ISSN No:-2456-2165

Land Mine Detection Robot using BLE-3.0 Voice Controlled, using Joystick and Gyroscopic sensor

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Abstract:- Robotics is expanding quickly in the modern world and is already participating in many facets of our everyday life. Engineers have chosen to work in this sector to create or construct robots that will improve human existence since robotics is a part of the communication of technological growth. In today's technological environment, there are several forms of mobile robots. There are humanoid robots, water-based robots, wheels robots, tracks robots, and more. In this study, a four-wheeled remote control robot vehicle is created to detect metal. The system is put into use with the help of the Arduino platform, an android app, and a metal detector winding. With the help of an Android-based gadget, this robot car was created. The brain of the robot is an Arduino Uno. It also comprises the portion of the programme that makes use of a portable application. The metal-detection robot described in this study can be controlled via Bluetooth remote control while also being able to detect metal. In terms of detection, turning, and pricing accuracy, the suggested design is contrasted with the automated robot. The results demonstrate that the suggested design robot vehicle can provide a precise and quick metal movement detection, easier turning, and less expensively. The space between buried landmines and the sensor heads has a significant impact on metal detectors' capacity to detect landmines. As a result, human deminers physically scan the ground with metal detectors while ensuring that the sensor heads follow the surface. By adjusting the distance and angle of the sensor heads, robots may aid in landmine detection while doing it correctly and safely. In this study, a quantitative analysis of the impact of mechanical manipulator-based gap and attitude control on the performance of landmine detection has been done. In order to do this, the study details the creation of a Controlled Metal Detector (CMD) that allows for precise adjustment of the gap and attitude of the sensor head.

***Keywords**:- Metal Detector, Robotics, Communication, Safety, Bluetooth, Arduino, Magnetics, Android Application, Voice Controlled, Gyroscopic sensor.*

I. INTRODUCTION

Robots may be employed to execute tasks in dangerous places and to control the unsettling instability levels present there. Robots are progressively becoming indispensable for regular topic applications, such as military applications and Urban Hunt and Salvage. Robots are being used to carry out a range of chores in a number of new tiny robotic applications. Generally speaking, robots are still used for hazardous human-risking tasks, such as control automaton, spy robot, salvage robot, therapeutic operation, and so on. To look for metal artefacts buried in the earth, robots equipped with metal detectors are used. Metal detectors are used by military bomb disposal experts to look for mines buried in mine fields and under roadways. Metal detectors are also used by electricians to look for electrical lines that are concealed in walls. In airport terminals, metal detectors are used to check passengers for metal objects, such as cuts and weapons. Metal detectors are routinely used to trawl through former battlegrounds and historic places in search of artefacts, jewelry, and antiquated coins. They are used in food industries to examine and make sure that no metal objects accidently fell into the food from an industrial facility. This project focuses on inventing and creating a robotic vehicle that can detect land mines by sensing metals on its path in front of it. A control unit interfaced metal detector circuit that alerts the user to a potential metal ahead. The metal detector circuit is installed atop a robotic vehicle, and it works by automatically detecting metals underneath. Our project stands out from others since it seeks to lower manufacturing costs so that this robotic system may be used in low-budget scenarios, which are common in emerging and impoverished countries.

Managing buried metals may be done in a variety of ways, some of which are risky for the lives of nearby residents. The globe over, several ongoing studies are also being conducted. In order to find hidden metals and mines with greater accuracy, they are working to enhance the current techniques or searching for new ones. The use of various configurations of mine detecting equipment and carrying vehicle in the intended direction and with precision is done with the intention of finding all mines. The effectiveness of the detector has a significant impact on the metal-searching bot.

With little expense, this concept aims to outperform earlier, comparable solutions. An all-terrain robot with wireless communication would be a highly flexible answer, therefore I've opted to use one. The frame, power solution, and wireless hardware design were the main responsibilities. In the parts that follow, the main idea is discussed.

