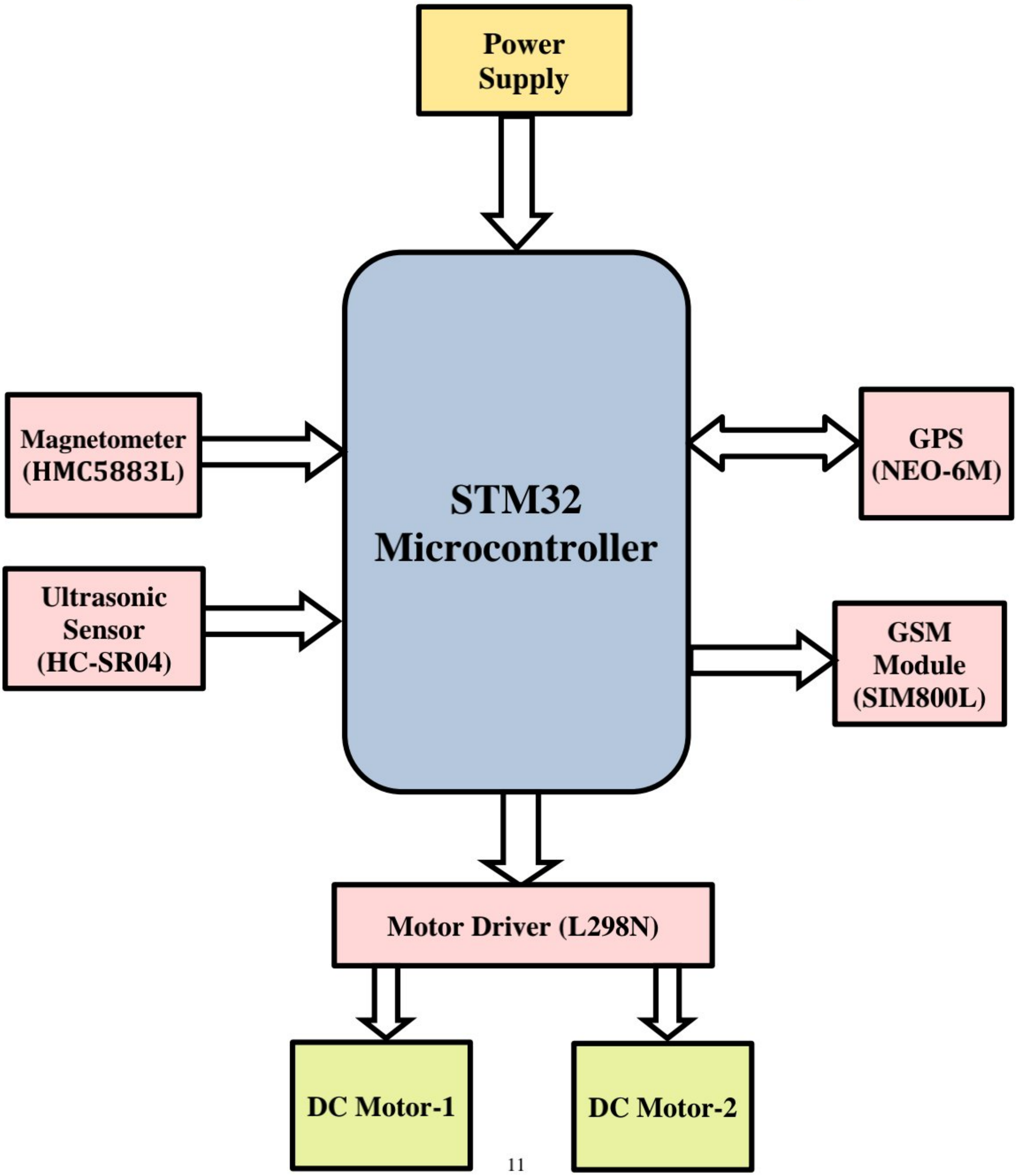
2. Design and Implementation of an Autonomous Mine Detection Robot
Authors: A. Gupta, P. Verma, and K. Singh
Description:
This research focuses on developing a low-cost, mobile robot for landmine detection using embedded systems and wireless communication. The robot is equipped with a Neo-6M GPS module for accurate location tracking and a magnetometer sensor for metal detection. The STM32 microcontroller is used to process sensor readings and control motor movements via an L298N motor driver. The study highlights the advantages of using an autonomous system over manual demining, including increased efficiency and reduced casualties.

3. Wireless Sensor Network-Based Landmine Detection System
Authors: Dr. R. Sharma, T. Kumar, and S. Patel
Description:
This paper explores the integration of wireless sensor networks (WSN) in landmine detection robots. The proposed system utilizes multiple autonomous robots communicating over a CAN bus network, allowing for collaborative mapping of landmines in a hazardous area. Each robot is equipped with a magnetometer, GPS module, and GSM module for real-time data transmission. The study emphasizes the importance of sensor fusion and communication protocols for enhancing detection accuracy and reducing false positives.

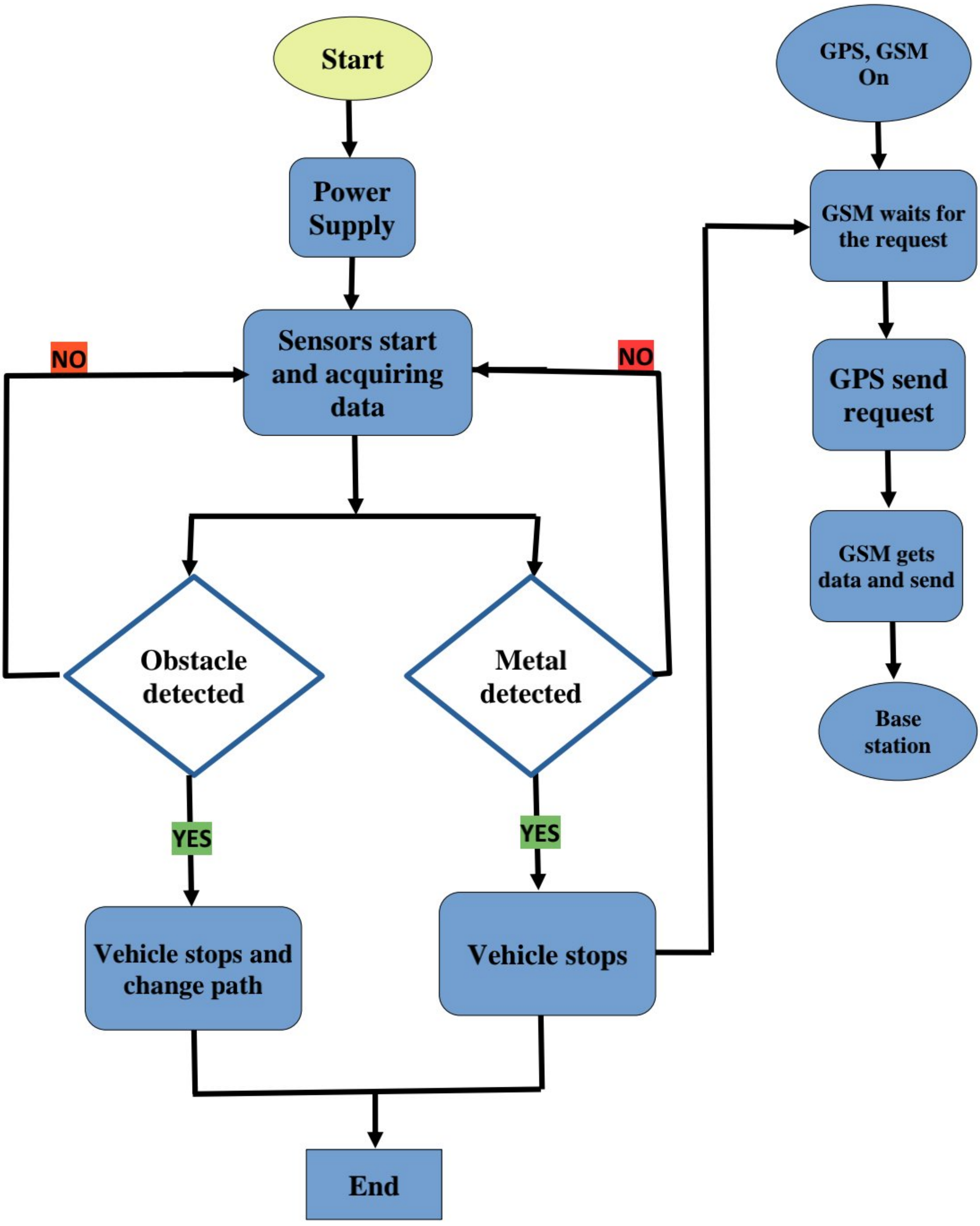
4. Embedded System-Based Real-Time Navigation for Mine Detection Robots

Authors: L. Brown, C. White, and D. Adams
Description:
This research discusses the implementation of real-time navigation algorithms for autonomous landmine detection robots. The system employs an HC-SR04 ultrasonic sensor to detect and avoid obstacles while following a pre-defined path. The STM32-based embedded system ensures real-time processing of sensor data and efficient control of the DC motors. The study concludes that integrating real-time operating systems (RTOS) with embedded controllers enhances the performance of mine detection robots.

3. BLOCK DIAGRAM



4. FLOW CHART


Start
Power Supply
Sensors start and acquiring data
NO
NO
Obstacle detected
Metal detected
YES
YES
Vehicle stops and change path
Vehicle stops
End
GPS, GSM On
GSM waits for the request
GPS send request
GSM gets data and send
Base station

