Dayananda Sagar University

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Kudlu Gate, Bengaluru-560068

A Project Report on

"LAND-MINE DETECTION ROVER"

Submitted in partial fulfillment of the requirements for the award of the degree

BACHELOR OF TECHNOLOGY

in

ELECTRONICS AND COMMUNICATION ENGINEERING

by

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CERTIFICATE

This is to certify that the ***Project*** *entitled* ***"LAND-MINE DETECTION ROVER"*** *has been successfully carried out by* ***TOUHEED KAZMI (ENG16EC0092), VISHAL G YADAV (ENG16EC0095)*** *and* ***VEERABHADRA V P (ENG16EC1018)*** *in partial fulfillment of the requirement for the award of the degree* ***BACHELOR OF TECHNOLOGY*** *in* ***ELECTRONICS & COMMUNICATION ENGINEERING*** *by* ***DAYANANDA SAGAR UNIVERSITY*** *during the academic year 2019-2020.*

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CANDIDATE'S DECLARATION

We hereby declare that the in-house project presented in this synopsis titled "Land-Mine Detection Rover" in partial fulfilment of the requirements for of the award of the degree of Bachelor of Technology in Electronics and Communication have to submit in School of Engineering, Dayananda Sagar University, Bangalore, is an authentic record of my own work that would be carried out during 7th semester (period from Aug 2019 to Dec 2019) under the guidance of "Dr. Payal Verma" SoE, DSU Bangalore.

The matter embodied in this synopsis has been submitted by us for award of degree of Bachelor of Technology.

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ABSTRACT

In this generation, rescuing and saving a person's life is the most honorable achievement in which we concern during various considerations such as usual accidents caused through this chaotic world. Let us consider an example, of the native people, who are currently surviving in African countries, from the period of both World wars I & II. During that century, there were huge chunks of land mine that were implanted by the rival countries. These land mines are still active in those regions of the country and the civilians are frightened to even dig a small pit in their neighbourhood or to even walk on the streets of the locality. By researching and resolving their normal diurnal issues of facing to detect and diffuse the active land mines in that region. We are going to implement the technology of detection of the implanted land mines through the metal detector module with the manual control of the rover. This detector will detect the land mines that are buried and on the surface of the soil, which helps the civilians to safely locomote on streets. Additionally, the user is also provided with a RF transmitter module joystick to control the movement of the robot. The metal detector module which is placed on the rover will detect the land mines through the electromagnetic induction. The rover is constructed with rocker-bogie suspension which has become a proven mobility application known for its superior vehicle stability and obstacle-climbing capability. On the whole, the application of the metal detection rover will enhance its vast impact on the recognition of implanted land mines that are hidden in various cities in Africa.

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CHAPTER 1
INTRODUCTION

1.1 OVERVIEW

A land mine is a self-contained explosive device which is placed onto or into the ground that explodes when triggered by a vehicle, a person, or an animal. In today's devastating world, there is no precaution for the jawans, safeguarding at the border of the nation. They are engaged in major operations assigned to them by their captain, risking their life in dangerous ambience. Soldiers come across land mines, if some of them is not aware of the land mine set up by the terrorists, by accidently stepping on it which leads to self-suicide. To avoid this scenario, we are going to integrate the application of detecting land mine with robotics that gives precautions to the soldiers by sending the land mine detection rover and then plan to move ahead and execute their operation.

1.2 TYPES OF LANDMINES

1.2.1 Anti-Tank Mines (AT)

Are designed to destroy tanks and armored vehicles. Anti-Tank Mines are comparatively bigger than Anti-Personnel Mines and require more pressure to detonate.

Fig. 1.1 Anti-Tank mine

1.2.2 Anti-Personnel Mines (AP)

An explosive device made to injure or kill a person**.** They are designed to injure rather than to kill a person in order to increase the medical burden and evacuation burden on the enemy.

