

Landmine Detection Robotic Vehicle with GPS Positioning

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ABSTRACT

Landmines remain a serious threat to military personnel and civilians because they can remain concealed for long periods and may be triggered by human or vehicle movement. Manual mine detection is hazardous and requires personnel to operate in potentially dangerous environments. This paper presents the design and implementation of a landmine detection robotic vehicle with GPS positioning intended to reduce direct human exposure during mine-searching operations. The developed prototype combines a metal/proximity detection sensor with an ultrasonic sensor, Arduino UNO based control, DC motor drive, GPS positioning, GSM-based SMS communication, Bluetooth remote control, and a 16×2 LCD display. During operation, the robotic vehicle moves through the target area while continuously monitoring the metal detection sensor. When metallic material associated with a possible mine is detected, the controller stops the vehicle, activates an audible indication, displays a warning message, and communicates the detected location through the GSM system. The ultrasonic sensor assists navigation by identifying nearby obstacles and initiating an avoidance response. The prototype is designed as a relatively low-complexity and economical robotic platform for remote landmine detection and location reporting. Experimental observations from the developed model demonstrate movement in multiple directions, mine detection, obstacle avoidance, local warning, and position reporting capabilities.

Keywords— Landmine detection, robotic vehicle, Arduino UNO, ATmega328P, metal detector, GPS, GSM, ultrasonic sensor, Bluetooth, mine detection robot.

INTRODUCTION

Landmines are explosive devices that are commonly concealed beneath or near the ground and can cause severe injury or death when activated. They have historically been used in conflict zones and may continue to pose a danger long after military operations have ended. The uploaded project report identifies anti-personnel and anti-tank mines as two broad categories and emphasizes the need for safer methods of detecting concealed mines.

Conventional mine-searching activities can expose soldiers and civilians to significant risks. Consequently, robotic systems can provide an alternative approach in which detection equipment is mounted on a mobile platform and operated without requiring personnel to physically enter the suspected mine area. The proposed system employs a robotic vehicle equipped with a metal sensing arrangement for identifying metallic objects. Once a possible mine is detected, the vehicle is stopped and the location is communicated using GPS and GSM technologies. An ultrasonic sensor is incorporated to assist the vehicle in identifying obstacles during movement.

The central controller of the proposed prototype is an Arduino UNO based on the ATmega328P microcontroller. The controller receives information from the detection and navigation sensors and generates commands for the motor driver, warning indicator, display, and communication system. The vehicle can also be controlled remotely through a Bluetooth interface. The combination of detection, navigation, control, and location reporting provides a compact platform for experimental study of robotic mine-detection systems.

The remainder of this paper presents the related work, proposed system architecture, hardware and software implementation, operating methodology, experimental observations, advantages, applications, and conclusions.

LITERATURE SURVEY

Research on robotic landmine detection has mainly focused on reducing human exposure to hazardous minefields through the use of mobile robots, metal detection, wireless control, and embedded controllers. Bharath J. [1] developed an automatic landmine detection robot using a microcontroller and a metal detector interfaced with the robotic platform, providing a comparatively low-cost approach for detecting buried metallic objects. Abilash and Paul Chandra Kumar [2] investigated an Arduino-controlled landmine detection robot, demonstrating the suitability of Arduino-based embedded control for integrating sensors and motor-control systems. Patil and Bombale [3] reviewed wireless landmine detection robots and highlighted the importance of remote operation for keeping operators away from suspected minefields. Sasikumar *et al.* [4] proposed a multi-utility landmine-detecting robotic vehicle that extended the robotic platform toward surveying and monitoring applications. These studies establish the importance of combining mobile robotic platforms with detection and wireless-control technologies for safer minefield operations.