5. HARDWARE DESCRIPTION

5.1 STM32F407

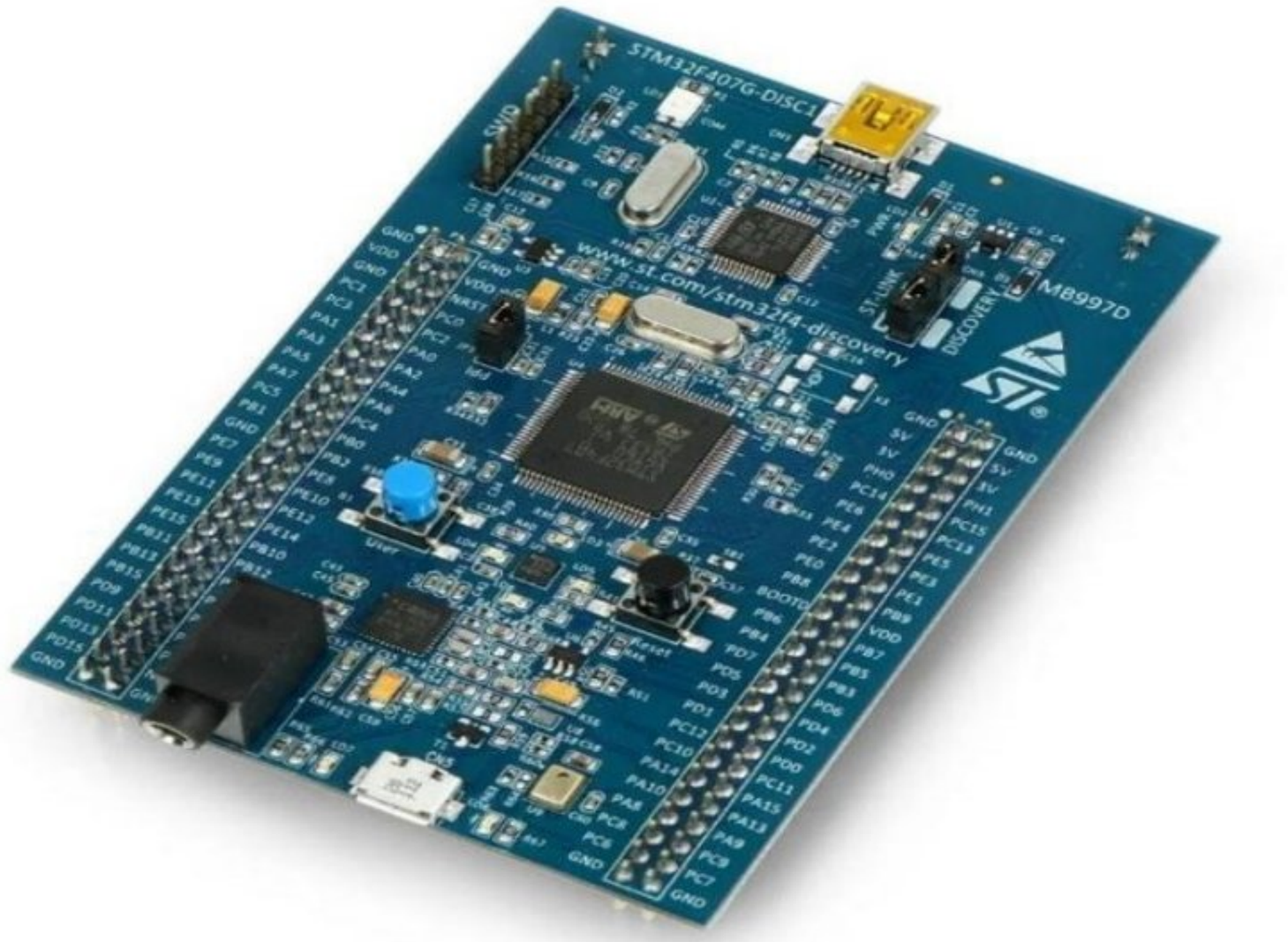


Fig 1: STM32F407

The **STM32F407VG Discovery board** is small devices based on ARM Cortex™-M4 micro-controller, which is a high-performance microcontroller. This board allows users to develop and design applications. It has multiple modules within itself which allows the user to communicate and design the interface of different kinds without relying on any third device. The board has all the modern system modules peripherals like CAN, DAC, ADC, audio port, UART, I2C, etc which makes it one of the best-developing devices.

The STM32F407 lines are designed for medical, industrial and consumer applications where the high level of integration and performance, embedded memories and rich peripheral set inside packages as small as 10 x 10 mm are required. The STM32F407 offers the performance of the Cortex™-M4 core (with floating point unit) running at 168 MHz.

Performance: At 168 MHz, the STM32F407 delivers 210 DMIPS/566 CoreMark performance executing from Flash memory, with 0-wait states

using ST's ART Accelerator. The DSP instructions and the floating-point unit enlarge the range of addressable applications.

• 2x USB OTG (one with HS support)

• Audio: dedicated audio PLL and 2 full-duplex IZS

• Up to 15 communication interfaces (including 6x USARTs running at up to 11.25 Mbit/s, 3x SPI running at up to 45 Mbit/s, 3x IZC, 2x CAN, SDIO)

• Analog: two 12-bit DACs, three 12-bit ADCs reaching 2.4 MSPS or 7.2 MSPS in interleaved mode

• Up to 17 timers: 16- and 32-bit running at up to 168 MHz

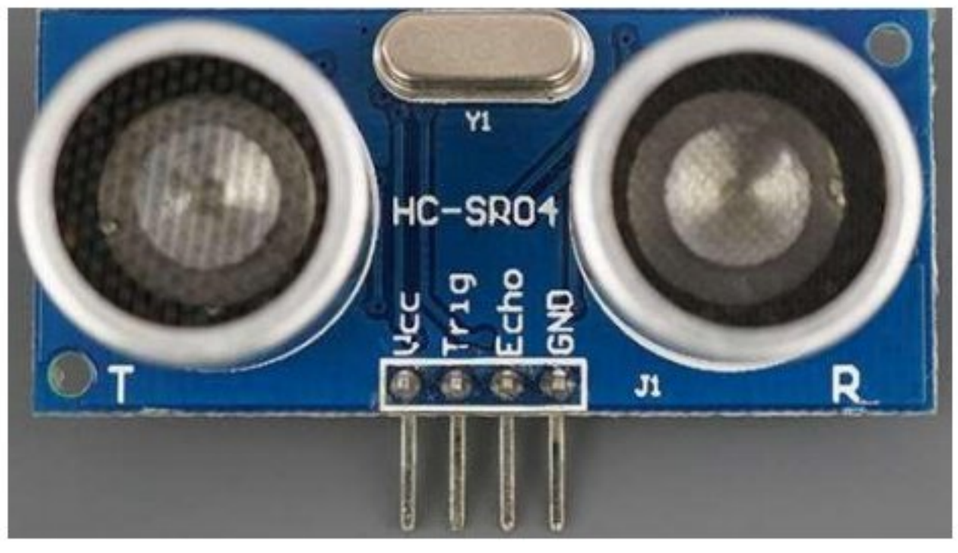
• Easily extendable memory range using the flexible static memory controller supporting Compact Flash, SRAM, PSRAM, NOR and NAND memories

• Analog true random number generator The STM32F407 product lines provide from 512 Kbytes to 1 MByte of Flash, 192 Kbytes of SRAM, and from 100 to 176 pins in packages as small as 10 x 10 mm.

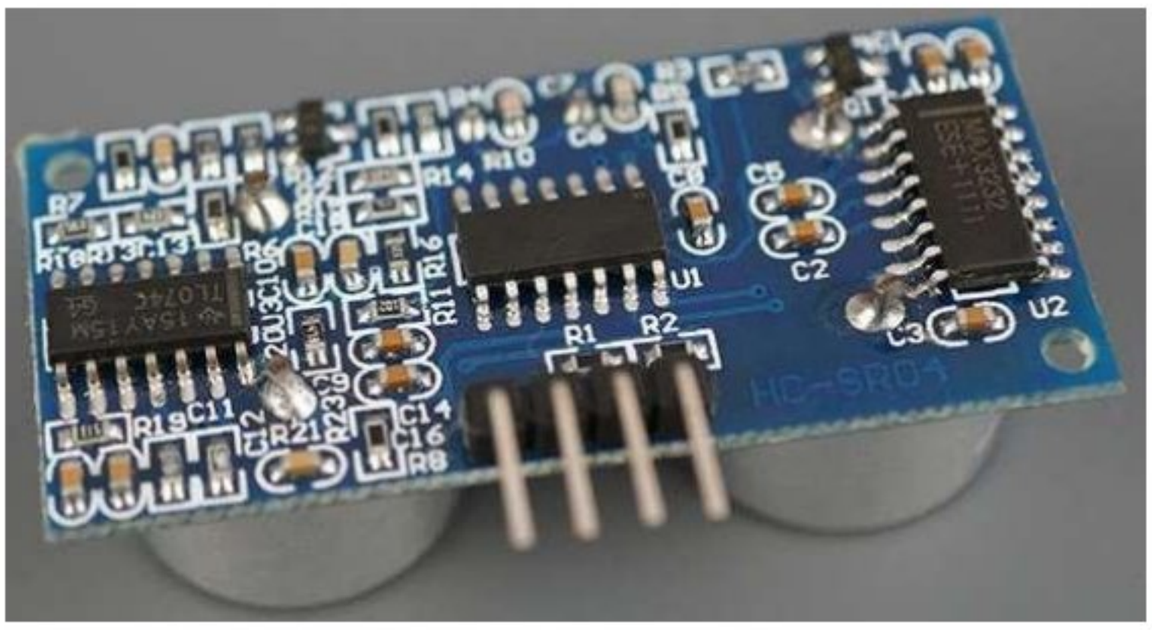
5.2 HC-SR04 Ultrasonic Sensor

The HC-SR04 ultrasonic sensor uses sonar to determine the distance to an object. This sensor reads from 2cm to 400cm (0.8inch to 157inch) with an accuracy of 0.3cm (0.1inches), which is good for most hobbyist projects. In addition, this module comes with ultrasonic transmitter and receiver modules.

The following picture shows the HC-SR04 ultrasonic sensor.



The next picture shows the other side of the sensor.



- **HC-SR04 ULTRASONIC SENSOR TECHNICAL DATA**

The following table shows the key features and specs of the HC-SR04 ultrasonic sensor. For more information, you should consult the sensor's datasheet.

Power Supply	5V DC
Working Current	15 mA
Working Frequency	40 kHz
Maximum Range	4 meters
Minimum Range	2 cm
Measuring Angle	15º
Resolution	0.3 cm
Trigger Input Signal	10uS TTL pulse
Echo Output Signal	TTL pulse proportional to the distance range
Dimensions	45mm x 20mm x 15mm

- **HC-SR04 ULTRASONIC SENSOR PINOUT**

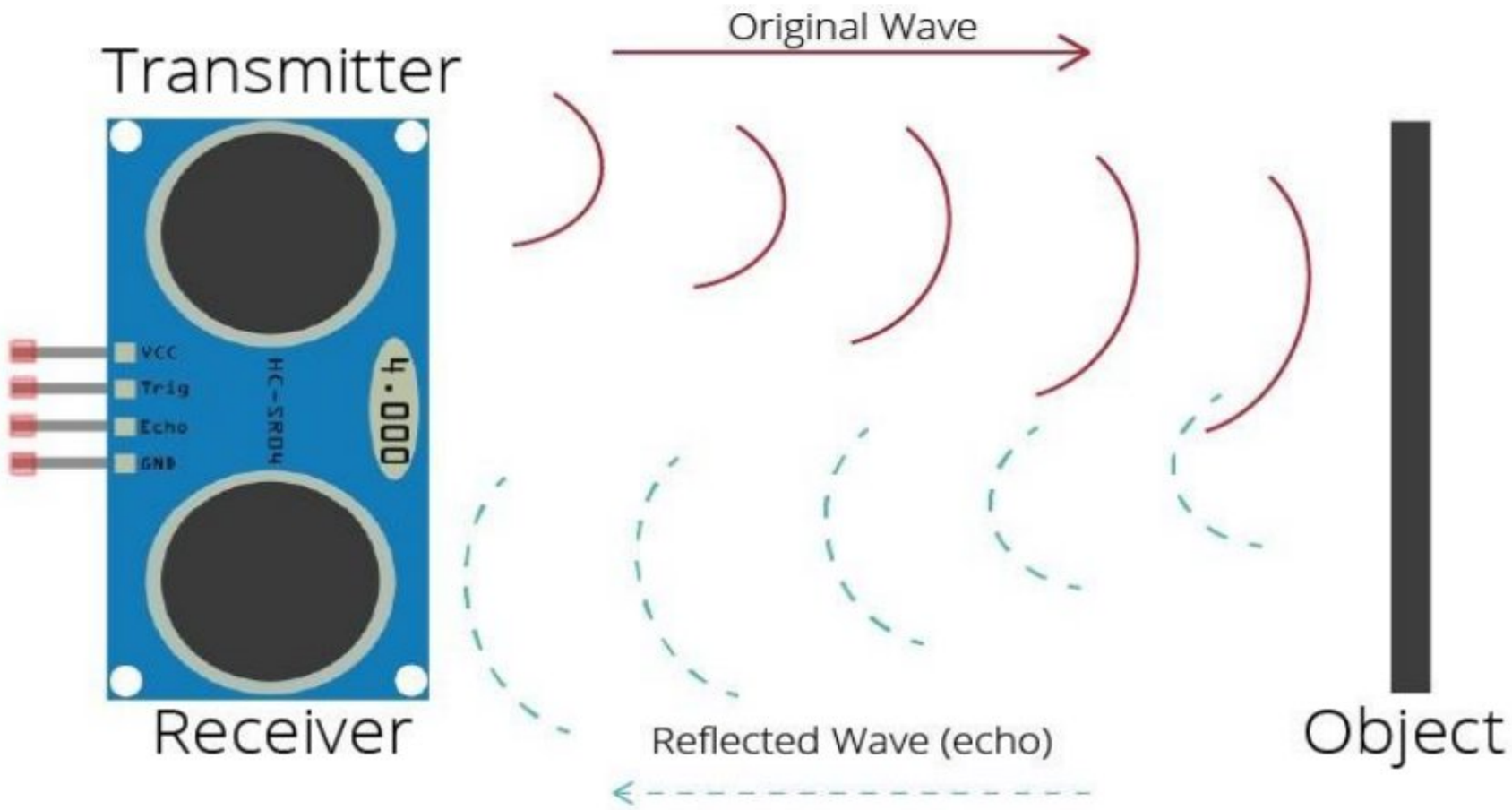
Here is the pinout of the HC-SR04 Ultrasonic Sensor.