II. RECENT WORKS

Nearly everyone in today's contemporary world utilises cellphones, which are a regular part of their daily lives. This research included using cellphones to control robotic movement. Such robotic movement control systems employing cellphones have been developed by several researchers. In this case, our goal is to build a robot and attach the metal detector circuit to it. Here, a special application has been developed to operate the robotic hardware, which regulates the robot's movement. A smartphone running Android is used to operate the embedded hardware, which was created using an ATmega328P microcontroller. The Android phone issues orders to this controller, which then collects the data and uses the motor driver L293D to operate the robot's motors. The robot has four directions of movement: forward, backward, left, and right. Bluetooth is being used to connect the Smartphone to the hardware. The Arduino UNO was equipped with a Bluetooth HC-05 module in order to accept instructions from the smartphone. The robot was attached to a metal detector circuit, which was used to find the metal. When it discovered the metal, a beep was produced [1].

Urban city landfills are experiencing a challenge with garbage buildup. Different types of garbage, such as metallic and plastic waste, have an impact on our ecosystem. A difficult task is creating a robotic system for collecting metallic debris. Only a little amount of study has been done on robotic trash collecting and processing systems. In this study, we propose a robotic system that may be used to the collecting and processing of metallic trash. This robot has a metal detector, an ultrasonic sensor, a power and control unit, and actuators. This autonomous robot is capable of doing things like avoiding obstacles and finding metal [2].

The robotics age is characterized by the use of personal computers and advanced software to power mechanical constructions. A standalone software called Hyperlink allows users to communicate with computers' distant devices. The robotic devices' orientation and movement are controlled by a supporting system called wireless communication. The goal of this study is to control the conductive metal seeking robot in each of the eight orientations. The robot is placed at a certain angle using an IR sensor component. To locate the desired metal, a concentrator coil type metal detector is employed. The data is sent to the remote-control portion of the robot using an offset quadrature phase shift keyed modulation stream (OQPSK) at a frequency of 2.4 G Hz. Calculations of the mechanical load are made to build the robot. The created model works well on surfaces that are uneven [4].

The metal detecting robot that is being proposed is solar-powered. Using a mobile phone, we can operate a robot from a distance. It has a metal detector circuit on an Arduino board. Robots have GSM, which can broadcast and receive mobile phone signals. For obstacle avoidance, it has an ultrasonic sensor. When the robot detects metal, it emits an alert and sends SMS messages to a mobile phone. Additionally, it can GSM-send its location. It is beneficial for several applications, including the detection of land mines [7].

Landmine detecting robots are designed to cover as much ground as they can while accurately mapping out where landmines are located as well as any remaining space. This study offers a prototype model of a land mine detection robot that is effective but affordable, easily programmable, has the necessary precision, and is outfitted with a visual interface for charting landmines, tweaking PID, and aligning cameras. The manual, semi-automatic, and automatic controls for the differential drive robot are highlighted. In order to determine the precise location of the robot and offer live reckoning input to the robot's dead reckoning servo control, image processing is required. Balance Landmines are discovered with a beat metal detector. The user has a simple yet effective control when using the graphical user interface for the remote terminal computer to operate the robot. The system's overarching goal is to provide the user a robust, cost-effective, and at the same time user-friendly experience [12].

Finding metal components is the major purpose of this endeavour. Armed metal detectors are used by troops in the army to find land mines, which sometimes causes the land mine to detonate. So, the troops are killed. This project is used to resolve this issue. This project has a sophisticated message alert system. The technology "Ardino" was used to create this. In this project, a robot vehicle carrying the hole circuit is linked to an Arduino board via a metal detector. Bluetooth is used to operate this vehicle using radio technology and a Bluetooth module. When a metal object is detected by a metal detector, an Arduino sends a message to a mobile device via a GSM module. Because all three application programmes are combined onto a single board, this project just requires one Arduino board. With the help of this project, you may uncover priceless gems in underground and covered locations and identify land mines in uninhabited areas. Also utilised for security reasons is this project [14].

III. METHODOLOGY

The flow of electric current through a coil creates a magnetic field around it. The basic idea behind a metal detector is to emit a magnetic field while analysing the return signal from the target and surrounding area. A transmit coil used in a magnetic transmitter generates a variable electric current using transmit electronics. A coil that is attached to electronics for receiving and processing signals serves as the receiver. All of the gear is housed in an electronics housing that is linked to the coil by an electric connection, and this electronics housing is referred to as the "control box" since it has the coils inside of it. An oscillator that produces alternating current is also a part of a metal detector. The transmit coil in a metallic item functions as a conductor for this alternating current, which interacts with the coil to create another magnetic field all around it. The transmitted magnetic field changes over time, usually at speeds comparable to very acute sound impulses. Electric currents known as eddy currents pass through metal objects as a result of this fluctuating transmitted magnetic field. Another coil called the receiving coil is part of the metal detector's loop. The magnetic field changes brought on by the presence of the metallic item are detected by the receiving coil.

