Landmine Detection Using an Advanced Embedded microcontroller

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Abstract— **During warfare, the detection of landmines is of utmost importance for safely deploying armed vehicles in enemy territory. These vehicles, known as main battle tanks, are crucial for following the path set by manually operated pilot tanks, in order to prevent any damage or distractions to the battle tanks and to minimize casualties among defense crews. Our landmine-detecting robotic vehicles serve the primary purpose of identifying landmines across a large expanse of the defense field. The detonation of these landmines can result in severe harm to soldiers and even release toxic pollutants into the environment. Traditionally, the robots are deployed prior to the commencement of war in the war-based area, where they play a critical role in saving the lives of soldiers.**

Keywords— AT mega 328p, GPS, GSM, Robotic Vehicle, Landmines, Toxic Pollutants, Defense.

I. INTRODUCTION

Landmines are explosive devices that not only have the potential to cause fatalities among both humans and animals but also to endanger agricultural land, water reservoirs, and road development in border regions. Often concealed 10-40mm below the soil surface, these devices require a minimum pressure of 9kg to detonate, posing a significant threat to soldiers and civilians worldwide. Through the utilization of unmanned technology, it becomes feasible to detect and relocate bombs via an integrated robotic arm without the need for human involvement. Consequently, the requirement for human presence in bomb detection is minimized. Robots are being diligently engineered, incorporating microcontrollers to ensure swift operations and minimize casualties associated with the detection and neutralization of land mines.[1]

Landmines have a long history, with early versions made of wood and metal. They became widespread during World War II. Over time, landmines evolved in design and purpose, from military use to being used in conflicts and civil wars. The humanitarian impact of landmines led to international efforts to ban them, resulting in the 1997 Mine Ban Treaty. Despite these efforts, landmines continue to pose a threat in various regions, necessitating ongoing detection and clearance. Landmine detection is needed to save lives, ensure safety, support post-conflict recovery, enable safe movement in conflict zones, protect the environment, and comply with international agreements.[4]

The Objectives of landmine detection:

I. Safety: The main goal is to ensure the safety of civilians, military personnel, and demining teams by detecting and removing hidden landmines.
II. Public Awareness: Education and awareness campaigns are crucial to inform local populations about the dangers of landmines and how to avoid them.
III. Humanitarian Impact: To minimize the humanitarian impact of landmines, including injuries and fatalities, and to support post-conflict recovery efforts.
IV. Land Clearance: Enabling the clearance and safe release of land for agricultural, infrastructure, and community development.

This paper presents an overview of landmine detection using embedded microcontrollers. Arduino microcontroller is employed in the vehicle. The vehicle system embedded with metal detector capable of sensing the landmine and buzzer from producing a warning alarm to the nearby personnel in that area and also send the location via GPS to user.

II. LITERATURE SURVEY

- Types of landmine detection techniques

There are various landmine detection methods are available, some of them are follows

I By using dogs

The Marshall Legacy Institute is dedicated to training Mine Detection Dogs and providing them to countries in need worldwide. These exceptional dogs rely on their extraordinary sense of smell to detect the

explosive Odors emitted by landmines. Through an intensive training program, they are taught to identify both metal and plastic mines. Once deployed to countries affected by landmines, these Mine Detection Dogs play a crucial role in locating buried landmines, facilitating their safe removal. [6]

II Ground Radar

Ground Radar means GPR is very effective against metal targets which are under the soil.it work on frequency variation, but there are more modern landmines introduce. For GPR it is much more difficult to detect modern plastic-cased landmines and this is due to low dielectric contrast between the landmine material and the soil itself. Now recent advances and signal-processing algorithms of radar technology have improved GPR performance against buried plastic landmines.[7]

III Forward-looking infrared

Forward-looking infrared (FLIR) cameras are commonly utilized in both military and civilian aircraft. They employ thermographic cameras that have the capability to detect infrared radiation. These cameras consist of sensors that can detect thermal radiation, which is typically emitted from a heat source, in order to construct an image suitable for video output. Identifying warm objects against a cooler background. [8]