Fig. 1.2 Anti-Personnel mine

1.3 FIRING MECHANISM

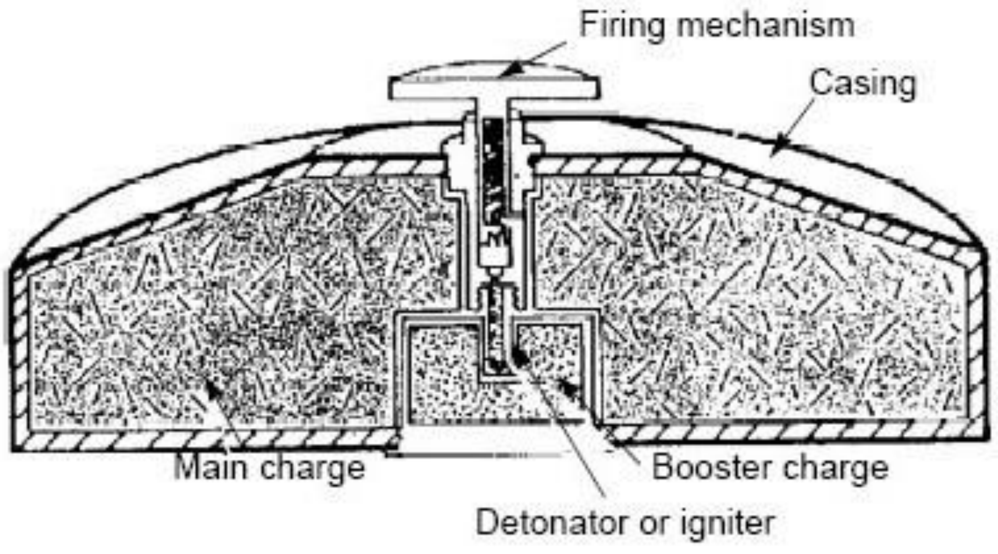

Fig. 1.3 Diagram of components

A land mine is can be activated using a number of like pressure, movement, magnetism and vibration. Any pressure applied to the flat firing plate on the top results in the downward movement that triggers the detonator causing the mine to explode.

1.4 TOPOLOGICAL SURVEY

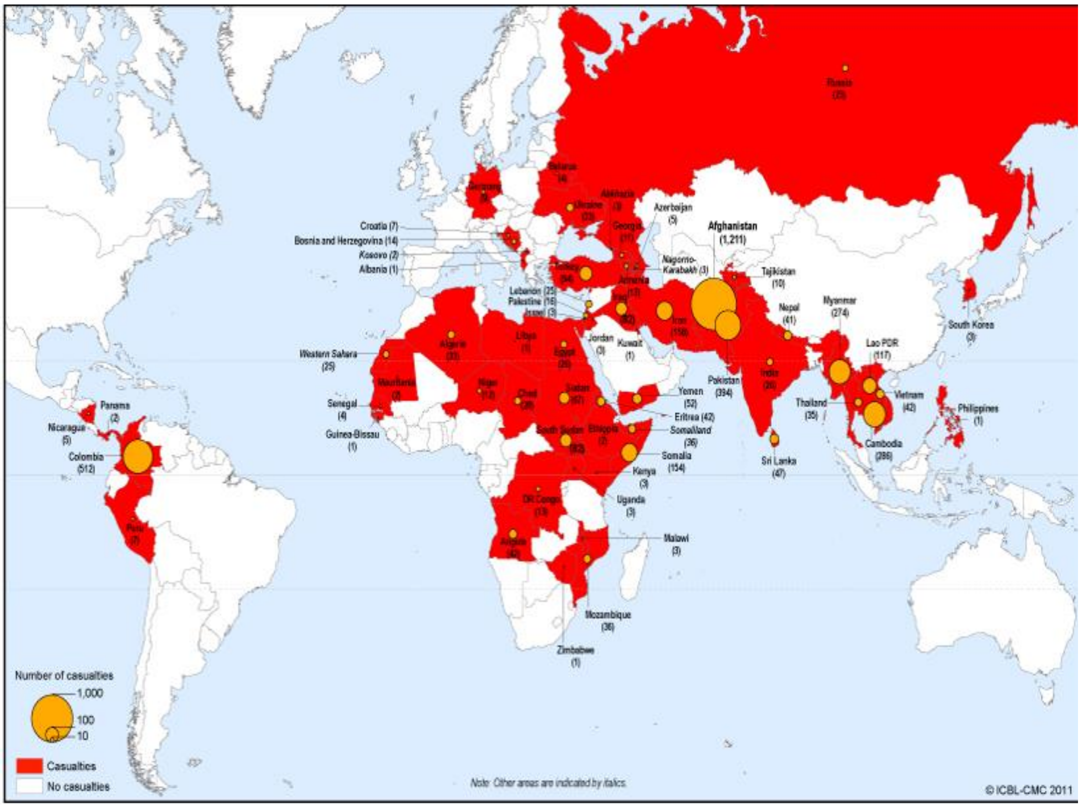

Fig. 1.4 Land mines explosive remnants of world war-i &ii, cluster submunition causalities in 2019

- The survey describes the various parts of the world where land mines are still active in 2019.
- These land mines are the remnants of both the world wars which were planted in most regions of the world.
- In the map, the regions in major red indicate the casualties of land mine, in the sense most of the land mines are diffused but still there are parts that are active.
- The regions in big orange section indicate the casualties of land mine between 1000 – 10000 million range/km.

