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Landmine Detecting Robot

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Abstract: *The Landmine detecting robots are designed to cover maximum possible area of landmine field for detection of landmines. The detected landmines along with scanned and leftover area are represented on a visual map with accuracy in millimeters. This paper presents a prototype model of land mine detecting robot that is powerful yet low cost and easily controllable. A graphical user interface is developed for plotting the landmines, scanned & leftover area presentation, PID tuning and camera alignment. Emphasis is placed on the control of the differential drive robot in auto mode, semi-auto mode and the manual mode. Image processing technique is employed to find the accurate position of robot which provides the live reckoning feedback to the dead reckoning servo control of the robot. Metal detector is the sensor used to detect landmines. The graphical user interface for the remote terminal computer provides the effective control for the robot. The system is simple but powerful and intelligible to achieve the required results.*

Keywords: Metal detector, Robot, Military Bomb disposal, GPS, Aurdunio, Microcontroller

I. INTRODUCTION

Landmines – buried remnants of conflict – continue to pose a deadly threat worldwide, claiming lives and limbs long after wars have ended. These indiscriminate weapons lurk beneath the soil, often in regions now struggling to rebuild. But a new hope is emerging from the field of robotics: landmine-detecting robots. These technological saviors are poised to revolutionize the way we approach demining, bringing safety and efficiency to a process that is historically slow, dangerous, and heartbreakingly necessary[1-12].

Robots can be utilized to complete work in perilous zones and can be used to manage troublesome instability levels in such areas. Gradually robots are becoming dynamically vital for standard subject applications, for instance, Urban Hunt and Salvage and military applications. A variety of small robotic applications now arising where robots are utilized to complete an assortment of errands. By and large, robots are still utilized for unsafe work which is dangerous for humans, e.g., control automaton[13-25], spy robot, salvage robot, therapeutic operation[26-35] and so forth. Robots are known to perform tasks automatically without much human intervention, except for initial programming and instruction set being provided to them. From a broad view, robotics is actually the continuous endeavour of robotics engineers to make machines capable of performing tasks as delicately as human can do and also the complicated, tough and repeated tasks which humans would prefer not to do[36-56].

The advancements in the field robotics are made possible by use of microprocessors and microcontrollers with the intelligent combination of them with servo motors, sensors and actuators. Metal detecting robot is utilized to search for metal objects covered up in ground. Military bomb disposal specialists use metal detectors to scan for area mines covered up beneath streets and in mine fields. Electricians also use metal detectors to scan for electrical cables hidden in walls. At airplane terminals, metal finders are utilized to scan travellers for metal protests, for example, cuts and firearms. For searching old combat zones and historical sites. Hoping to find treasures, jewellery and old coins, metal detectors is frequently used. In food factories, they are used to check and verify that no metal things have fallen from industrial factory into the food unintentionally[57-76].

This project focuses on designing and developing a robotic vehicle that can sense metal in front of it on its way like detecting land mines. A metal detector circuit interfaced to the control unit that alarms the user about a suspected metal ahead. The metal detector circuit is mounted on a robotic vehicle and its operation is to detect metals underneath automatically. Researchers proposed several methods to promote the metal detection robot for identifying strong and weak conductive metals. Here, we aim to make a robot and to connect the metal detector circuit to it.

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- **Remote Controlled Technology**: Proposes Remote controlled technology that detects using Beagle Bone Black in embedded system domain. This project works with the proximity sensor as its metal detector. When the metal is detected it sends the output to the mail. The signal getting from RF transmitter through RF receiver is also sent to the Beagle Bone Black. The Beagle Bone Black directly cannot drive the motors. So Beagle Bone Black sends the output to the L293 motor driver. This motor driver runs the motors. The advantage of this technology is Improvement of detection rate. This project can be further enhanced by using live streaming and used wireless by using Wi-Fi modules in the robot[1].
- **Efficient Design of a Metal Detector:** Proposed Efficient Design of a Metal Detector Equipped Remote-Controlled Robotic Vehicle using Bluetooth communication and Android smart phone; mobile app Technology. 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. Aims at reducing the cost of production, so this robotic system can be deployed in a low budget situation, which is typical in the developing and the underdeveloped world. The one drawback to any locator design is its requirement of a coil, which must be very precisely and inflexibly positioned[2].
- **IOT controlled Metal Detecting Robot:** proposes IOT controlled metal detecting robot with remote video transmission to assist bomb detection and rescue team using RPI. The technology OS used in Raspberry pi is Linux. The important advantage of this project is Remote Operation. Industries are using IoT solutions for monitoring, control, process, inventory tracking, data links and bar code reading devices[4].
- **Internet of Things (IoT) Integration:** The integration of IoT technologies with ammonia detection systems has unlocked new avenues for data collection, analysis, and decision-making. By connecting sensors to cloud-based platforms, users can access real-time monitoring data, receive alerts, and leverage predictive analytics for proactive management of ammonia-related risks [7].

