Dual Mode Metal Detecting Robotic Vehicle

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***Abstract*—The robot used in this research features a metal detector and two modes. Remotely controlling affordable robotic vehicles that can also detect metal items is made possible by RF (radio frequency) technology. The robot is automated even without an RF remote.The suggested controlled robotic vehicle might be utilised for activities involving metal detecting, such as looking for landmines, dodging obstacles, and picking the optimum path without putting humans or employees in risk. To communicate with the robot controller, utilise the buttons in the transport (operator) portion. The robot may go ahead, go backward, turn left, or turn right thanks to the orders that specify how to move. The robotic vehicle is propelled by two motors in the receiver assembly. Before transmitting the order to the DC, the receiver decodes it.**

I. Introduction

The robot is an autonomous device that performs the functions normally assigned to a human being or machine in human form. Overall, it's a machine that works despite the presence of a living human being. Robots are used in special applications such as handling hazardous situations and tasks requiring high precision and speed. Hazardous events usually occur due to human negligence. Robots can be used to perform work in hazardous areas and can be used to manage delicate levels of instability in these areas. To realize real-time border security inspection and monitoring, an intelligent remote monitoring system has been developed. Wireless sensor networks are used to detect physical or environmental conditions such as temperature, gas, people, metal, etc.The basic working principle of a metal detector is very simple and is based on the principle of electromagnetic induction.As the name suggests, it is an electronic device that can identify if metal parts are present in or around places that are usually hard to reach, such as inside rocks, closed bags, under land, etc. This metal detector is used to detect objects. From something as dangerous as a landmine to something as valuable as a gold mine. The metal detector certainly can identify coins, gemstones, gold nuggets, heaps, or whatever we are looking for nearby without knowing how capable our indicators are. To show signs of improvement, knowing what the indicators do is essentially We dug a foot and found nothing. We developed the opening and dug the other foot, but still nothing. We could keep digging another five or six feet before finally giving up. The microprocessor-based metal detector (Raspberry Pi) explained in our quest is a frequency meter that measures resonant frequency or duration. Our system consists of sensor networks, embedded systems, and intelligent programs on robotic vehicles. Whenever there is a deviation from the original state, the sensors on one side of the robot (i.e., VEHICLE SIDE) send a signal to the remote side (i.e. USER SIDE) and display the detected quantity on LCD. It can also climb terrain at specific angles. This project is sure to revolutionize defense systems as surveillance and inspection robots.

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II. Literature Review

Kadhim et al. stated the recent outsized impact of technology on our lives has both advantages and disadvantages. However, most technologies should be used for the benefit of humanity and society so that their good effects are greatly increased at the cost of their flaws. Researchers want to create robust collaborative robots capable of performing difficult tasks without human intervention. Metal detector robots are one of the foundations of robotics as they are more efficient than outdated technologies which are manual, laborious and slow. This article highlights three main themes.

According to Alauddin et al., the goal of this work is to develop and build a remote-controlled robot with an electronic metal detector that can search for landmines without jeopardising people's lives. Metal detectors can find covered metal, and robots can be remotely controlled. Build prototypes to translate ideas and concepts from the theoretical phase into actual hardware components. The proposed concepts are then tested and experimented with using software programmes that are integrated into the system. There is a robot control app available for the Android operating system. A Bluetooth technology system connects the controller and the robot. The robot can move in a regulated manner while adhering to commands from Android.

Ananya Bhattacharya stated that the goal of this project is to create a mobile robot that can detect metal on the way.

The robot can only be used indoors and on flat surfaces. An Arduino Uno R3 microcontroller is used to drive a metal detecting robot. When the ultrasonic sensor detects an obstacle or object, the robot avoids it. Inductive proximity sensors are used in metal detectors to detect metal. It can also alert users when metal is detected.

Adnan Maqsood et al. proclaimed that the aim of this project is to develop a mobile robot capable of detecting metals in its immediate environment. This robot can only be used indoors and the level becomes Arduino Uno R3 microcontroller is used to operate the metal detecting robot. When the ultrasonic sensor detects an obstacle or object, the robot avoids it. Metal detectors use inductive proximity sensors to search for metal. In addition, it will be able to alert the user if metal is found.