A smartphone is one of the most potent and quickly evolving gadgets in today's world, and all credit for this goes to the device's potent CPU chip and communication system. Bluetooth is one such technique of communication.

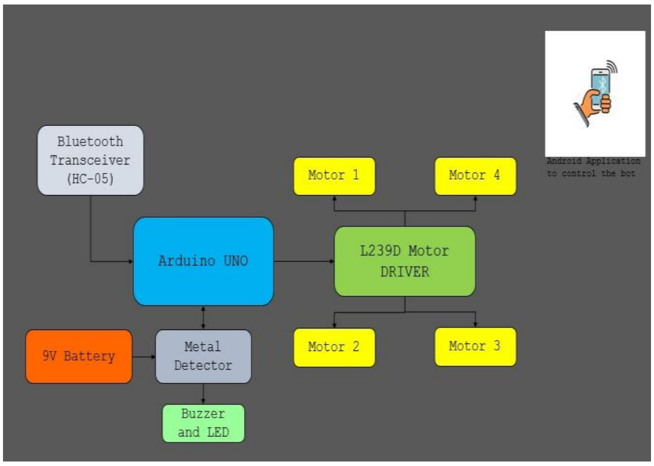

Fig. 1: Block diagram of the proposed Metal Detector Robot

In this architecture, the necessary work is performed by an android application using a microcontroller. Bluetooth technology makes it easier for the robot and the application to connect. The orders given will be sent across the channel and received by the module. The goal of a voice-controlled rover is to respond to the user's orders. The Block diagram of the proposed system is depicted in Fig. 1.

With the use of cutting-edge smartphone technology, we want to create a robotic car that is both easy to use and cost-effectively. The vehicle will be remotely operated using an Android smartphone.

The steps to achieve this are as follows:

- Get the Google Play Store app "Arduino Bluetooth Control."
- Ensure that your smartphone and the HC-05 are linked by entering the password "1234". Then, from the list of available apps, choose HC-05.
- Next, choose the voice command.
- Speak "Ahead" aloud to propel the vehicle forward.
- To reverse the direction of the automobile, say "Backward."
- Speak "Left" to veer the vehicle to the left.
- Say "Right" to signal the automobile to turn to the right.
- To put the automobile in park, say "stop."
- After using the device with Bluetooth, disconnect the connection.
- The Joystick and G-sensor may also be used to operate the robot (Gyroscope).

It's easier to run a robot and increases productivity and efficiency when you can merely speak to it to give it instructions. Google's speech recognition technology is used in the app to convert speech to text when voice commands are processed by the phone. Following that, Bluetooth is used to send the text to the recipient side. Using the UART serial communication protocol, text received over Bluetooth is sent to the Arduino Uno board. The SMS message is verified using Arduino code. Every time a matching string appears in the text, Arduino adjusts the rover's motions in the directions of forward, backward, turning right, turning left, and stopping.