For decades, the painstaking work of landmine removal has been primarily carried out by brave individuals, armed with metal detectors and sheer courage. This method, while vital, is incredibly time-consuming and exposes deminers to immense risk. Each sweep of the soil could trigger a buried explosive, a terrifying reality for those on the front lines. This is where robotics comes in, offering a safer and potentially faster alternative[77-89].

How Do These Robots Work?

The designs of landmine-detecting robots vary, but they generally incorporate a combination of advanced technologies:

- **Metal Detectors:** Like their human counterparts, many robots utilize highly sensitive metal detectors to identify the metallic components of landmines.
- **Ground Penetrating Radar (GPR):** These systems use radio waves to create detailed images of the subsurface, allowing robots to detect not just metal but also the shape and size of buried objects.
- **Infrared Sensors:** These sensors can detect subtle differences in temperature between the soil and buried landmines, which can be particularly useful in certain environments.
- **GPS and Mapping Technology:** Robots can meticulously map the areas they've surveyed, ensuring no ground is left unchecked and providing valuable data for human deminers.
- **Autonomous Navigation:** Some sophisticated robots can navigate complex terrain autonomously, further enhancing efficiency and reducing the need for human intervention.
- **Robotic Arms and Manipulators:** Some designs incorporate robotic arms that can carefully excavate and even neutralize landmines in some instances, under the supervision of trained personnel.

The benefits of using robots in landmine detection are clear:

- **Enhanced Safety:** The most significant advantage is the reduction of risk to human deminers. Robots can enter dangerous areas and conduct searches without putting lives on the line[90-95].
- **Increased Efficiency:** Robots can work longer hours and cover more ground than humans, speeding up the process of demining[96-105].
- **Improved Accuracy:** With various sensors working in tandem, robots can often detect landmines that might be missed by traditional methods[106-112].

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- **Data Collection:** Robots can collect valuable data about the location and types of landmines, which can be used for future operations[113-119].
- **Access to Difficult Terrain:** Some robots are designed to navigate challenging landscapes such as steep hills, dense vegetation, or flooded areas where it's too dangerous for humans to work[120,121].

While landmine-detecting robots hold enormous promise, there are still challenges to overcome. The cost of developing and deploying these sophisticated machines can be significant. Also, adapting robots to rapidly changing conditions in the field requires ongoing research and development. False positives can be another issue, causing delays and requiring human verification.

Despite these challenges, the future of landmine detection looks increasingly robotic. As technologies advance and become more affordable, we can expect to see more widespread use of these invaluable tools. Future robots might even be capable of completely autonomously locating, neutralizing and deactivating landmines, making the world a safer place, one step at a time.

The development of landmine-detecting robots is not just about improving existing methods; it represents a fundamental shift in how we approach the problem of landmines. It's a testament to human ingenuity and a commitment to using technology to alleviate suffering. These robots offer a crucial tool in the global effort to create a mine-free world, allowing communities to rebuild, children to play safely, and generations to live free from the fear of these silent killers.

III. PROBLEM IDENTIFIED

There are many things that can interfere with the proper operation of a metal detector. Easily 80% of "metal detector" problems are found to be caused by outside influences rather than the metal detector itself. Today's metal detectors are sophisticated electronic devices. Because the metal detector is made of a transmitting and receiving antenna, it is susceptible to other signals that might be present in the area. The best method to minimize the interference is to place a shield around the possible source and electrically ground the shield.

IV. SYSTEM OVERVIEW: HARDWARE AND SOFTWARE COMPONENTS AND BLOCK DIAGRAM

Software:

The system utilizes the Arduino IDE for programming and Proteus for simulation and circuit design.

Hardware:

Key hardware components include an Arduino Uno microcontroller, a Metal Detector Sensor, UltraSonic Sensor a 16x2 LCD display, a buzzer, a breadboard, and a GSM and GPS module for communication.

SOFTWARE used

1. Arduino Uno
2. Proteus

Hardware used

1.16 x 2 LCD display
2. Metal Detector Sensor
3. UltraSonic Sensor
4. Arduino Uno
5. Buzzer
6. Bread Board
7. GSM Module
8. GPS Module

The following Fig.1 Shows the Block Diagram of this work. This diagram illustrates a robot system for detecting Landmines. An Ultra Sonic and Metal Detector sensor detects the landmines. Arduino microcontroller is employed in this robot. The robot system is embedded with mine detector capable of sensing the landmine using the sensor

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employed. When a mine is detected by the sensor, the sensor sends a message to the microcontroller which then displays the message on LCD screen. The GSM module, operated through Attention Command, sends an SMS to registered number. The robot continues to advance and search ahead if the sensor doesn't identify any mines. The robot is interfaced with the PC by deploying a Arduino Uno. The locomotion of the robot is carried out by the DC motor. This mine Detection Robotic Vehicle uses a mine sensing coil to detect mines hidden under the surface of the earth. This Robot has been equipped with ultrasonic sensor to help it with obstacle sensing. Thus, making is capable to automatically scan a particular area for hidden mines.