More advanced research has investigated multisensor and terrain-adaptive robotic systems. Rachkov, Marques, and De Almeida developed a multisensor demining robot incorporating a metal detector, infrared detector, and chemical explosive sensor. The robot was designed to operate over rough terrain and carry demining equipment, although the additional sensing equipment increased the system weight. Kang *et al.* investigated the design requirements of a mine-detection robot for Korean minefields and considered a track-based platform equipped with metal detection and ground-penetrating radar, together with distance sensing for maintaining an appropriate sensor-to-ground distance over uneven terrain. Based on these studies, the proposed system focuses on a simpler integrated architecture incorporating an Arduino UNO controller, metal/proximity sensor, ultrasonic obstacle detection, GPS positioning, GSM-based SMS notification, Bluetooth control, and DC motor drive. This combination provides detection, navigation, remote operation, and location reporting within a comparatively low-complexity prototype.

PROBLEM STATEMENT

Manual detection of landmines in suspected areas exposes soldiers and civilians to a high risk of injury or death. Since landmines can remain concealed beneath the ground, locating them safely and identifying their position is a challenging task. Therefore, there is a need for a robotic system that can detect metallic landmines remotely, avoid obstacles during movement, and provide the location of a detected mine without requiring direct human presence in the hazardous area.

OBJECTIVES

1. To develop a robotic vehicle capable of detecting concealed metallic landmines using a metal/proximity sensor and safely stopping the vehicle when a possible mine is detected.
2. To integrate GPS and GSM technologies for identifying and remotely communicating the location of the detected mine, along with ultrasonic-based obstacle detection for safer navigation.

PROPOSED SYSTEM

The proposed system is a landmine detection robotic vehicle with GPS positioning designed to reduce human involvement in hazardous mine-searching areas. The system consists of an Arduino UNO based on the ATmega328P microcontroller, metal/proximity sensor, ultrasonic sensor, GPS module, GSM module, HC-05 Bluetooth module, L293D motor driver, two DC motors, 16×2 LCD with I²C interface, buzzer, and a 12-V battery supply. The Arduino acts as the central controller and receives signals from the metal detection and ultrasonic sensors while controlling the motors, warning system, display, and communication modules. The robotic vehicle can be remotely operated using Bluetooth and can move in forward, backward, left, and right directions.

During operation, the robotic vehicle moves through the suspected area while the metal/proximity sensor continuously monitors for metallic objects. When a possible mine is detected, the sensor sends a signal to the Arduino, which immediately stops the motors and activates the buzzer. A “BOMB DETECTED” message is displayed on the LCD,

while the GPS module provides the location information. The GSM module is then used to transmit an SMS containing the detection warning and location information to a registered mobile number. Simultaneously, the HC-SR04 ultrasonic sensor measures the distance to obstacles; when an obstacle is detected within the programmed threshold, the controller stops the vehicle and initiates a turning maneuver before continuing the search. Thus, the proposed system integrates mine detection, obstacle avoidance, robotic movement, GPS positioning, and GSM-based notification into a single prototype platform.

BLOCK DIAGRAM

The Fig 1 shows the overall architecture of the proposed landmine detection robotic vehicle. The Arduino UNO acts as the central controller, receiving inputs from the power supply, metal sensor, and camera, while controlling the LCD display, motor drivers, robot mechanism, and HC-05 Bluetooth module. The motor drivers operate the robotic mechanism, enabling remote movement and detection of suspected landmines.