F. Y.C. Albert's abstract of this study describes the construction of a remotely controllable metal detector robot powered by solar energy. By deploying a metal detector robot powered by solar energy in the field, the detection system for mine can be independent of electricity and gasoline. Metal mines can be found around suspicious areas by adding inductive sensors, a camera and an ATmega32 microprocessor. The radio frequency (RF) module is used to create and implement the proposed robotic system for device communication. The high-precision metal detection results of the robot's test can show that the robot can be used for robotic applications in minefields.

C K Chen said robotics is a rapidly developing field that has impacted many elements of our daily lives. Robotics is an integral part of the technological development exchange, and engineers choose to grind in this field to create robots that can improve human world. In today's technological environment, mobile robots come in many forms. Wheeled robots, humanoids, water bases, and other features are common. Therefore, in this study, a four-wheeled remote control robot car was constructed. Build a system using a metal detector coil, an Android app, and an Arduino platform. This robotic car was created with an Android-based smartphone. The brain of the robot is an Arduino Uno board. The software section using portable applications is also included. In this study, a metal detection robot was created that provides Bluetooth remote control and metal detection on a robotic vehicle. The automated robot was compared to the proposed design in terms of price, direction and detection accuracy. The study results show that the proposed design robotic vehicle can accurately and quickly detect the movement of metal, is easier to turn and costs less.

Alrumaih et al. stated RD efforts is being done to develop reasonably priced robotic vehicles capable of seeing metallic things in their route utilising OF (radio frequency) technology on flat, shallow terrain, such as that seen around trash, in parks, or along lakeshore habitats. The system's development was primarily focused on utilising it to traverse challenging terrain at existing archaeological sites. As a result, it was necessary to create an autonomous and trustworthy robot that could traverse such terrain and transport a sensor payload capable of spotting objects. Using the BFO (Beat Frequency Oscillator) technique, the robotic vehicle is outfitted with an automated metal detector circuit that notifies the operator when a target is discovered.The robot's two primary components are the sending end and the receiving end. To communicate with the robot controller, utilise the buttons in the transport (operator) portion. The robot may go forward, backward, turn left, or turn right thanks to the orders that specify how to move. The robotic vehicle is propelled by two motors in the receiver assembly. The signal is decoded by the receiver, which then instructs the DC motor with the proper orders.

Pratik's work describes a new robot that uses metal detectors to detect metallic objects moving overhead. For metal detecting operations, the robotic robot is driven by an Android app using cloud-based Wi-Fi technology. The versatility and ease of modification of this project make it suitable for a wide range of applications. According to experimental research, the mobile control robot can move in any direction in response to commands, and the metal detector circuit beeps when it detects a metal object.

Naveed Ahsan et al. stated the most destructive devices placed below or above the earth's surface are landmines. These deadly robots are buried in large areas, making them difficult to spot with the naked eye. It is necessary to identify these killing devices in order to protect organisms from them. Using the metal detector sensor mounted on the front of our robotic vehicle, the robot will go out into the field and search for underground mines. Using a Bluetooth module that can drive motors, the robot can be moved. A Bluetooth RF app on an Android phone will be used to drive the robotic vehicle.

According to Mujiarto et al., the Metal Detector Robot is a tool that uses an Android-based smartphone to scan a given region for the presence of metal, including landmines. Since the usage of landmines may cause hurt or death, detectors are essential. When searching for landmines with the antiquated method of straight sweeping, it is extremely dangerous to unintentionally step on a landmine. The robot system employed in this study is equipped with a metal detector that may be used to detect the presence of metal via coil induction as it approaches the metal. The frequencies of the metals identified are shown on the LCD, which acts as an interface. The Arduino UNO-programmed DC current motor controls the robot's mobility. The buzzer will ring and the LCD will display the detected metal frequency when the robot senses the presence of metal. According to the testing results, a smartphone with an Android operating system can operate the robot up to 15 metres away. The effective detection radius is 88 millimetres away from the detector head.