VCC	Powers the sensor (5V)
Trig	Trigger Input Pin
Echo	Echo Output Pin
GND	Common GND

- **HC-SR04 ULTRASONIC SENSOR WORKING**

The ultrasonic sensor uses sonar to determine the distance to an object. Here is how it works:

- The ultrasound transmitter (trig pin) emits a high-frequency sound (40 kHz).
- The sound travels through the air. If it finds an object, it bounces back to the module.
- The ultrasound receiver (echo pin) receives the reflected sound (echo).



Considering the sound's velocity in the air and the travel time (time passed since the transmission and reception of the signal) we can calculate the distance to an object.

Here is the formula:

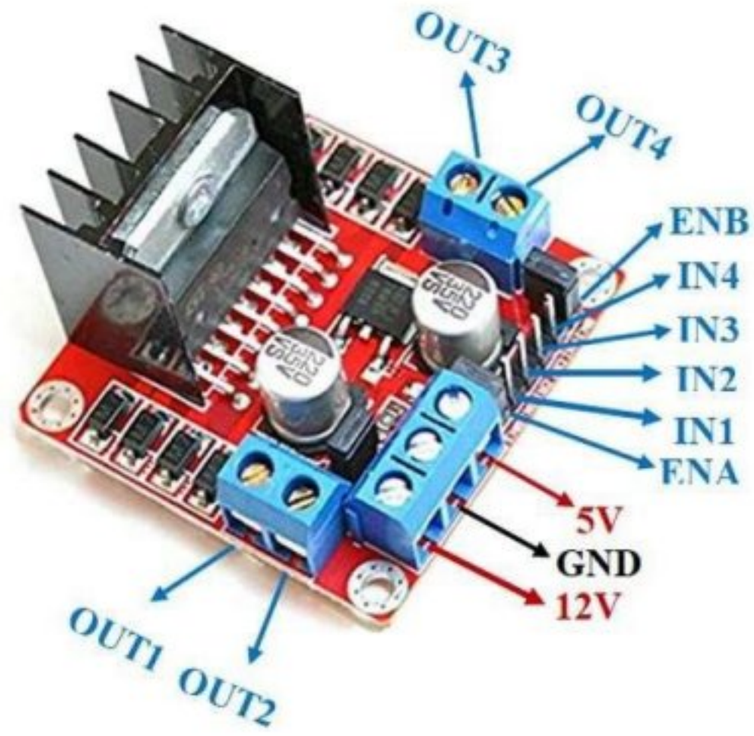
distance to an object = ((speed of sound in the air) *time)/2

- speed of sound in the air at 20ºC (68ºF) = **343m/s**

5.3 DC Motor

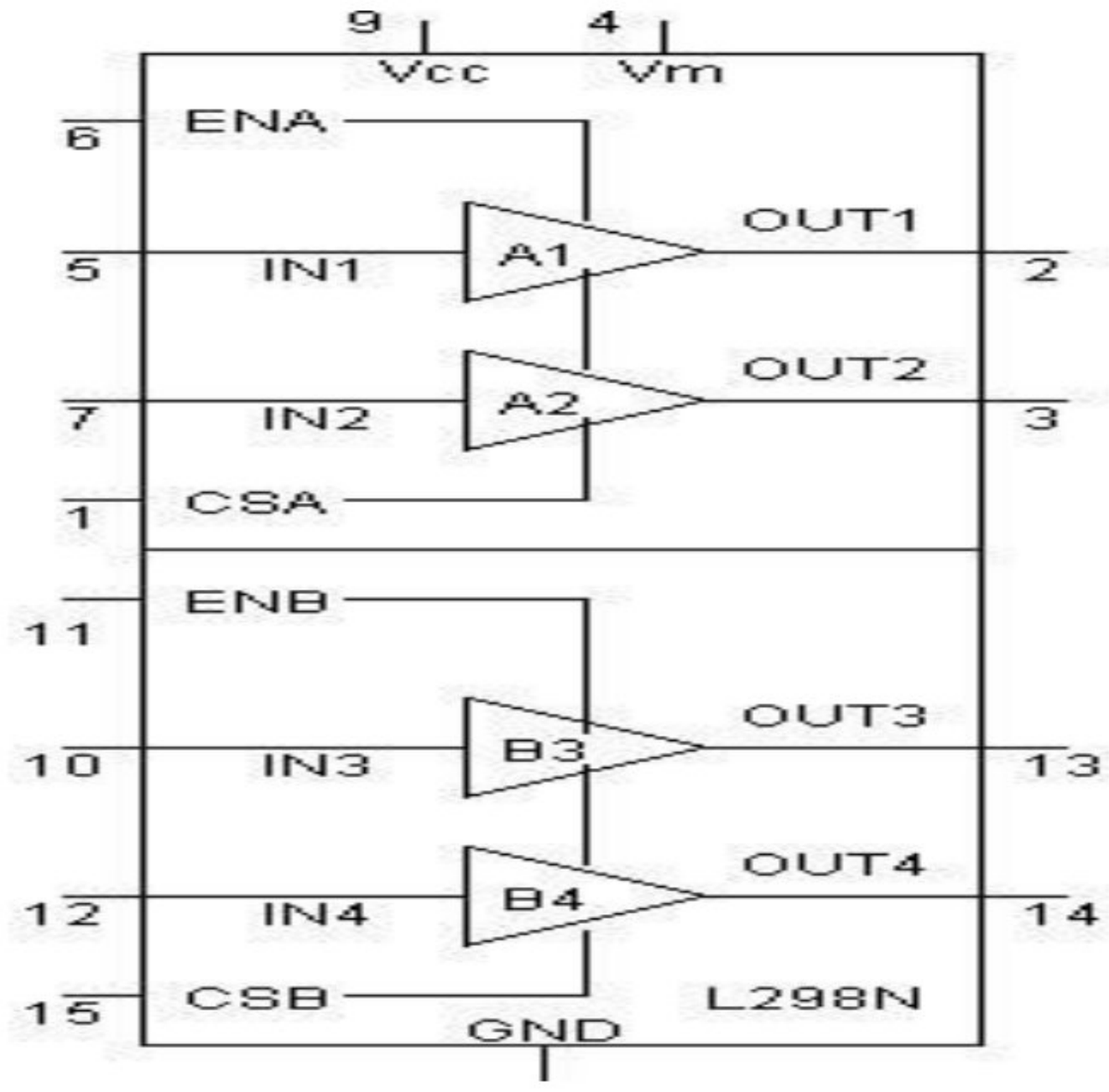
A DC motor or direct current motor is an electrical machine that transforms electrical energy into mechanical energy by creating a magnetic field that is powered by direct current. When a DC motor is powered, a magnetic field is created in its stator. The field attracts and repels magnets on the rotor; this causes the rotor to rotate. To keep the rotor continually rotating, the commutator that is attached to brushes connected to the power source supply current to the motors wire windings.

5.4 L298N MOTOR DRIVER MODULE



This **L298N Motor Driver Module** is a high-power motor driver module for driving DC and Stepper Motors. This module consists of an L298 motor driver IC and a 78M05 5V regulator. **L298N Module** can control up to 4 DC motors, or 2 DC motors with directional and speed control.

MOTOR DRIVER INTERNAL CIRCUIT



- **L298N MODULE PINOUT CONFIGURATION**

Pin Name	Description
IN1 & IN2	Motor A input pins. Used to control the spinning direction of Motor A
IN3 & IN4	Motor B input pins. Used to control the spinning direction of Motor B
ENA	Enables PWM signal for Motor A
ENB	Enables PWM signal for Motor B
OUT1 & OUT2	Output pins of Motor A
OUT3 & OUT4	Output pins of Motor B
12V	12V input from DC power Source
5V	Supplies power for the switching logic circuitry inside L298N IC
GND	Ground pin

L298N consists of four independent power amplifiers. Two of them form H-bridge A while other two form H-bridge B. **One H bridge** is used to switch the polarity in controlling direction of DC motor. **Pair of H Bridge** is used to control a bi-polar stepper motor.

- Amp A1 and A2 => H Bridge A
- Amp B1 and B2 => H Bridge B

Basically, L298N is used to drive inductive or magnetic loads, so there can come voltage spikes in output. To avoid that voltage spikes there should be some internal parasitic or Flywheel diodes. But it lacks them. We use externally these flywheel diodes. They can be 1N5819 Schottky diodes or 1N4001 rectifier diodes.

2Each bridge is provided with enable pins (ENA, ENB) and current sense pins (CSA, CSB). Current sense pins can be tied to ground but we can also insert low value resistor and its voltage reading is proportional to current. Both enable pins can be used at the same time which makes all for outputs active at the same time. All the four inputs and Enable pins work on 5v TTL logic which makes the connection easy with microcontrollers.

- ENA=5v, High logic (Amplifier A1 and A2 on)
- ENA=0v, Low logic (Amplifier A1 and A2 off)
- ENB=5v, High logic (Amplifier B1 and B2 on)
- ENB=0v, Low logic (Amplifier B1 and B2 off)

• L298N MOTOR DRIVER MODULE WORKING

Now consider an example. We will use H bridge motor diver IC L298N and two DC motors. This IC is used to control these motors. What we want to do is to change the polarity of motors so they can run in either direction depending upon logic.

INPUTS: Four inputs are provided to the four power amplifiers of L298N. We can use push buttons and whenever specific push button is pressed; specific motor will start running. Two inputs will monitor each motor. Instead of push button, we can use logic toggle in proteus simulation for our ease.

Enable bits are used to select specific amplifier. ENA can select two amplifiers A1, A2 and similarly ENB can select two amplifiers B1, B2. While using as a bridge circuit, ENA selects bridge A and ENB selects bridge B. To drive both the motors by using H bridges, both enable bits are set high.