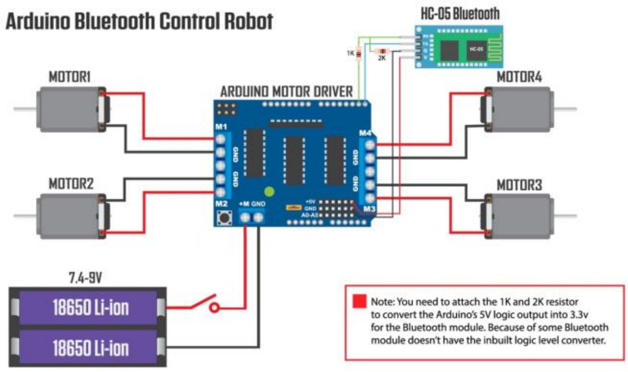

Fig. 2: Circuit diagram of the proposed system

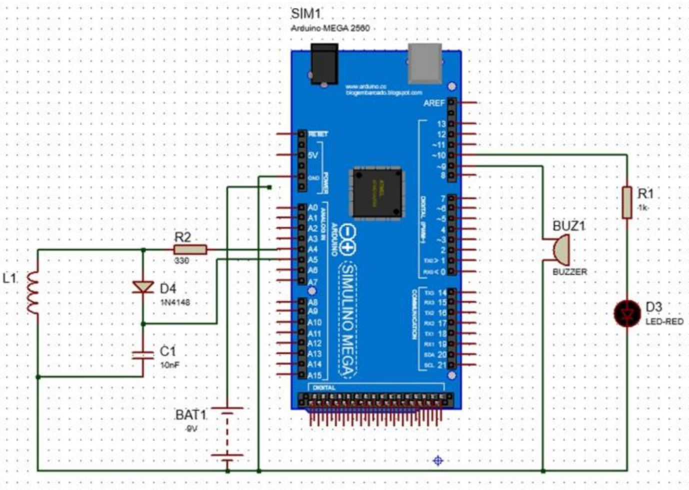

Fig. 3: Circuit Diagram of the metal detector circuit being tested

The drive circuit and metal detector employed in the proposed system's circuit diagram are shown in Figures 2 and 3.

The L293D Motor Driver shield, Solid copper Coil, HC-05 Bluetooth Module, and Arduino UNO board are the circuit's primary components. An Android smartphone with Bluetooth built in serves as the project's transmitter.

ISSN No:-2456-2165

The Smartphone uses Bluetooth to transmit the command to the HC-05 Module on the bot. The micro-controller subsequently decodes the supplied command, which causes the necessary job to be finished. An additional functionality that provides feedback on the connection status of the bot has been introduced to the Android application. In the metal detector circuit, I utilised a detector made of solid copper coil.

The coil creates a magnetic field all the time that current flows through it. Additionally, the magnetic field's modification creates an electric field. Faraday's law states that because of this electric field, a voltage builds up across the coil that opposes changes in the magnetic field. This is how the coil produces inductance, which means the created voltage fights a rise in current. Henry is the symbol for inductance, and the method for calculating it is:

$$L = (u_0 * n^2 * A) / l \quad (1)$$

Where,

L- Inductance in Henries

u_0- Permeability, its $4\pi * 10^{-7}$ for Air

N- Number of turns

A-Inner Core Area ($\pi\,^2$) in m

l- Length of the Coil in meters

A coil's inductance varies when a metal object is in close proximity to it. Depending on the kind of metal, the inductance might differ. When it comes to ferromagnetic elements like iron, it rises and falls for non-magnetic metals.

The value of inductance varies significantly depending on the coil's core. The inductors with air cores, which are seen in the diagram below, won't have a solid core. In essence, they are coils that have been left in the air. It's either nothing or air that the inductor's magnetic field flows through. The inductances of these devices are very low-value. Keep in mind that this coil is air-cored, thus if a piece of metal is introduced close to the coil, the metal piece serves as the core for the inductor. The coil's inductance is significantly altered or raised when this metal serves as the core. The total reactance or impedance of the LC circuit changes significantly with this abrupt rise in coil inductance as compared to the situation without the metal component.

We must thus determine the coil's inductance in order to detect metals in this Arduino metal detector project. This is why we utilised the LR circuit (Resistor-Inductor Circuit) that we previously described. In this circuit, a coil with around 20 turns—or a winding with a 10 cm diameter—has been employed. To create the coil, the wire was wound around an empty tape roll.

Arduino generates a wave or pulse that is sent to the LR high pass filter. The coil will as a result produce brief spikes at each changeover. The inductance of the coil directly affects how long the spikes' pulses are. In order to measure the inductance of the coil, we use these spike pulses. Due to the spikes' relatively brief length (about 0.5 microseconds) and the difficulty of measuring them with an Arduino, it is impossible to measure inductance correctly in this case. In its place, a capacitor that is charged by an increasing pulse or spike is utilised. And just a few pulses were necessary to fully charge the capacitor so that Arduino analogue pin A5 could read its voltage. Arduino then used an ADC to read the capacitor's voltage. By setting "capPin" as the output and checking the voltage, the capacitor was swiftly depleted. The duration of this whole procedure is around 200 microseconds. We repeated the measurement and averaged the results to get a better result. In this manner, the estimated inductance of the coil is determined. The LED and buzzer are used to identify the presence of metal once the result has been received.

IV. RESULTS AND DISCUSSIONS

The proposed system's hardware implementation is shown below, along with screenshots of the Android apps' user interfaces that are used to Bluetooth-control the robot.