According to Zubair et al., the purpose of landmine detection robots is to search as much of the potential landmine field as possible for landmines. With millimeter-level accuracy, a visual map shows the discovered landmines, scanned area, and residual region. This study offers a powerful, cost-effective, and user-friendly prototype land mine detecting robot. A graphical user interface is developed for the mapping of landmines, display of the scanned and leftover area, PID modification, and camera alignment. The automated, semi-

automatic, and manual control of the differential drive robot are highlighted.The robot's dead reckoning servo control receives live reckoning data through an image processing technique to identify its exact location. A metal detector is used as a sensor in order to find landmines. The most effective control for the robot is provided through the graphical user interface of the computer's remote terminal. The approach is simple yet effective, and it is clear how to use it to achieve the desired outcomes.

Farooq's et al. essay provides evidence of the issue and consequences of landmines in defense-related industries. To prevent human casualties, we suggest a robot with the ability to find concealed mines and wireless user control. The robot is outfitted with unique wheels that are controlled by an HBridge module, allowing it to travel in any direction. We concentrate on human and robot safety in this study; the robot is outfitted with specialised range sensors that aid in avoiding field barriers by precisely recognising their locations. For the project's construction, a particular kind of prototype constructed of thin, temperature-resistant metal is utilised to transport all the pieces. The robot is equipped with a wireless camera that records and communicates its current location. Robot is controlled by a microcontroller. This method has the practical advantage of decreasing the number of casualties since it allows for effective control of the robot and strong obstacle location determination.

Yadav Ajay, et al. claims that the major goal of this effort is to find metal components. The soldiers in the army utilise portable metal detectors to discover land mines, which occasionally causes the land mine to detonate. This method of killing the soldiers. This project is used to deal with this problem. A sophisticated message-based alert system is present in this project. This was produced using "Ardino" technology. This project entails placing the hole circuit on one robot car after attaching an Arduino board to a metal detector. This car is controlled via Bluetooth radio technology and a Bluetooth module. When a metal detector picks it up, the Arduino utilises a GSM module to transmit a message to a mobile smartphone. This project just needs one Arduino board because all three application scripts have been combined into one board. With this initiative, you may find priceless riches in subterranean and covered areas, as well as land mines in remote locations. There are other security-related applications for this project.

Kirubakaran et al. stated that this initiative uses the Internet of Things to improve surveillance in our nation. It is a Rover-style gadget that is helpful in dangerous border regions and on terrain where humans are not allowed to travel. In this project, the rover's movement and the camera's rotation may both be managed online. As a result, we can manage this equipment from any location in the world. It offers live streaming and further details on that subject. In order to move the rover safely, obstacles are detected using an active IR sensor. Additionally, it features a MQ2 smoke sensor, which detects the presence of gas and flammable gas in the surroundings. A sensor that uses ultrasound is used to track the movement of nearby objects.Servo motors are used in this project to control the camera's pan and tilt. Utilising a land mine detecting circuit also allows for the detection of land mines. Using a Raspberry Pi 3 model B, IOT can be supported with ease. The detected information is stored on an SD card. This gadget is used to stop abnormally dangerous occurrences and human casualties. With the use of a smoke sensor, it stops forest fires. This tool might be helpful for surveillance and detection tasks. The present location of the rover on the map may be determined using GPS.

Land mine identification is crucial when sending armed vehicles into hostile area, according to Abilash et al. These armed vehicles, sometimes known as main battle tanks, are used to manually follow the route of the pilot tank to avoid damage to/distraction from the battle tank and defence crew losses. After a conflict, mines that were planted to protect people and reduce deaths can be located and deactivated with a mine-detecting robot. In this work, it was recommended to develop a prototype wirelessly controllable land mine detection robot (LDR). The robot was designed with people's safety in mind and has specialised range sensors that it uses to avoid obstacles. This project's prototype was created from a thin, temperature-resistant metal. The robot's current location is determined and communicated via a Global Positioning System (GPS) sensor. To accurately manage and traverse the proposed path while avoiding obstacles, algorithms for path planning, obstacle identification, and avoidance were used. An Arduino microcontroller is used by this robot. The robot system has a buzzer that can sound an alarm to warn nearby workers and a metal detector that can detect landmines. The robot moves by being propelled by a DC motor. The robot and computer are connected using a ZigBee device.

III. METHODOLOGY

The methodology used in this study is described in this part, along with the specific tools, techniques, and methodologies that rely on sensor-based technology. The research process demonstrates the creation and design of the proposed system. Block diagram for the same is given as fig.1 .