OUTPUTS: There are four outputs. The output for motor A is obtained from out1 out2 pins and similarly for motor B output is obtained from out3 out4 pins. L298N does not have built in protection diodes we used external diodes to prevent the IC from getting damaged.

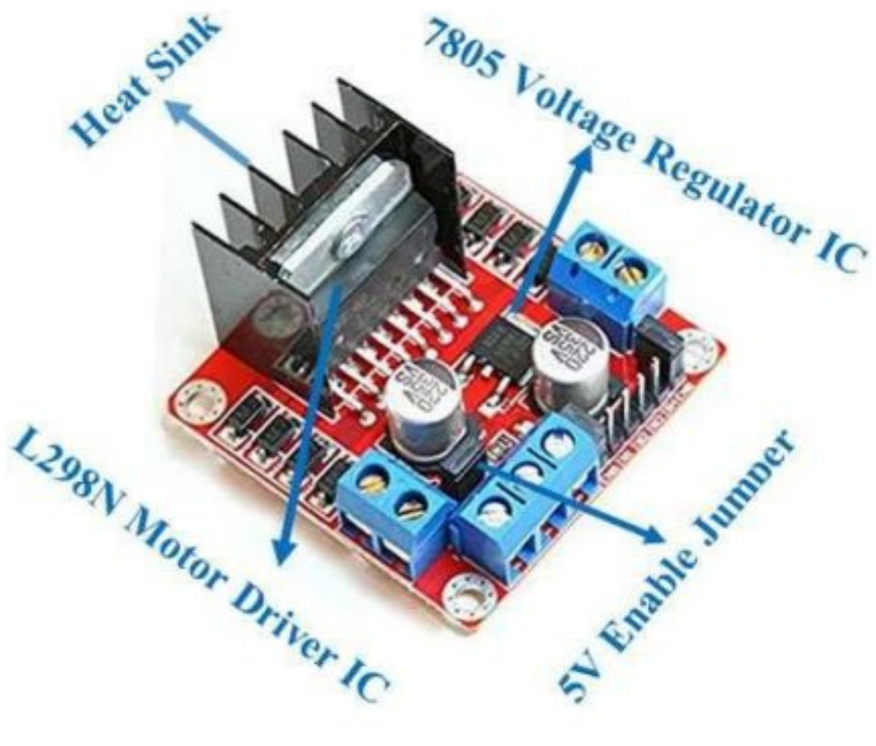
This IC is using two different voltages. On input side, 5v is given to the pin 9 (Vss), push buttons and enable bits. On output side, pin 4 (Vs) supplies the motors and it can be upto 46 volts. Here we are not using the current sensing scheme, so we have grounded those pins 1 & 15. Motors speed will be lower if low voltages are on output side.

FEATURES & SPECIFICATIONS

- Driver Model: L298N 2A
- Driver Chip: Double H Bridge L298N
- Motor Supply Voltage (Maximum): 46V
- Motor Supply Current (Maximum): 2A
- Logic Voltage: 5V
- Driver Voltage: 5-35V
- Driver Current:2A
- Logical Current:0-36mA
- Maximum Power (W): 25W
- Current Sense for each motor
- Heatsink for better performance
- Power-On LED indicator

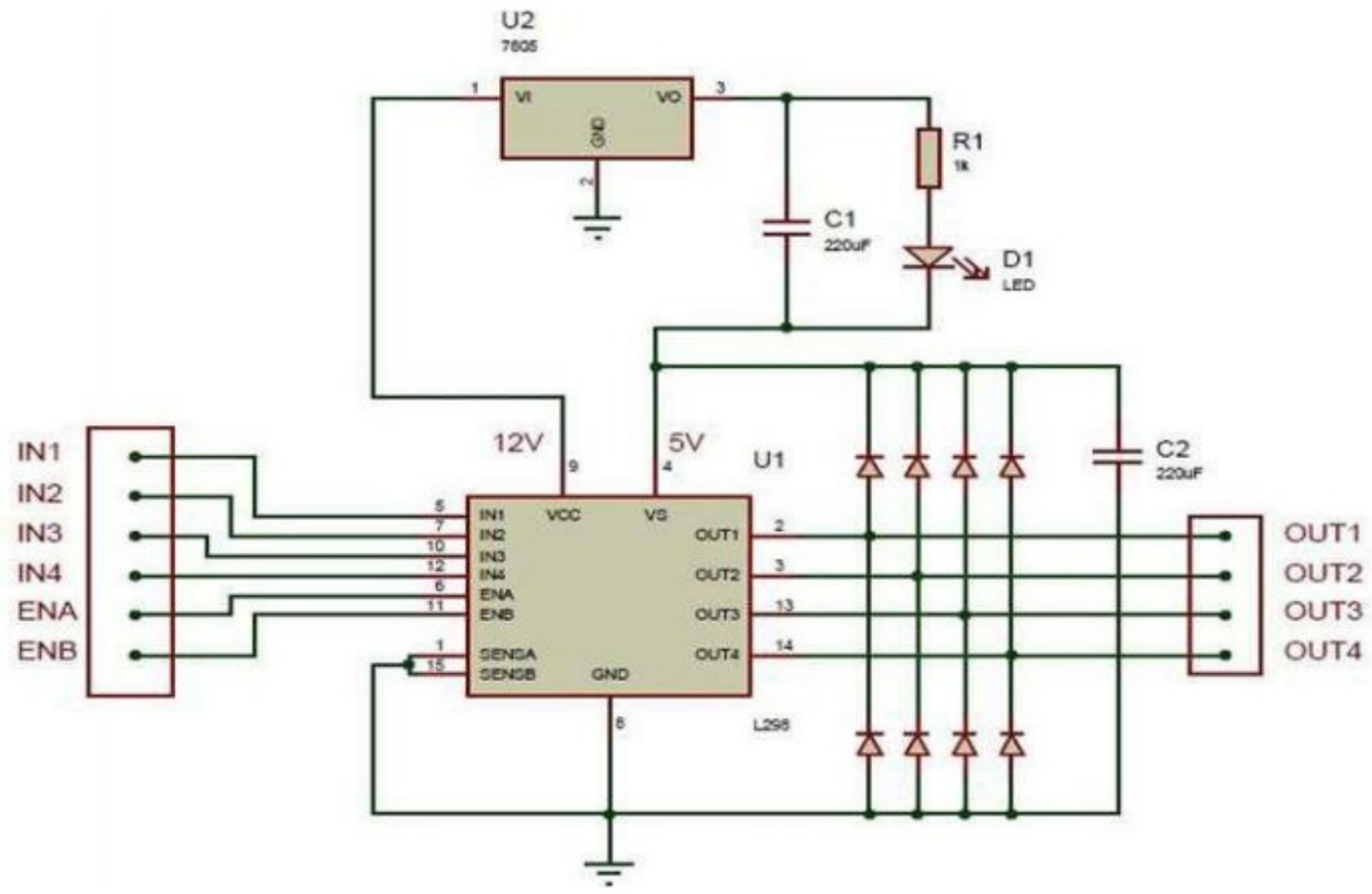
BRIEF ABOUT L298N MODULE

The L298N Motor Driver module consists of an L298 Motor Driver IC, 78M05 Voltage Regulator, resistors, capacitor, Power LED, 5V jumper in an integrated circuit. 78M05 Voltage regulator will be enabled only when the jumper is placed. When the power supply is less than or equal to 12V, then the internal circuitry will be powered by the voltage regulator and the 5V pin can be used as an output pin to power the microcontroller. The jumper should not be placed when the power supply is greater than 12V and separate 5V should be given through 5V terminal to power the internal circuitry.



ENA & ENB pins are speed control pins for Motor A and Motor B while IN1& IN2 and IN3 & IN4 are direction control pins for Motor A and Motor B.

Internal circuit diagram of L298N Motor Driver module is given below:



APPLICATIONS

- Drive DC motors.
- Drive stepping motors
- In Robotics

5.5 HMC5883L Magnetometer

The following picture shows the HMC5883L Magnetometer.

The next picture shows the other side of the sensor.

A magnetometer is used for measurement of magnetic field direction in space. Most navigation systems use electronic compasses to determine heading direction. It has several types such as fluxgate, magnetoresistive, magneto-inductive and others.

Working Principle

The **HMC5883L** is a 3-axis digital magnetometer (compass) commonly used for navigation and detecting magnetic fields. While it is **not designed specifically for metal detection**, it can be used to detect ferromagnetic metals (like iron, steel, and nickel) due to their influence on the Earth's magnetic

field. However, it **cannot detect non-ferromagnetic metals** like aluminum, copper, or gold.

1. **Detecting Magnetic Disturbances:**

- The HMC5883L measures the strength and direction of the surrounding magnetic field.
- When a ferromagnetic object is brought close, it disturbs the local magnetic field, and this change can be detected.

2. **Sensitivity & Limitations:**

- The sensor is highly sensitive to Earth's magnetic field, so external disturbances (like power lines, electronics, or magnets) can interfere.
- It works best when stationary or moving slowly.
- It does **not** generate a magnetic field like an actual metal detector; it only senses existing ones.

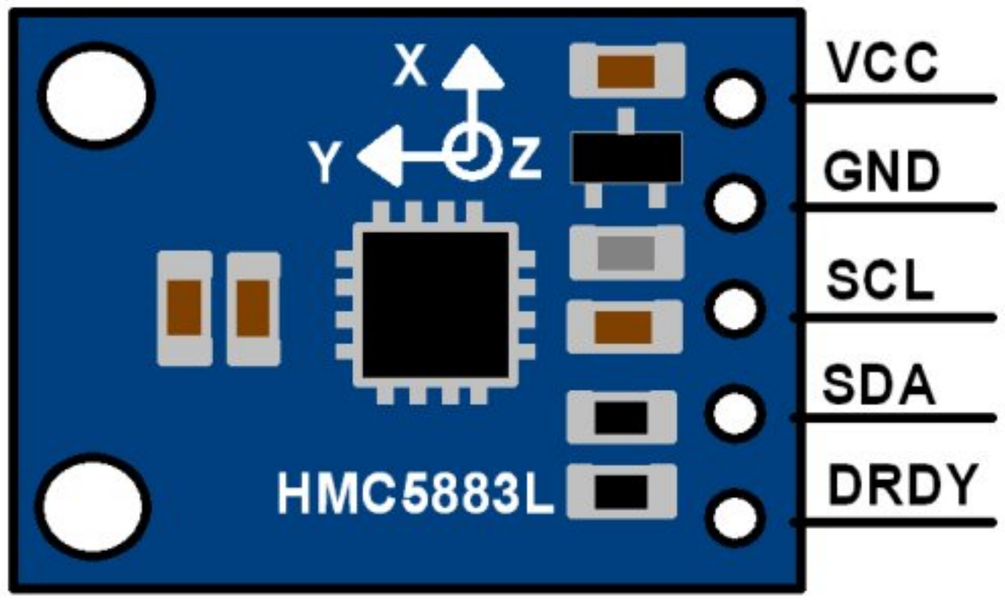
Steps to Use HMC5883L for Metal Detection

- **Connections (I2C Communication):**
  - **VCC** → 3.3V / 5V
  - **GND** → GND
  - **SCL** → I2C Clock (SCL)
  - **SDA** → I2C Data (SDA)

Features of HMC5883L,

- It can be used for low-cost compassing and magnetometry.
- It has 12-bit ADC and compass heading accuracy is up to 1° to 2°.
- It has Honeywell's Anisotropic Magneto Resistive (AMR) technology which provides precision in axis sensitivity and linearity.
- It uses I2C communication protocol to communicate with microcontrollers.

