
LANDMINE DETECTION ROBOTIC VEHICLE USING GPS.

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ABSTRACT

Landmine contamination poses a serious threat to human safety, especially in regions affected by wars and conflicts. Traditional methods of detecting landmines are slow, dangerous, and costly, exposing human operators to high risk. To overcome these issues, this project focuses on the development of a landmine detection robotic vehicle integrated with GPS technology for safe and efficient detection and location tracking of buried mines. The robot uses a metal detector sensor to identify metallic objects hidden underground, while an STM32 microcontroller processes the detection signals in real time. A GPS module provides the exact coordinates of the detected mines, which are shown on an LCD display and stored for future reference. Ultrasonic sensors are used to detect obstacles and help the robot move smoothly on uneven surfaces. The system operates in a semi-autonomous mode, using sensor data and embedded control logic to improve accuracy and ensure safe operation. With its energy-efficient and cost-effective design, the proposed system offers a reliable and scalable solution for defense and humanitarian demining efforts.

KEYWORDS: Smart Heating System, Temperature regulation, PID control algorithm, ESP32S3 Microcontroller.

INTRODUCTION

Landmine detection plays a crucial role in ensuring the safety of individuals in post-conflict and military affected regions. The presence of buried explosive devices continues to endanger lives and obstruct land utilization for decades after wars have ended. Traditional detection approaches, which depend on manual operation using handheld metal detectors, are highly dangerous, slow, and unsuitable for large-scale minefield clearance. With advancements in embedded systems, sensor technology, and robotics, it has become possible to design autonomous systems capable of detecting and locating landmines efficiently while

minimizing human risk. The Landmine Detection Robotic Vehicle with GPS utilizes a metal detector sensor to identify buried metallic objects and integrates a GPS module to record their precise geographic coordinates. The STM32 microcontroller manages all sensor data, movement control, and real-time processing, while ultrasonic sensors assist in obstacle avoidance for smooth navigation. This system offers a cost-effective, reliable, and safe solution for mine detection, enabling accurate mapping of hazardous zones and improving the overall effectiveness of demining operations

MATERIALS AND METHODS

Arduino IDE

The Arduino Integrated Development Environment (IDE) is a cross-platform software framework developed to streamline programming, upload and debugging processes for Arduino-based microcontroller platforms. It offers a user-friendly graphical interface for developing embedded applications, wherein programs referred to as "sketches" are written using a simplified variant of C/C++ and saved with the ".ino" file extension. The IDE includes essential features such as syntax highlighting, code compilation, serial communication tools, and library integration, making it well-suited for both novice and experienced developers in embedded system design and prototyping. The IDE supports serial communication with connected Arduino hardware and enables seamless integration with third-party libraries and board configurations. It is compatible with several operating systems such as Windows, MacOS, Linux, ChromeOS, and also offers portable versions for Linux and Windows platforms. The Arduino IDE serves as a comprehensive toolchain for embedded systems development, promoting accessibility and rapid prototyping within the open-source hardware ecosystem.

METHODOLOGY

The proposed Landmine Detection Robotic Vehicle with GPS operates through the integration of sensing, control, and communication subsystems to autonomously identify and locate buried landmines. The system is built around an Arduino Uno microcontroller that manages various sensors and motion components. A metal detection sensor serves as the primary sensing element, operating on electromagnetic induction to identify metallic objects beneath the ground surface. When the sensor detects a disturbance in the magnetic field, the microcontroller interprets it as a possible landmine and triggers an alert. To enhance detection reliability, the system validates the signal by performing repeated measurements to reduce

false positives. The vehicle navigates the terrain using ultrasonic sensors that continuously measure distance from obstacles, allowing the controller to adjust motor speed and direction through a motor driver circuit for safe maneuvering. A GPS module is incorporated to record the precise geographic coordinates of each detected mine, enabling accurate mapping of hazardous zones. Upon confirmation of a detection event, the system transmits the corresponding GPS data and sensor information to a remote monitoring platform using an ESP32 Wi-Fi module, or alternatively, a LoRa module for long-range communication. Simultaneously, the results are displayed on an LCD screen, accompanied by audible and visual alerts from a buzzer and LED indicator.

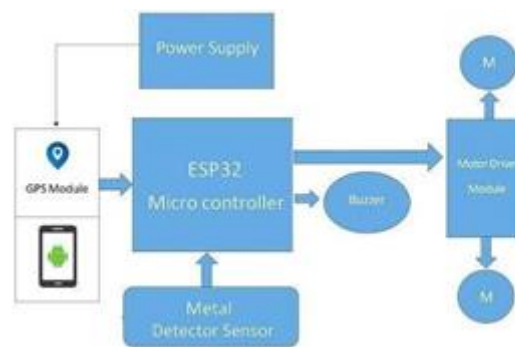


Figure 1. Block Diagram of proposed methodology.

RESULT AND DISCUSSION

The proposed Landmine Detection Robotic Vehicle with GPS system was successfully developed and tested to verify its operational performance. The robot efficiently detected buried metallic objects that represent landmines using the integrated metal detection sensor, which responded accurately to variations in the electromagnetic field. During field trials, the vehicle demonstrated stable mobility and effective obstacle avoidance through the use of ultrasonic sensors, enabling smooth navigation across uneven terrain. The GPS module accurately recorded the geographic coordinates of detected objects, and these locations were displayed in real time on the LCD module. Simultaneously, the ESP32 Wi-Fi module transmitted the detection data and coordinates to a remote monitoring interface, ensuring reliable wireless communication. Experimental observations confirmed that the system achieved accurate detection, dependable wireless transmission, and low power consumption. Overall, the results validate the system's capability to perform autonomous landmine detection, precise localization, and real-time reporting, making it a viable and cost-effective solution for hazardous area surveying and demining operations.



Figure 2. Prototype of the proposed methodology.

CONCLUSION

This study demonstrates the effectiveness of integrating metal detection, GPS localization, and wireless communication technologies into a single robotic platform for autonomous landmine detection. The system efficiently identifies buried metallic objects using an electromagnetic induction-based sensor while accurately recording their geographic coordinates through the GPS module. The integration of ultrasonic sensors ensures safe navigation and obstacle avoidance, allowing the robot to operate smoothly in complex terrain. The incorporation of the ESP32 Wi-Fi module enables seamless data transmission to a cloud interface, providing real-time visualization and remote monitoring of detected landmine locations. Experimental evaluations confirm that the proposed design delivers reliable detection performance, stable communication, and low power consumption. Overall, the developed system offers a practical, low-cost, and scalable solution for minefield surveying and hazard mapping, thereby enhancing operational safety and supporting efficient demining efforts.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this paper.

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