IV Metal Detector

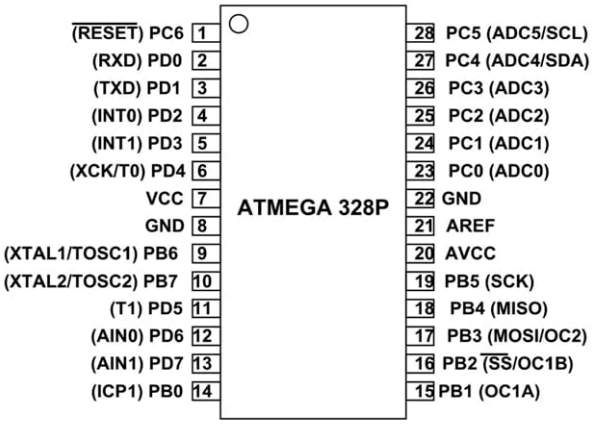
A metal detecting sensor is a type of sensor utilized for the purpose of detecting the presence of metal objects in various applications. This sensor operates by generating an electromagnetic field that interacts with the metal object, resulting in a modification in the field. Subsequently, this alteration is identified by the sensor. Metal detecting sensors find their application in a wide range of scenarios, including security systems, industrial metal detection, and consumer metal detectors. Consequently, they play a crucial role in efficiently and non-invasively detecting metal objects, thereby ensuring the safety and protection of individuals and valuable items.[9]

Sr. No.	Methods	Components	Merits	Limitations
1	By using Dog	Dog	Sensitivity to Scents Mobility and Adaptability Real-Time Detection Low Cost and Efficiency	Safety Risks Training and Maintenance Deployment Challenges Limited Coverage
2	GPR (Ground penetrating radar)	Transmitter, Antenna, Receiver.	It is safe for use in public spaces and wide variety of projects.	It cannot tell the composition of a target
3	Forword-Looking Infrared	Mercury Cadmium telluride	Non contacts detection Day and night capability reduce fault alarm	Limited detection range expensive cost limited penetration
4	Metal Detector	Copper coil, Capacitors, Diodes	Sensitivity of metal Non- distractive Cost effective Rapid Sensitivity	Limited to surface mine Detect only metallic landmine

Table 1. Summery of landmine detection techniques

- Microcontroller

We use advanced microcontroller ATmega328p because it is 28 pin microcontrollers, having 3 ports which are name as port B, port C, port D.



Developing Landmine detection vehicle involves advance microcontroller integrated with GPS, GSM module. All components are integrated with ATmega 328P which is Arduino development platform. These devices send message to emergency contact with current location. With help of camera, it captures images it also used for information purpose. With all this feature this device contain detection and diffusion of landmine using robotic arm. Block Daigram for landmine detection is shown in fig.1 below.

III. METHODOLOGY

In methodology we see the bloack daigram and flowchart of the system as follows.

I Block Diagram

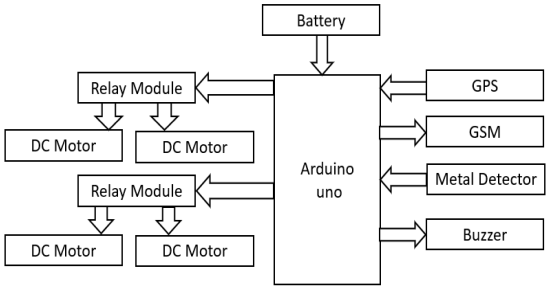


Fig.1.Block daigram

This is the block daigram of landmine detection. We use here advanced microcontroller Atmega328p to which we make a connection. Our battery ,gps, gsm, metal detector, buzzer, relay module all are connected to the microcontroller. We use 12v, 1.5A battery source to power the vehicle. We connect 3 batteries of 4v in series to get the 12v supply, but our microntroller run on 5v supply, this conversion is made by inbuild voltage regulator 7805 in microntroller. GPS can track the current location of landmine and GSM send it to the microcontroller for QWfurther action. We use metal detector to detect the position of landmine in that there is copper wire wound and using electromagnetic induction we can detect it. After detection buzzer on and sound signal is obtained. We use relay module for robotic arm. There are four dc motors for movement purpose. There is one knief on the top of arm which is used to cut the wire of landmine about 2mm. camera is also there to capture the live images of landmine. We connect camera to battery. Solar plate is used for additional power source to charge the battery.