HMC5883L Pinout



HMC5883L module has five pins as shown in above figure,

VCC: Connect 5V DC supply to this pin.

GND: Connect ground to this pin.

SCL: Connect serial clock out from master device to this pin.

SDA: Connect serial data line from master device to this pin.

DRDY: Data Ready status signal pin output from module to master device.

This device is controlled through on-chip registers, shown in the table below:

Specification of HMC5883L Magnetometer

1.Supply Voltage: 2.16 to 3.6 V DC

2.Communication: I2C (Inter-Integrated Circuit)

3.Sensitivity: ±0.88 mG per digit

4.Field Range: ±8.1 Gauss

5.Data Output Rate: 0.75, 1.5, 3, 7.5, 15 Hz

6.Operating Current: 130 μA

Address Location	Name	Access
00	Configuration Register A	Read/Write
01	Configuration Register B	Read/Write
02	Mode Register	Read/Write
03	Data Output X MSB Register	Read
04	Data Output X LSB Register	Read
05	Data Output Z MSB Register	Read
06	Data Output Z LSB Register	Read
07	Data Output Y MSB Register	Read
08	Data Output Y LSB Register	Read
09	Status Register	Read
10	Identification Register A	Read
11	Identification Register B	Read
12	Identification Register C	Read

From above table,

- **Configuration Register A** is used to set the data output rate and the measurements mode of the module.

- **Configuration Register B** is used to set the gain of the device.

- **Mode register** is used to set the operating mode of the HMC5883L like Idle mode, Single-measurement mode, Continuous measurement mode.

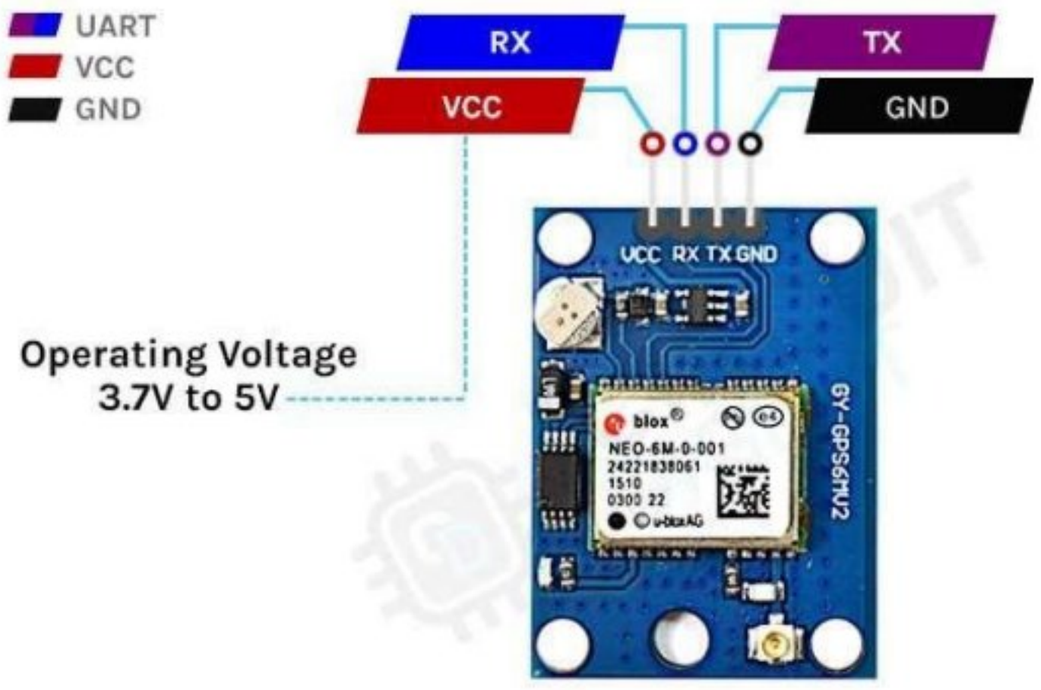
- **Data Output Registers** are used to store X, Y and Z axis values. As these values are 16-bit wide, those values are stored in two 8-bit registers. So, we need to read each axis value from two 8-bit registers. These values are in 2's complement form i.e. we need to copy it in 16-bit signed variable to get decimal value.

- **Status Register** gives device ready status and status of data output register i.e. whether it is locked or not.
- **Identification Registers** are used to identify the device.

5.6 NEO-6M GPS MODULE

NEO-6M GPS MODULE PINOUT

The NEO-6M GPS module has four pins: GND, TxD, RxD, and VCC. The TxD and RxD pins are used to communicate with the microcontroller.



GND is the ground pin of the GPS Module and it should be connected to the ground pin of the ESP32.

TXD is the transmit pin of the GPS module that needs to connect to the RX pin of the ESP32.

RXD is the receive pin of the GPS module that needs to connect to the TX pin of the ESP32.

VCC is the power pin of the GPS module and needs to connect to the 3.3V pin of the ESP32.

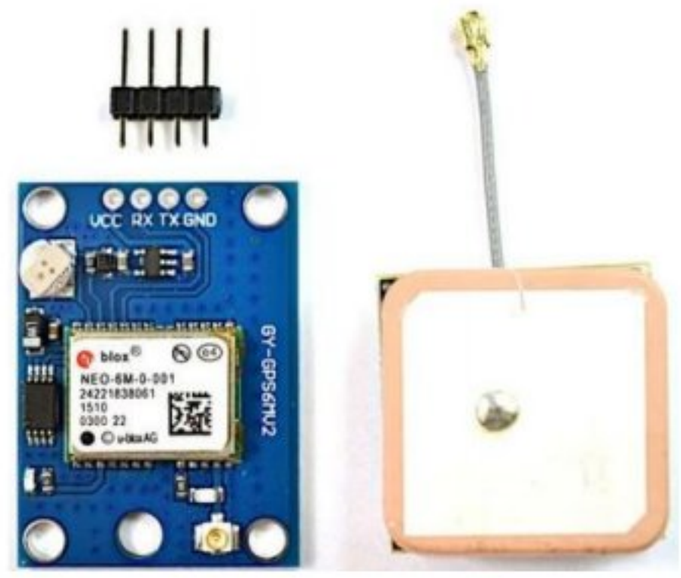
NEO-6M GPS MODULE – PARTS

The NEO-6M module is a ready-to-use GSM module that can be used in many different applications. The parts on the NEO-6M GPS

module are shown below-

The NEO-6M GPS module has five major parts on the board, the first major part is the NEO-6M GPS chip in the heart of the PCB. Next, we have a rechargeable battery and a serial EEPROM module. An EEPROM together with a battery helps retain the clock data, latest position data(GNSS orbit data), and module configuration but it's not meant for permanent data storage. Without the battery, the GPS always cold-starts so the initial GPS lock takes more time. The battery is automatically charged when power is applied and maintains data for up to two weeks without power. Next, we have our LDO, because of the onboard LDO, the module can be powered from a 5V supply. Finally, we have our UFL connector where we need to connect an external antenna for the GPS to properly work.

OVERVIEW OF THE NEO-6M GPS MODULE



The Global Positioning System (GPS) is a system consisting of 31 satellites orbiting earth. We can know their exact location because they are constantly transmitting position information with time through radio signals. At the heart of the breakout board, there is the NEO-6M GPS module that is designed and developed by u-blox.

This is very small but it packs a lot of features. It can track up to 22 satellites over 50 channels while consuming only 45mA of current and has an operating voltage of 2.7V ~ 3.6V. One of the most interesting features of this module is its power-saving mode. This allows a reduction in system power consumption. With power-saving mode on, the current consumption of the module reduces to 11MA only.

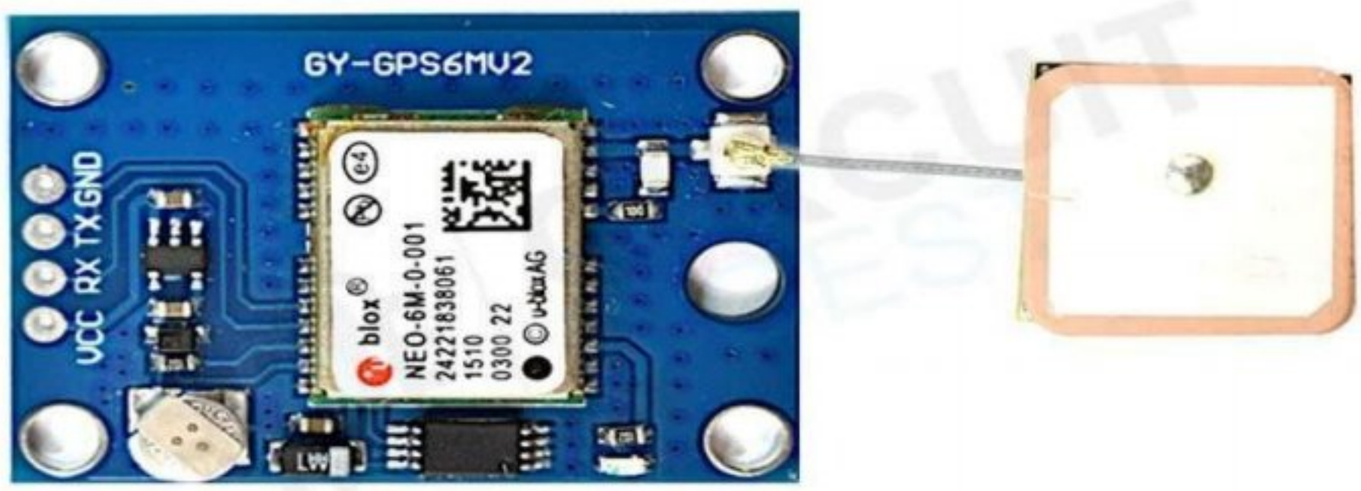
NEO-6M Module datasheet.

Position Fix LED Indicator:

If you take a close look at the NEO-6M GPS module board, you can find a small LED that is used to indicate that the GPS module is able to communicate with the satellites.

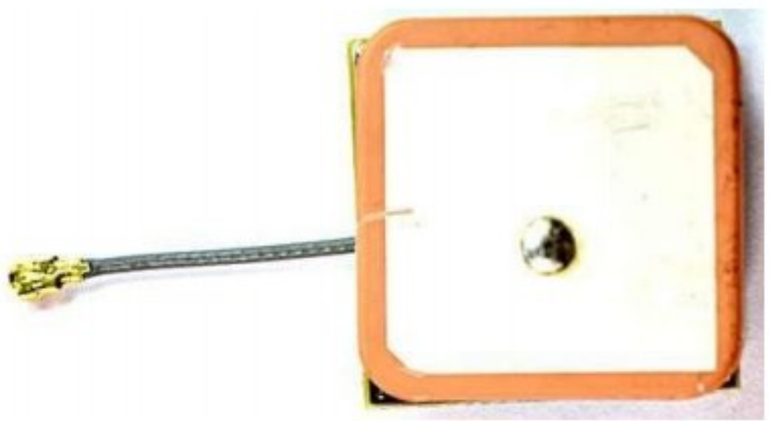
1. No blinking – it is searching for satellites.Blink every 1s – Position Fix is found (the module can see enough satellites).