A. Hardware part

1) Raspberry pi: The Raspberry Pi is utilised as the primary component since it manages the robot's movements and all of its functions. It uses a Raspberry Pi 3 Model B board. This board has 40 general-purpose input and output pins and a quad-core processor, making it quicker and more powerful than its predecessor. It is capable of 60 frames per second 1080p MP4 video playback. It has Bluetooth and Wi-Fi built in. Moreover, the device has four USB 2.0 connections with 480 Mbps data transmission, an 802.11n wireless LAN, a 400 MHz video core for multimedia, 1 GB of LPDDR2 memory with 900 SDRAM, and two interface connectors for a camera and a display.

2) Ultrasonic sensor: The ultrasonic sensor is an electrical device that measures the distance between an object being used as an aim and the sensor using ultrasonic sound waves.

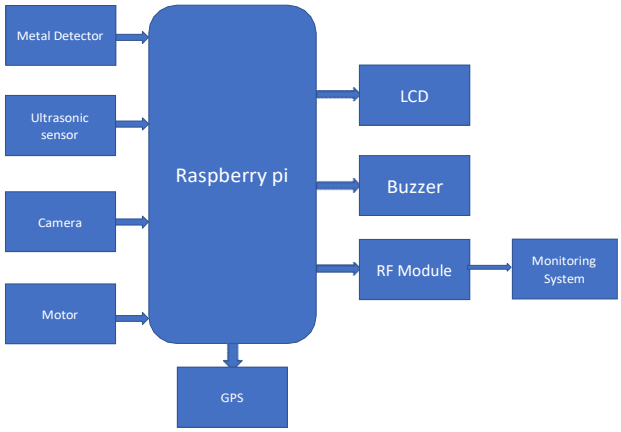

Fig. 1. Block Diagram

The sound that is reflected is then converted into an electrical signal. This electrical signal is first received by the Raspberry Pi, which then sends it to the surveillance system for further image processing. Audible sound travels more slowly than ultrasonic waves do. The two main components of an ultrasonic sensor are the transmitter, which uses piezoelectric crystals to make sound, and the receiver, which collects the reflected signal. It may be used to avoid collisions as well as for obstacle avoidance and detection purposes depending on how long it takes for transmission and reception.The ultrasonic sensor operates at 5V with a theoretical measuring distance of about 2 cm to 80 cm. it operates at a frequency of 4 Hz.

3) Metal detector: An electrical device that can find metal buried beneath or concealed inside of items. They typically consist of a portable device with a sensor probe that may be swept across the surface or over other objects. A constant beep sound or a moving needle on an indicator are both used to indicate when the metal has been discovered. Also, this gadget provides some feedback on the proximity of metal by beeping louder when it is close to metal items. The oscillator that produces the alternating current that flows through the coil in the metal detector circuit creates the alternating magnetic field.Eddy currents will be produced in a piece of metal if it is close to the coil, and this results in the metal producing its own magnetic field. The magnetic field shift brought on by the metallic object may be seen if another coil is used to measure the magnetic field.

B. Software part

The goal of this work is to create a Raspberry-Pi-based landmine detecting system. The Raspberry Pi is a single-board computer featuring an ARM Cortex A53 quad-core Processor running at 1.2 GHz. It contains four USB 2.0 ports with 480Mbps data transmission, an Ethernet connector with a maximum throughput of 100 Mbps, 1 GB of LPDDR2 - 900 SDRAM, 40 extensible general-purpose input-output pins, complete HDMI video interface, DSI (Display Interface), and CSI (Camera Interface). The Raspberry Pi and image processing technologies are combined in this project. All parts are attached to the Raspberry Pi, which is mounted on a robotic wheel structure, and used as input. The motors attached to the wheels are in charge of its movement. Every metal object, such as landmines, located nearby is detected by the metal detector circuit, which is interfaced.This detected signal is sent to the monitoring system, which will then use image processing and GPS positioning to indicate the location of the metal. For the goal of avoiding obstacles, an ultrasonic sensor is utilised. At a certain moment, the robotic gadget will be launched into the playing pitch. The Raspberry- Pi will now travel autonomously in the field in accordance with the programming that has been done, and if it detects a metal item, it will report its location to the monitoring system. Furthermore, since an ultrasonic sensor is used to detect impediments, its operation won't be impacted by them. The monitoring system will map the exact position of the landmine using all of the readings that were obtained.Flowchart for the software part is shown in fig.2