Sr. No.	Component	Specification
1	Battery	12v,1.5A
2	DC motor	30RPM
3	Solar plate	100W,12V
4	Buzzer	12V
5	Motor Driver	16 pins (LN293)
6	HC-05	50-100cm

Table 2. Components specification

Our whole model is controlled by android phone. We use blynk app from that we send the command to vehicle. Bluetooth model HC-05 is used for the connection of android and vehicle. It's range is about 50-100cm. So we can drive our vehicle using android and after detection of landmine we diffuse it using robotic arm by cutting the wire using knief.

II Flowchart

The flowchart and description of the system is given below

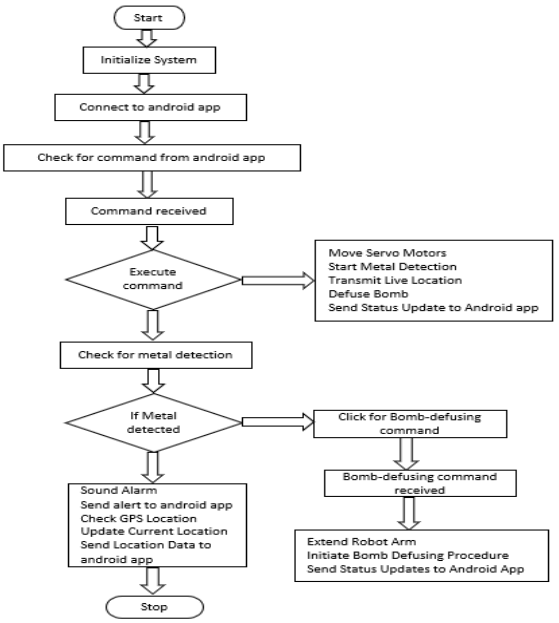


Fig.2. Flowchart of Message sending system

This the flowchart that illustrates the operation of the Landmine Detecting Vehicle through the Blynk mobile app. Our vehicle is connected to the mobile device via the Bluetooth module HC-05, which has a range of 50-100 cm. We are able to control the vehicle by sending commands from the mobile app. In the future, for larger vehicles, we plan to use a Bluetooth module called Laura, which has a range of 2-10 km.The first step in the flowchart is the start block, where we power on the vehicle. After starting, the system goes through an initialization process to start all the necessary components. The next step involves establishing a connection between our landmine detecting vehicle and the Android app. Once the connection is established, we wait for commands from the Android app to drive the vehicle. Upon receiving a command, the vehicle performs the corresponding action. These actions include servo motor motion, vehicle motion, metal detection initiation, and transmission of live location, diffusing bombs, and sending status updates back to the Android app.

Each action requires a different command; therefore, it is important to execute the action according to the given command. After the vehicle has completed its motion, it is crucial to detect any landmines by using the metal detection

command. If a metal object is detected, two actions need to be taken. Firstly, an alarm should be activated and an alert message should be sent to the Android app. Secondly, the GPS location needs to be checked and the current location data should be sent to the Android app via GSM. Additionally, it is necessary to send live images of the detected landmine. From the information provided, it is important to acknowledge the detection of a landmine and the necessary action that must be taken. These parameters play a significant role in obtaining precise location data and accompanying photographs

Following the detection process, the landmine must be defused, and we await the landmine detection command that can be received by our vehicle via our Android application. Once the command for bomb defusing is confirmed, indicating the presence of a bomb, appropriate action is taken using our robotic arm. Upon receiving the command to extend the robot arm, the initial bomb defusing procedure begins. Our landmine can be safely diffused by cutting the wire connecting it using a knife, specifically a 2mm wire. After successfully cutting the wire, it is crucial to communicate the status updates to our Android app. This showcases the operational capabilities of our landmine vehicle when utilized in conjunction with an Android application.

VI Conclusion

The research aim is to provide a survey for developing a robot that can detect mine, as the robot may employ several sensors in order to help in mining. deployment of a landmine detection robot marks a significant milestone in the realm of humanitarian demining. Through its advanced sensors and autonomous capabilities, the robot streamlines the process of identifying and neutralizing hidden explosive devices, thereby safeguarding the lives of civilians and aiding in the restoration of affected territories.

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