2. Blink every 1s – Position Fix is found (the module can see enough satellites).



ANTENNA:

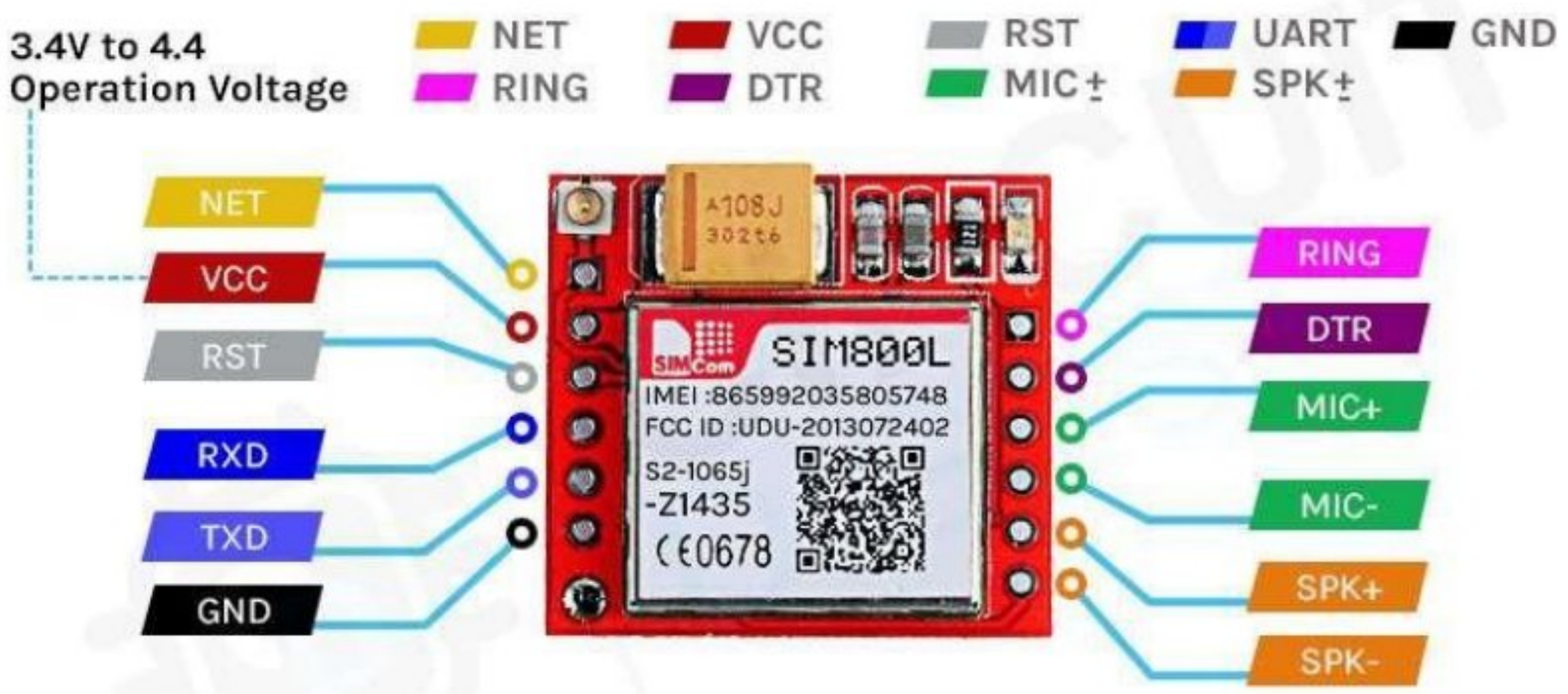
The module comes with a -161 dBm sensitive patch antenna that can receive radio signals from GPS satellites. You can connect the antenna to a small UFL connector which we have mentioned in the parts marking section of this article.



For most outdoor applications, the patch antenna will work just fine but for more demanding or indoor applications it is advised to use a 3V active GPS antenna.

5.7 SIM800L GSM/GPRS MODULE

The SIM800L GSM/GPRS module has 12 pins which are NET, VCC, RST, RXD, TXD, GND, SPK-, SPK+, MIC-, MIC+, DTR, RING.



NET is a pin where you can solder the helical antenna that comes with the module.

VCC is the Power supply pin of the module and it needs to be powered anywhere from 3.4V to 4.4 volts. Connecting this module to a 5V supply will most likely destroy it and if you connect it to 3.3V it will not even run. A lithium battery or a buck converter with 2A current capacity is recommended for this module.

RST is the hard reset pin of the sim800L module. If you are having trouble communicating with this, pull the pin low for 100ms.

RXD is the RX pin for the module used in serial communication.

TXD is the TX pin for this module used in Serial communication.

GND is the Ground pin for this module; connect this pin to the Ground pin of the ESP32.

RING is the ring indicator pin of the module. This pin generally is active high. It will go low for 120ms to indicate incoming calls and can also be configured to pulse when an SMS is received.

DTR this pin can be used to put the module in sleep mode. Pulling the pin high puts the module in sleep mode and disables the serial. Pulling it low will wake the module up.

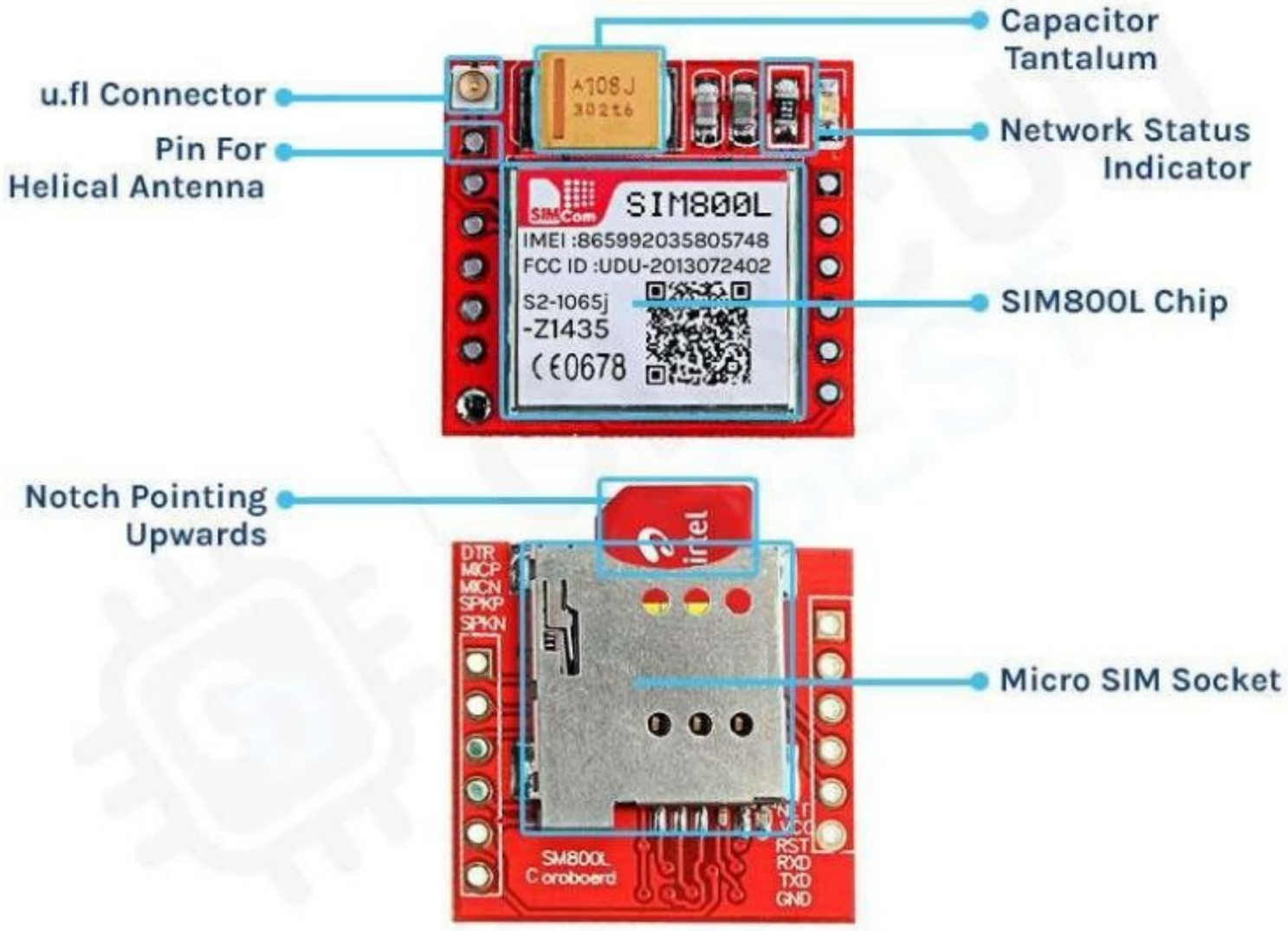
MIC+- These two pins can be used to connect an external microphone to the module.

SPK+- these two pins can be used to connect an external speaker to the module.

SIM800L GSM/GPRS MODULE PARTS

The SIM800L module is a compact, versatile, and easy-to-use module for GSM and GPRS. The parts marking of the module is shown below.

If you take a closer look at the SIM800L module there is not much on the PCB. On the front side of the PCB, we have the UFL connector and the SIM800L module itself. We also have some capacitors for decoupling and we have a 1K current limiting resistor for the LED. Finally, we have a big 100uF,16V tantalum capacitor on board. On the backside of the board, we have the sim holder that is a push-to-lock type connector. This means you just need to insert a SIM card and push it for the card to work.



OVERVIEW OF THE SIM800L GSM/GPRS MODULE

At the heart of the breakout board, there is the SIM800L GSM/GPRS Module made by SimCom. As mentioned in the above pinout section, the operating voltage of this device is 3.4V to 4.4V which means you can power this module directly from a lithium polymer battery. Other than that, all the usable pins are broken out to a 0.1" pin pitch that makes this module very breadboard friendly. It also has auto baud rate detection for ease of use. The module needs an external antenna to connect to the network, which is why there are two antenna options available for this board. In the package, you will get a helical antenna that you can directly solder to the NET pin of the module. But if you want to keep the antenna far away from the module board there is an option for connecting the external antenna with the onboard UFL connector. Any sim card with 2G connectivity will work with this module.

LED STATUS INDICATOR:

As we have mentioned earlier, there is an LED indicator on the top of the SIM800L module. It will blink at various rates to indicate network conditions.

1. Blink every one second:

If the LED on the module is blinking every second, it indicates that the module is running but it is unable to connect to the cellular network right now.

2. Blink every two seconds:

When the onboard LED on the monitor blinks every two seconds this means the GPRS data connection you requested is active and ready to accept requests on demand.

3. Blink every three seconds

When the LED on the module is blinking every three seconds, the module is connected to a network and can send/receive voice and SMS.

- **ADVANTAGES**
  - The Robot can operate automatic as well as in manual mode
  - The mode switching is done very fast without any delay.
  - Robust system.
  - Low power requirement.