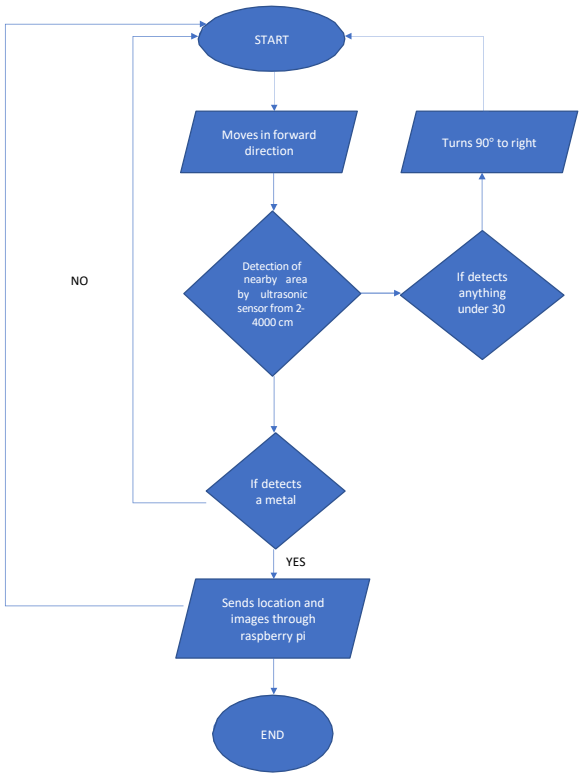

Fig. 2.

IV. Results

Images from the monitoring system's camera, GPS, and image processing tools may be used to assess the output in this project. The robot's camera records video of the area where

the metal detector picks up any metal objects, which is then delivered to the monitoring system together with the metal object's GPS position. The acquired photos are examined and tested for landmines using image processing techniques. If a landmine is found, the GPS position is found and it is registered using Python at the monitoring system at the designated spot. GPS uses satellite broadcast signals from space to deliver exact position information, which is described in three dimensions.The robot will return to its starting place when the entire detecting procedure is finished. The position of the landmines with their photographs grouped in a systematic way may be found by the operators by just checking their system. On a virtual plot with GPS position, the system will display all landmines found at the given plot at once. This will make discovery easier and lower the possibility of human fatalities.

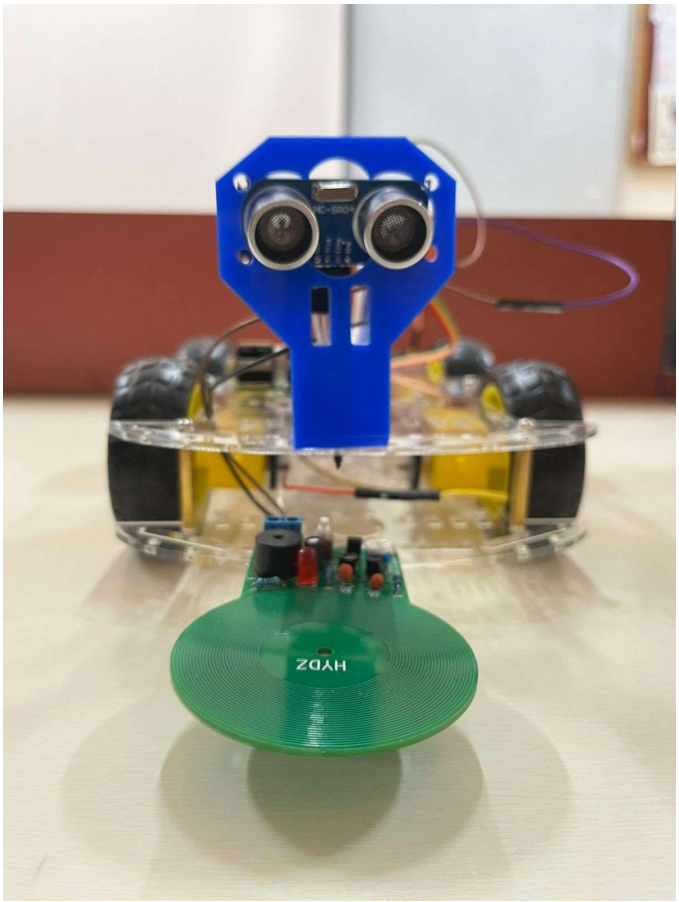

Fig. 3.