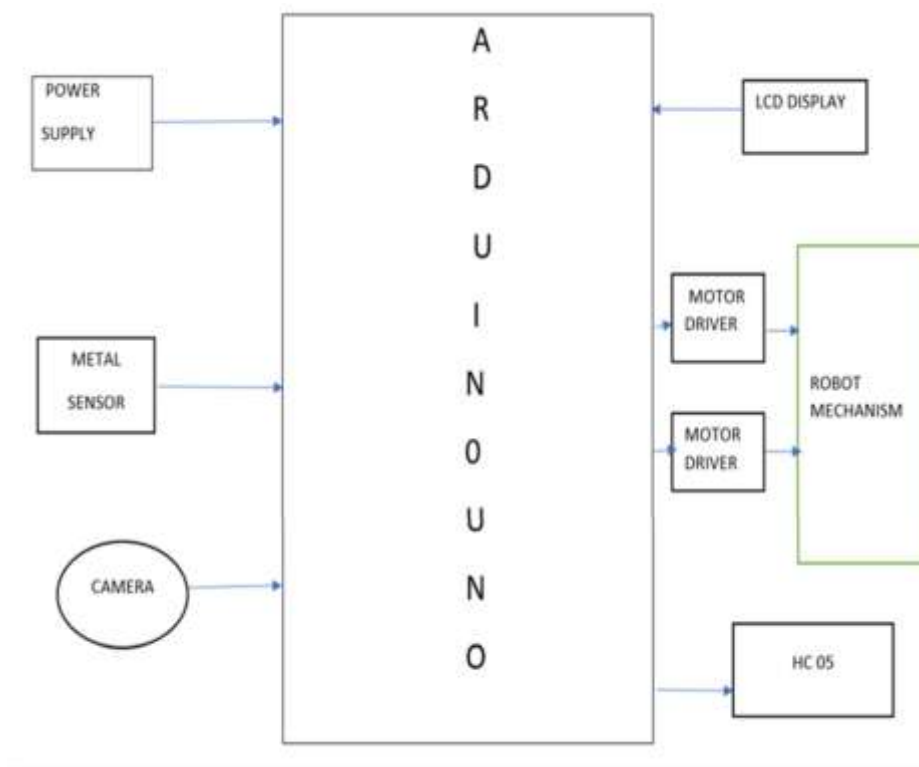


Fig 1 block diagram

CIRCUIT DIAGRAM

The Fig 2 shows the electrical interconnection of the proposed landmine detection robotic vehicle. The Arduino UNO serves as the main controller and interfaces with the 12 V battery, GPS module, metal/proximity sensor, HC-SR04 ultrasonic sensor, HC-05 Bluetooth module, and 16×2 LCD through an I²C converter. The controller sends motor-control signals to the motor driver, which operates the two DC motors (M1 and M2) for movement of the robotic vehicle.