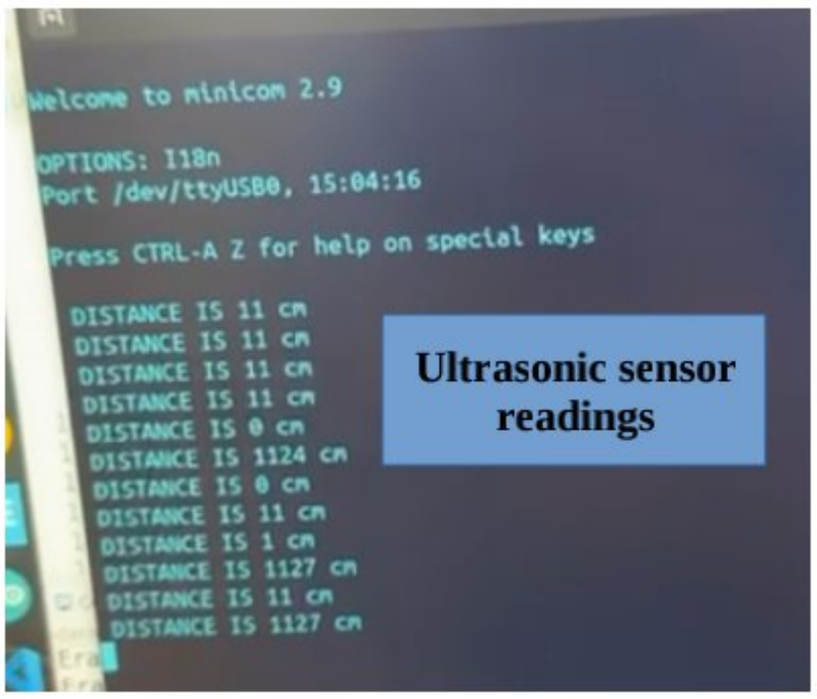
- **DISADVANTAGES**
  - The magnetometer sensor may struggle to differentiate between landmines and other metallic objects, leading to false positives.
  - The system relies on DC motors, GPS, GSM modules, and sensors, which consume significant power, leading to short operational time.
  - GSM module-based communication may not work efficiently in remote areas with poor network coverage.

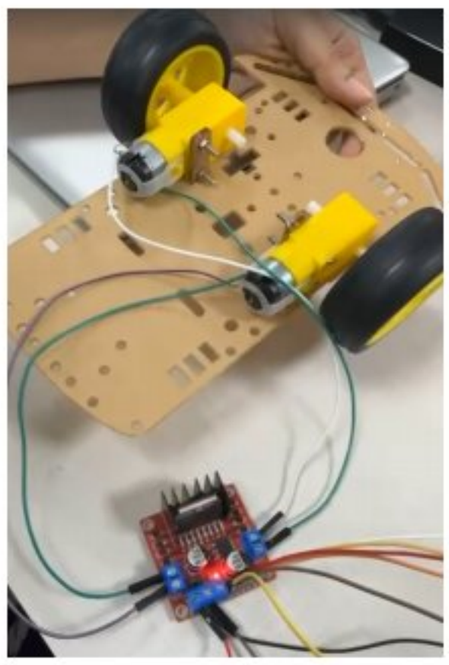
6. SOFTWARE REQUIREMENTS AND SPECIFICATIONS

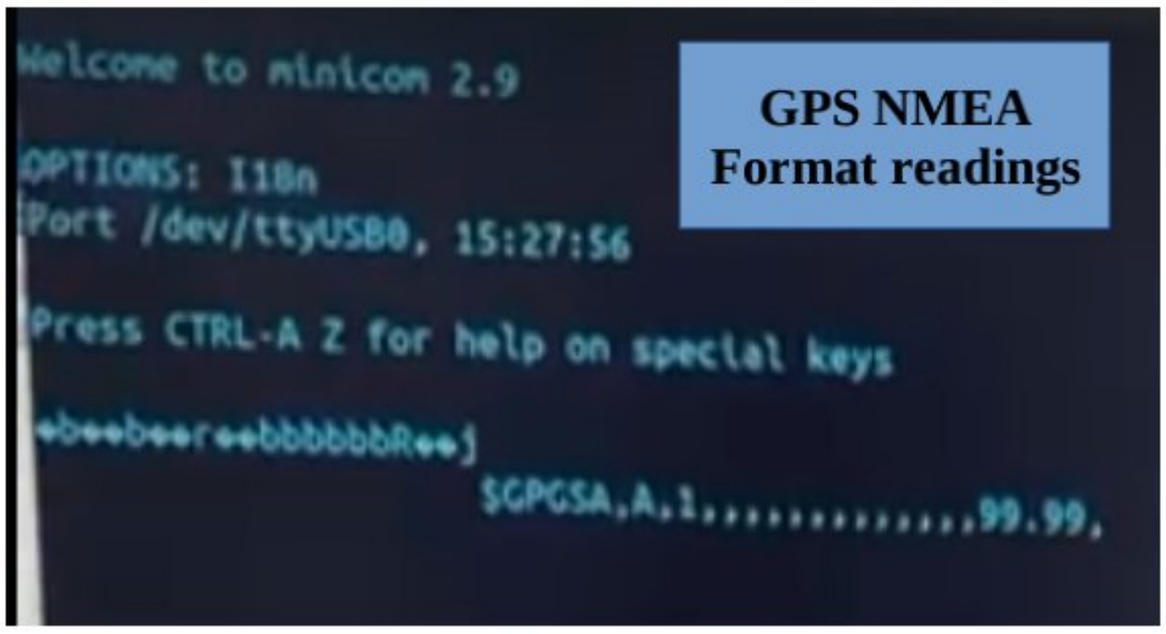
6.1 STM32CubeIDE

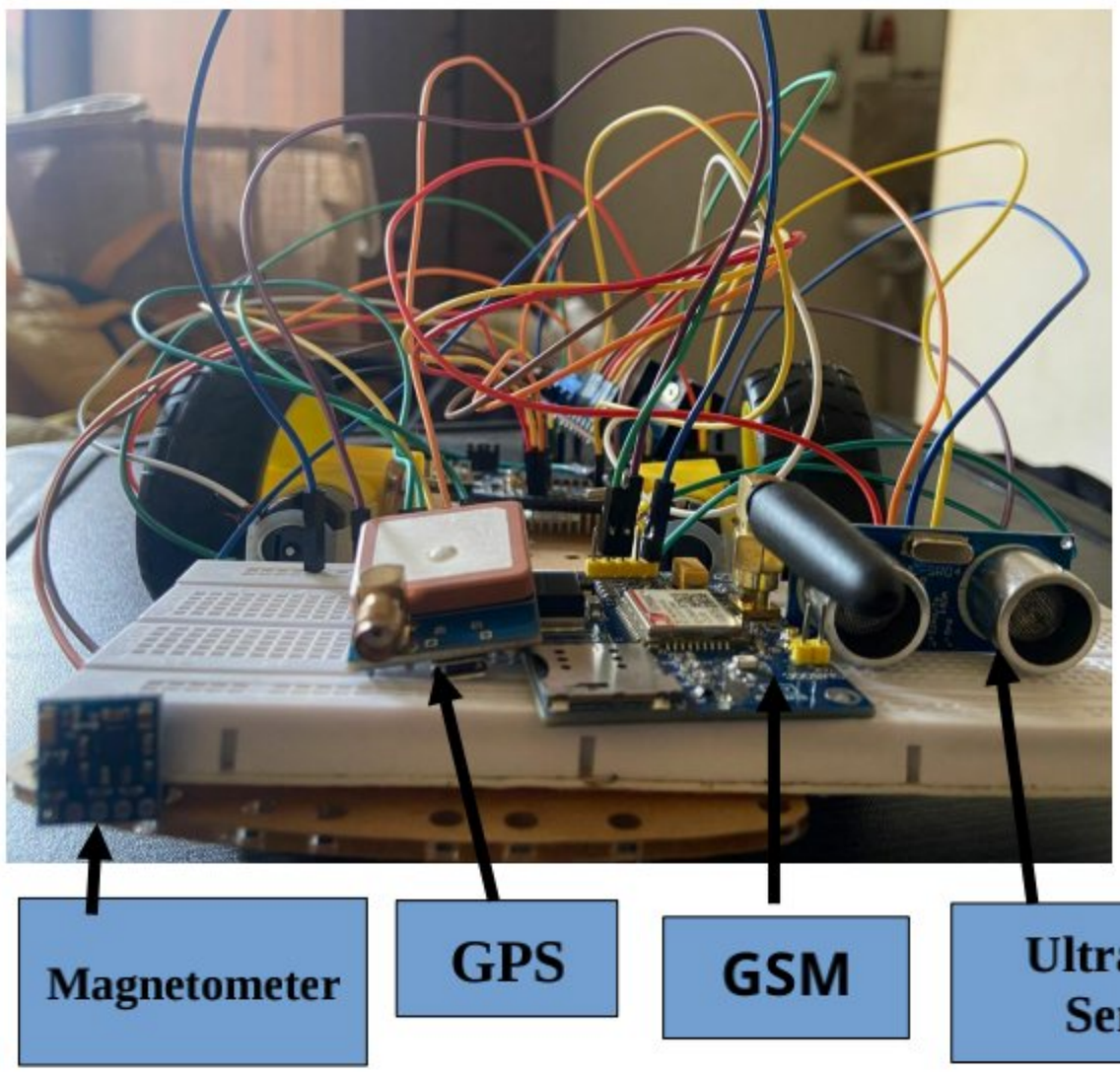
STM32CubeIDE is an all-in-one multi-OS development tool, which is part of the STM32Cube software ecosystem. STM32CubeIDE is an advanced C/C++ development platform with peripheral configuration, code generation, code compilation, and debug features for STM32 microcontrollers and microprocessors. It is based on the Eclipse®/CDT™ framework and GCC toolchain for the development, and GDB for the debugging. It allows the integration of the hundreds of existing plugins that complete the features of the Eclipse.