V. Conclusions

Nowadays, there are several landmine detectors in operation, although many of them are handled by humans. The majority of these manually controlled detectors fall short in that their controllers and sensors are ineffective. There is a significant danger of loss of life and property as a result of these defects. These errors put the lives of the locals or military troops in peril. The creation of an autonomous, rigid, and effective robotic system is required to address these issues since doing so will help to mitigate the losses that would otherwise occur.

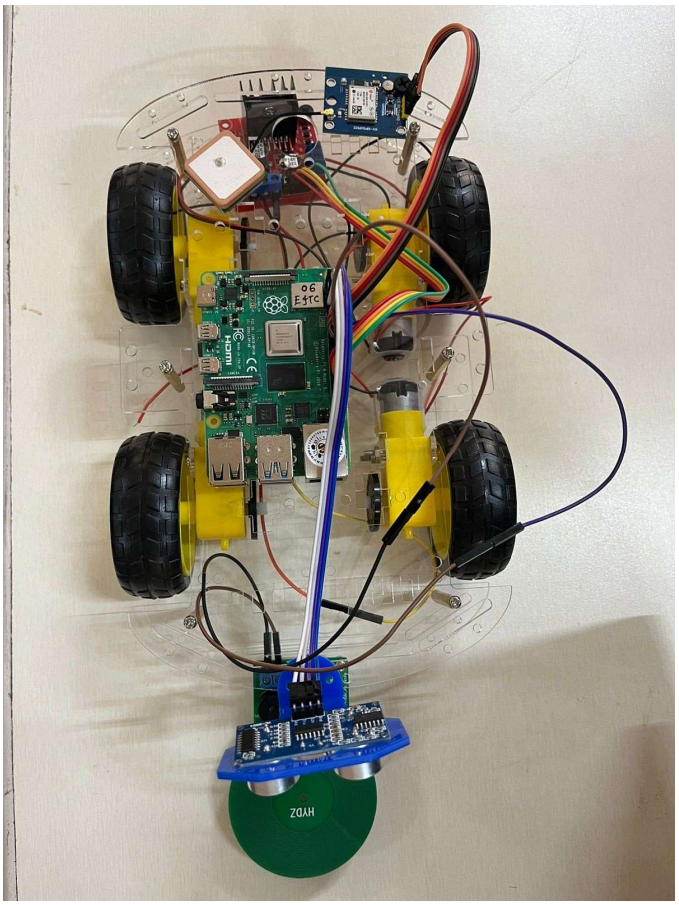

Fig. 4.

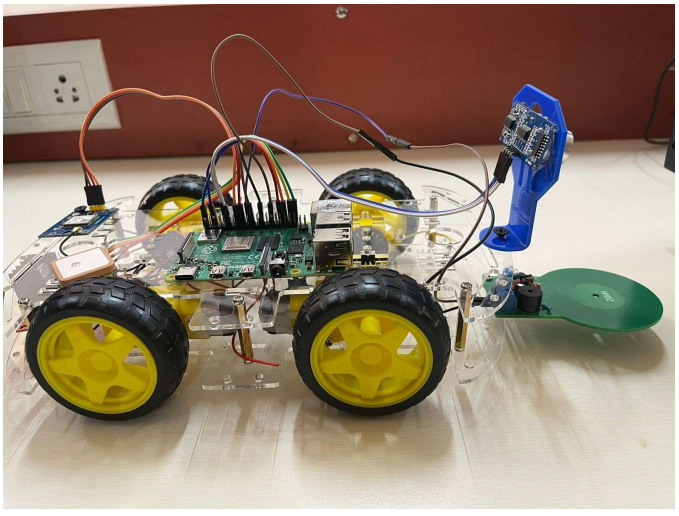

Fig. 5.

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