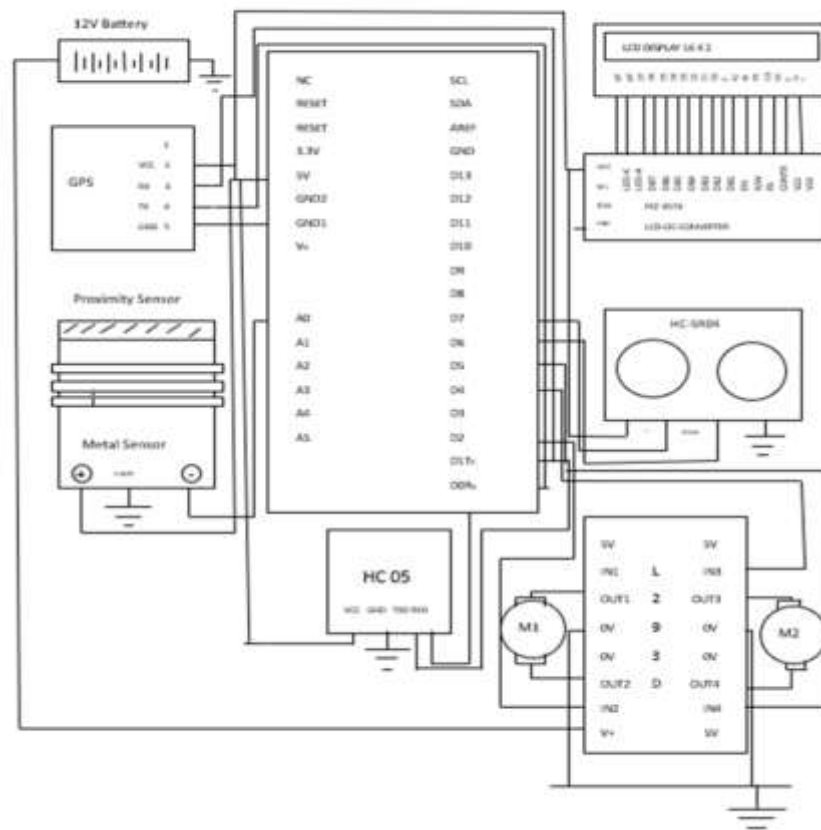


Fig 2 circuit diagram

METHODOLOGY

The proposed landmine detection robotic vehicle is developed by integrating sensing, control, communication, positioning, and motor-drive subsystems around an Arduino UNO controller. A 12-V battery supplies the robotic platform, while the Arduino UNO based on the ATmega328P acts as the central processing unit. The metal/proximity sensor is interfaced with the controller for detecting metallic objects that may indicate the presence of a landmine. Two DC motors are connected through an L293D motor driver to provide forward, backward, left, and right movement. An HC-05 Bluetooth module enables manual wireless control of the vehicle. The HC-SR04 ultrasonic sensor is incorporated for obstacle detection, and a 16×2 LCD with an I²C interface provides information such as measured distance and detection status. During normal operation, the robot moves through the target area while the controller continuously monitors the metal sensor and ultrasonic sensor. The ultrasonic sensor transmits a pulse and measures its return time to determine the distance from an obstacle. If the measured distance falls below the programmed 10-cm threshold, the controller stops the motors and initiates a turning maneuver to avoid the obstacle. At the same time, the metal-detection routine checks the sensor output. When metallic material is detected, the controller immediately stops the vehicle, activates the buzzer, and displays “BOMB DETECTED” on the LCD. The GPS subsystem is used to obtain the geographical position, while the GSM subsystem sends an SMS containing the detection warning and location information to the registered mobile number. Thus, the methodology provides a sequential process of robot movement → sensor monitoring → obstacle avoidance → metal detection → vehicle stopping → warning indication → GPS location identification → GSM notification.

RESULTS AND DISCUSSION

The Fig 3 shows the developed prototype was observed to provide movement in four directions: forward, backward, left, and right. The project report also states that the robotic vehicle can detect a mine ahead of it and stop when a detection condition is identified. These functions demonstrate the integration of the motor-control, sensing, and controller subsystems.

The metal detection sequence provides a local warning through the buzzer and LCD while the GSM subsystem provides remote notification. GPS positioning is incorporated to associate the detected mine with latitude and longitude information. The report identifies this positioning capability as an important feature because it allows the location of a detected mine to be identified in coordinate form.

Obstacle sensing provides an additional layer of navigation support. The HC-SR04 sensor continuously measures the distance ahead of the vehicle, and when the measured distance falls below 10 cm, the control program stops the robot and performs a turning maneuver. This prevents the vehicle from simply continuing forward into an obstacle.

The prototype therefore demonstrates the feasibility of integrating mine detection, robotic mobility, obstacle sensing, wireless control, location reporting, and warning indication within a single low-complexity platform. However, the available project report does not provide quantitative measurements such as detection probability, false-alarm rate, GPS positioning error, communication delay, battery endurance, or detection depth. Consequently, these performance parameters cannot be claimed from the available experimental results.



Fig 3 hardware setup

CONCLUSION

This paper presented the design and implementation of a landmine detection robotic vehicle with GPS positioning. The proposed prototype integrates an Arduino UNO controller, metal/proximity detection sensor, ultrasonic obstacle sensor, GPS, GSM communication, Bluetooth control, LCD, buzzer, motor driver, and DC motors. The robot is designed to move through a suspected area while monitoring for metallic objects. When a possible mine is detected, the vehicle stops, provides an audible and visual warning, and communicates location information through the GSM subsystem.

The experimental prototype demonstrates the basic feasibility of using a mobile robotic platform to reduce direct human involvement in landmine-searching activities. Its comparatively simple architecture and combination of detection, navigation, communication, and positioning functions make it suitable as a prototype for further research

and development. For practical deployment, however, extensive field validation, multisensor detection, improved localization, robust autonomous navigation, and quantitative safety and detection-performance evaluation would be required.

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