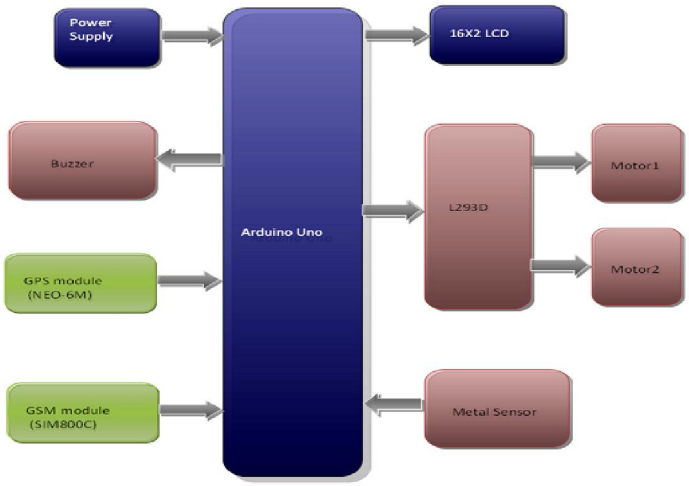

Fig.1 Block Diagram

V. SYSTEM DESIGN

The following Fig 2 Shows the circuit connection of this Work.

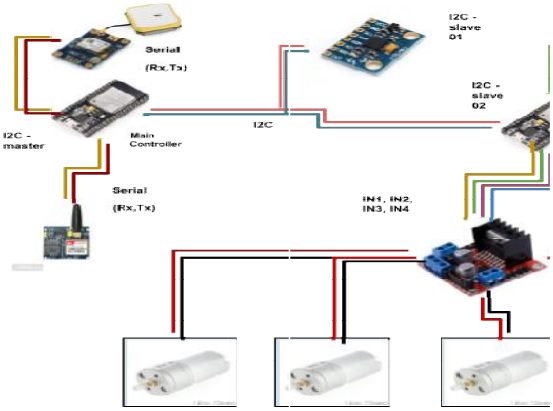

Fig.2 Circuit Diagram

Metal Detecting Sensor:

The metal detector is equipped with copper coils that can detect the presence of any metal. It consists of two Arduino one is primary the power supplier to the whole system and the other is secondary which is coupled with detector coil and commands the whole system after the metal is detected. When metal is detected, the information signal is transmitted to the controller.

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Remote Control System:

The remote-control system utilizes a radio frequency transmitter, while the control system on the computer or laptop uses the parallel port and control relays to remotely control the robot with the help of an app "Wi-Fi Controller ESP8266". The GPS transmits the robot's location through a IoT module data connection. The GPS control software is coupled with the metal detector coil and the controller.

Threshold Detection:

Metal identification sensor is Inductive proximity sensors that can identify metal targets. They don't identify non-metal targets like plastic, wood, paper, and earthenware. Not at all like photoelectric sensors, has this permitted inductive closeness sensors to identify a metal item through obscure plastic. The least difficult type of metal locator comprises an oscillator creating a rotating current that goes through a curl delivering a substituting attractive field. Assuming that a piece of electrically conductive metal is near the loop, vortex flows will be initiated (inductive sensor) in the metal, and this creates its very own attractive field. If one more loop is utilized to quantify the attractive field (going about as a magnetometer), the adjustment of the attractive field because of the metallic item can be identified.

Alert Mechanism:

Buzzer: This alerts the operator of potential danger by emitting a distinct sound upon detecting a landmine, enabling timely intervention and safe navigation for the robotic vehicle.

SMS Notification: The GSM module in landmine detection enables real-time communication between the robotic vehicle and a remote operator, facilitating data transmission and control commands for efficient navigation and safe detonation of detected landmines.

Location Notification: Aids in providing precise location data for effective navigation and mapping during landmine detection missions with robotic vehicles.

Real Time Data Visualization:

LCD in landmine detection robotic vehicles aids in real-time data visualization, providing crucial information on terrain and potential threats for efficient navigation and safe manoeuvring.

VI. CONCLUSION

Nothing should be more important than the lives and safety of the country's army men who risk their lives for country's safety from external enemies. There have been many cases of fatalities and injuries due to explosion of landmines. Till date a lot of research and development has been done and different types of landmine detection robots have been developed each having its own advantages and disadvantages. The variation in these robots is based on the controller or processor used, sensor interfaced, GPS tracking system and the locomotion technique used. This project describes design for wheeled robot for land mine detection purpose and implementation. The wheeled robot is less expensive, robust and it is a helpful tool in for military for surveying and monitoring purpose.

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