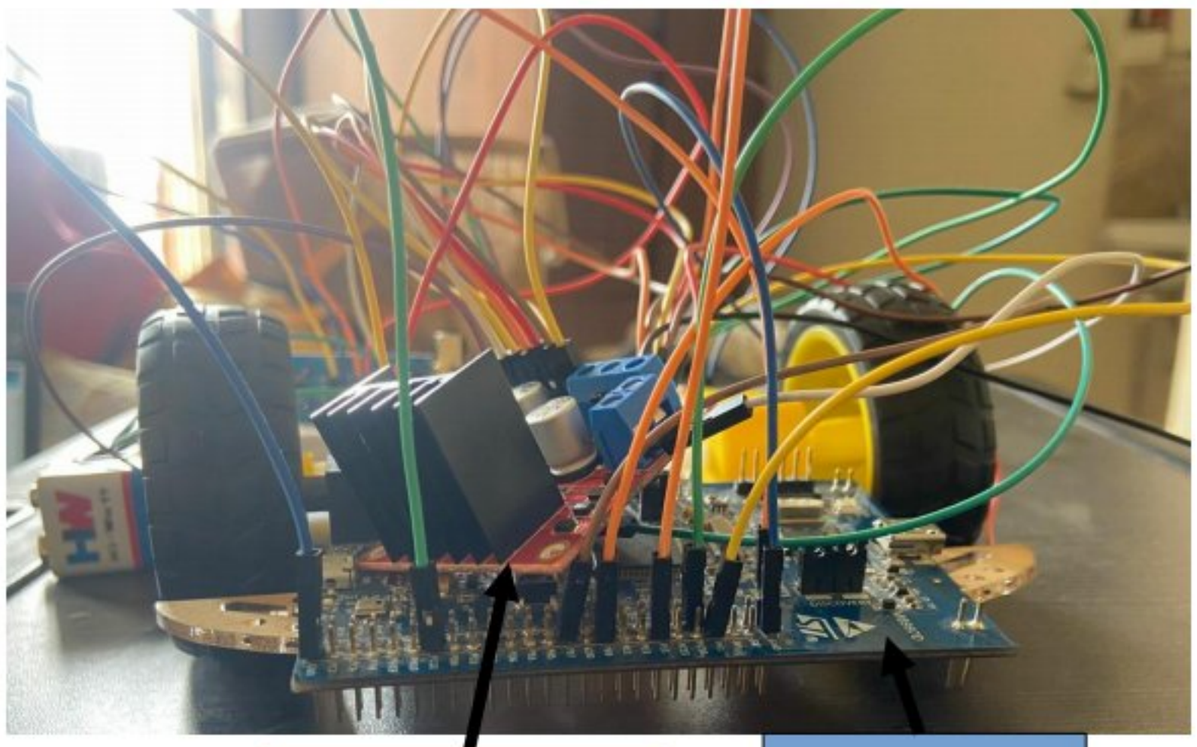
OUTPUT

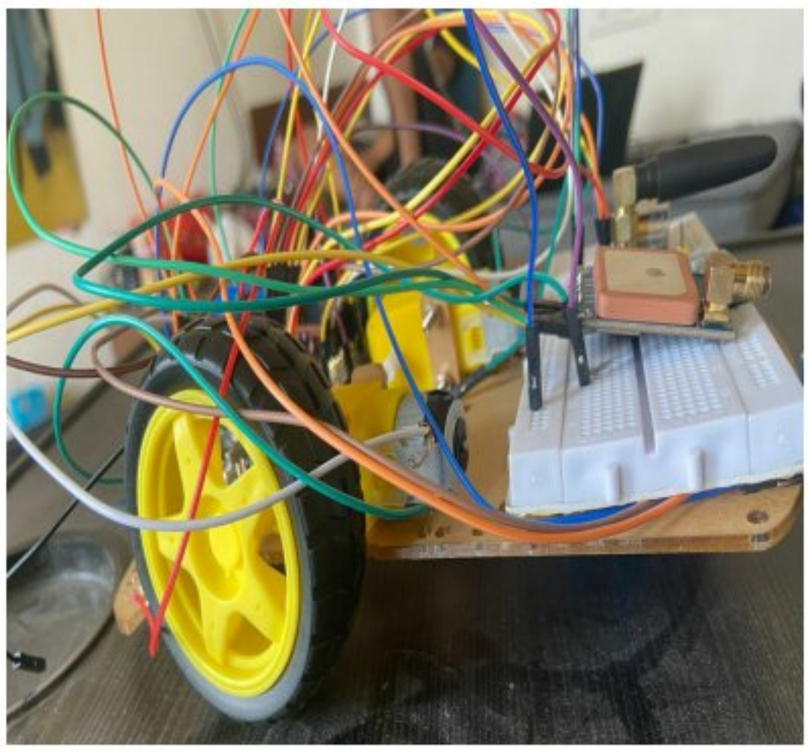

Welcome to minicom 2.9
OPTIONS: I18n
Port /dev/ttyUSB0, 15:04:16
Press CTRL-A Z for help on special keys
DISTANCE IS 11 cm
DISTANCE IS 11 cm
DISTANCE IS 11 cm
DISTANCE IS 11 cm
DISTANCE IS 0 cm
DISTANCE IS 1124 cm
DISTANCE IS 0 cm
DISTANCE IS 11 cm
DISTANCE IS 1 cm
DISTANCE IS 1127 cm
DISTANCE IS 11 cm
DISTANCE IS 1127 cm
Ultrasonic sensor readings

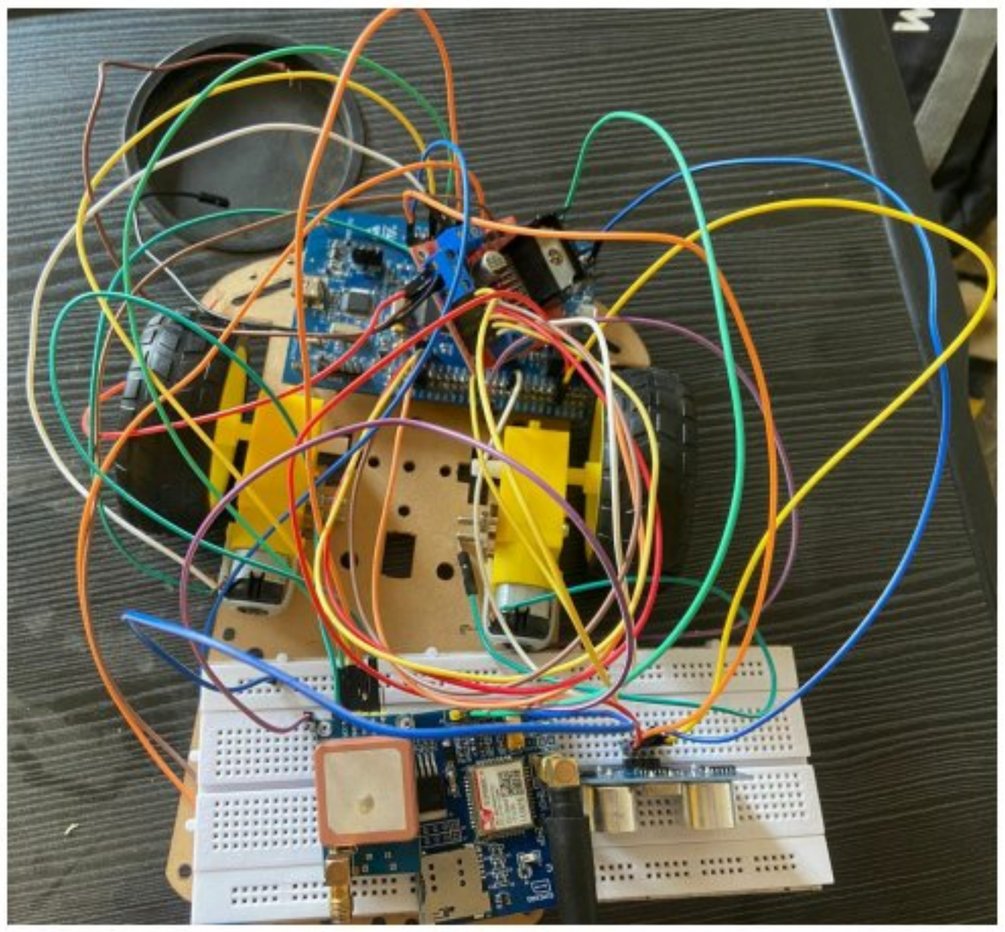


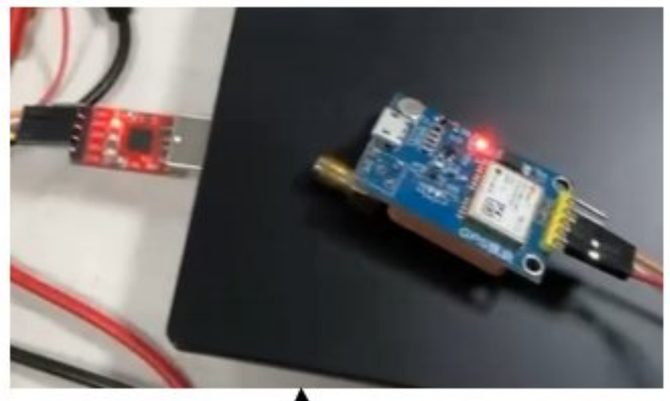

Welcome to minicom 2.9
OPTIONS: I18n
Port /dev/ttyUSB0, 15:27:56
Press CTRL-A Z for help on special keys
$GPGSA,A,1,,,,,,,,,,,,,99.99,
GPS NMEA Format readings


Magnetometer
GPS
GSM
Ultrasonic Sensor


L298N Module
STM32






GPS & UART Interfacing

7. CONCLUSION

The Landmine Detection Robotic Vehicle with GPS Positioning is very beneficial due its more advance features. Landmine detection detects the mine and locates position of mine on land surface and alert the respective department using notification. So it becomes very important to detect the mine and diffuse them. Thus by making use of Landmine Detection Robotic Vehicle with GPS Positioning, this project helps to save the life of our soldiers and armies in the areas where landmines are hidden by the enemies. The Landmine Detection Robotic Vehicle is an autonomous system designed to enhance the safety and efficiency of landmine detection in hazardous areas. By integrating a magnetometer sensor, STM32 microcontroller, Neo-6M GPS module, GSM communication, and ultrasonic sensors, the robot effectively scans and maps landmine locations while minimizing human risk. This project demonstrates the feasibility of using embedded systems and automation for demining operations. The tracked-wheel design ensures mobility over rough terrains, while real-time data transmission via SMS alerts allows for efficient mine mapping. The system offers a cost-effective and scalable solution compared to traditional manual demining methods. The integration of an ultrasonic sensor enhances the vehicle's ability to detect objects in its environment. Moving forward, the project's next phase involves the implementation of advanced features for landmine detection. Incorporating additional sensors, possibly including machine learning algorithms for improved detection accuracy and integrating a GPS module for obtaining precise coordinates of detected landmines. In conclusion, the development of a landmine detector using the STM32 microcontroller platform represents a significant step towards addressing the persistent threat posed by landmines in conflict-affected regions. Through the integration of sensors, signal processing algorithms, and decision-making logic, the proposed system offers a robust, reliable, and cost-effective solution for detecting landmines in various environmental conditions and terrain types. Overall, this project contributes to humanitarian demining efforts by providing a safer, autonomous, and technologically advanced approach to landmine detection.

FUTURE SCOPE

The Landmine Detection Robotic Vehicle has significant potential for improvement and expansion. Future advancements can enhance its accuracy, efficiency, and usability in real-world applications. Some possible areas of development include:

1. Integration of Advanced Sensors

- Multi-Sensor Fusion: Combining Ground Penetrating Radar (GPR) and Infrared Sensors with the magnetometer to detect non-metallic landmines.
- AI-Based Image Processing: Using thermal imaging and camera-based object detection to distinguish landmines from other metallic objects.

2. Artificial Intelligence & Machine Learning

- Implementing AI algorithms for pattern recognition to reduce false positives and improve detection accuracy.
- Using deep learning models to predict landmine locations based on terrain and past data.

3. Enhanced Navigation and Mobility

- GPS-Based Path Optimization: Developing algorithms for efficient area coverage to reduce scanning time.
- AI-Driven Obstacle Avoidance: Using LIDAR or AI-powered vision systems for improved navigation.
- Autonomous Swarm Robots: Deploying multiple robotic vehicles in coordination to speed up the detection process.

4. Improved Power Management

- Solar-Powered Operation: Integrating solar panels for extended battery life in remote areas.
- Energy-Efficient Motors & Components: Optimizing motor control using low-power embedded systems.

5. Wireless Communication & Remote Monitoring

- IoT-Based Data Transmission: Connecting the system to an online dashboard for real-time mine mapping.