Fig. 4: Side View of the proposed system

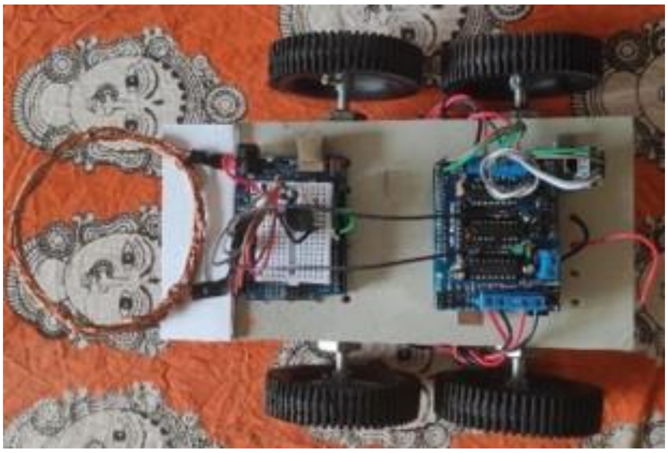

Fig. 5: Top View of the proposed system

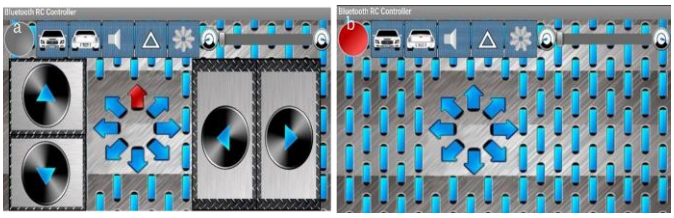

Fig. 6: User Interface of the Android Application used for Joystick control.

ISSN No:-2456-2165

Fig. 7: User-Interface for controlling the robot via Voice commands.


Fig. 8: Robot controlled via Joystick and Gyroscopic sensor.

Buzzer and LED will glow quickly to inform the user of any metal material in their route if it is identified that the bot is travelling through any metal.

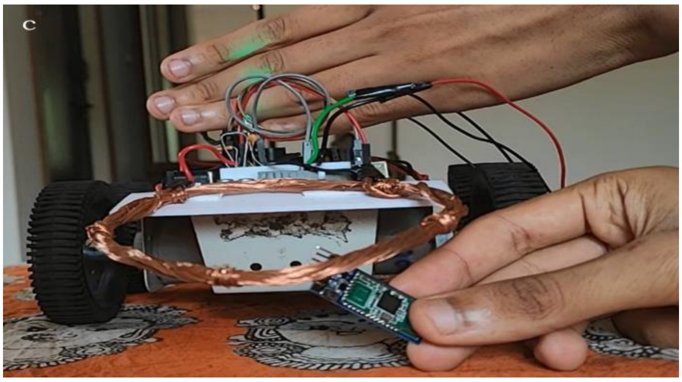
Fig. 9: LED flashing when a metal is brought close tto the detector circuit

Fig. 4 through 9 shows how the system is implemented on hardware with all of the controlling techniques for different test scenarios. The Bot performed well, and throughout the testing stages, it was helpful.

V. CONCLUSIONS AND FUTURE SCOPE

In order to employ a robot to identify a harmful object rather than people, we successfully created and manufactured a metal detector robotic vehicle. This greatly reduces the possibility of human damage or death. It has been successful to carry out experimental work. As a consequence, the embedded system allows for greater efficiency. It has been shown that the suggested strategy is quite useful for a variety of objectives. Without experiencing any issues, the metal detector operated at a consistent pace. We were also able to get the robot and the Android app to communicate wirelessly in this experiment.

By improving the functionality and adding new features, this project may be further improved. A gas sensor might be added to this project in the future, along with robotic arms connected for pick-and-place operations and other functions. The Proposed system offers the following advantages along with bright results;

- Ensure the bomb disposal team's security by adding an additional line of protection.
- Performance reliability.
- Constant workday and night.
- A decrease in operator mistakes.
- Can be persuaded to carry out even the riskiest duties fearlessly.

Method	**[2]**	**[5]**	**[8]**	**[10]**	**[13]**	**Proposed Method**
Dataset/Realtime	RT	DT	DT	RT	RT	RT
Accuracy	85 %	90 %	80 %	80 %	70 %	97%
Error Rate	15 %	10 %	20 %	20 %	20 %	3%

Table 1: Comaprison of the existing works with proposed system

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