- The regions in smaller orange section indicate the casualties of land mine between 10- 100 million range/km.
- The white regions are evacuated and rescued which are completely free from land mines.

1.5 OBJECTIVE

"Soldiers have got what it takes, but they have got everything it takes for saving a life". Saving a soldier's life is a major impact for the nation's well-being. Indian army's objective is to defend the nation's frontiers. Detection and dis-engaging of land-mines is also an important task for saving a jawan's life along with other activities. Progressing to advance the military unit, installation of the expendable rovers for detection of land mines is mandatory in saving a soldier's life. This can enhance the use of technology for a better execution of anti-terror operations.

CHAPTER 2
LITERATURE SURVEY

2.1 EXISTED METHODS

2.1.1 PRODDERS

Fig. 2.1 Soldiers searching for land mines

Primary methods of detecting a mine was prodding on soil surface with pointed stick. This has evolved to military prodders that has a metal detector at the end. The principle involved is electromagnetic induction. Nearly all mines have enough metal that can be detected with metal detector. No detector finds all mines.

In this method deminer’s head and hand are very close to mine which has high risk of self-suiciding.

2.1.2 DOGS

Dogs can smell landmines. This was demonstrated as early as in 1970’s. They are extremely sensitive smell of chemicals when compared to humans and other animals. Their true potential is unknown. They can detect the mines that most of the best chemical sensors cannot detect. Mine-detection dogs can sniff explosives like TNT.

German Shepherd, Belgian Malinois, Beagles and Labrador Retrievers are preferred breeds of dogs. Cost to train these dogs is about $10,000. They undergo training for a period of 8-10 weeks.

Fig. 2.2 Dog sniffing to find mine

2.1.3 RATS

Just like the dogs people are training rats to sniff chemicals like TNT that is present in the land mines. In Tanzania cost of training each rat comes around $6000. These mammals have been deployed in Cambodia and Mozambique. They are known to have cleared more than 10,000 mines.

Rats are of lower mass when compared to human or dogs, so their chances of triggering a land mine is very low. Dogs bond with their trainers but rats don’t, hence anyone can handle these creatures. They have fewer false positives compared to metal detectors. They can clear a mine in one day that metal detector would take about 2 weeks.

Fig. 2.3 Rat sniffing to find mine

2.1.4 MINE CLEARING MACHINES

This is mechanical demining that employs vehicles that have huge devices like rollers, tillers and excavators. They were used in military operations dating back as World War I. Initially they were cumbersome, unreliable and underpowered, but now additional efforts have been made to make safer cabin designs, additional armour, GPS system also remote control.

Fig. 2.4 Keiler mine clearing vehicle

2.2 HUMI

Fig. 2.5 HUMI a mine detection robot

HUMI is a mobile 6 wheeled robot that was developed to detect land mines. The first prototype was made using Ackermann geometry for better manoeuvrability and is an All Terrain Vehicle that moves on rough terrains and even inclinations controlled with the help of a joystick.

2.3 ROBOT LAND MINE DETECTOR

Fig. 2.6 Robot land mine detector

This is a mobile robot for detection of land-mine which has caterpillar track for vehicle propulsion with tracks of plates driven by 7 wheels on each side. The robot has an IP (Internet Protocol) camera that enables the handlers to visualize the area where the robot is at. The robot is controlled using radio frequencies.

This robot has a pump that collect air samples of the areas where it hovers these samples are brought back to the operator, later these samples are given to the dog unit for the analysis. If the area is found to be mine-prone then this bot is sent again to determine the exact location of the mine with the help of metal detector which is mounted in front of it.

This robot uses both metal detector and air sampler to determine the location of the Land-Mine which is later disarmed by humans.

CHAPTER 3

METHODOLOGY

3.1 BLOCK DIAGRAM

3.1.1 BLOCK DIAGRAM OF RF COMMUNICATION

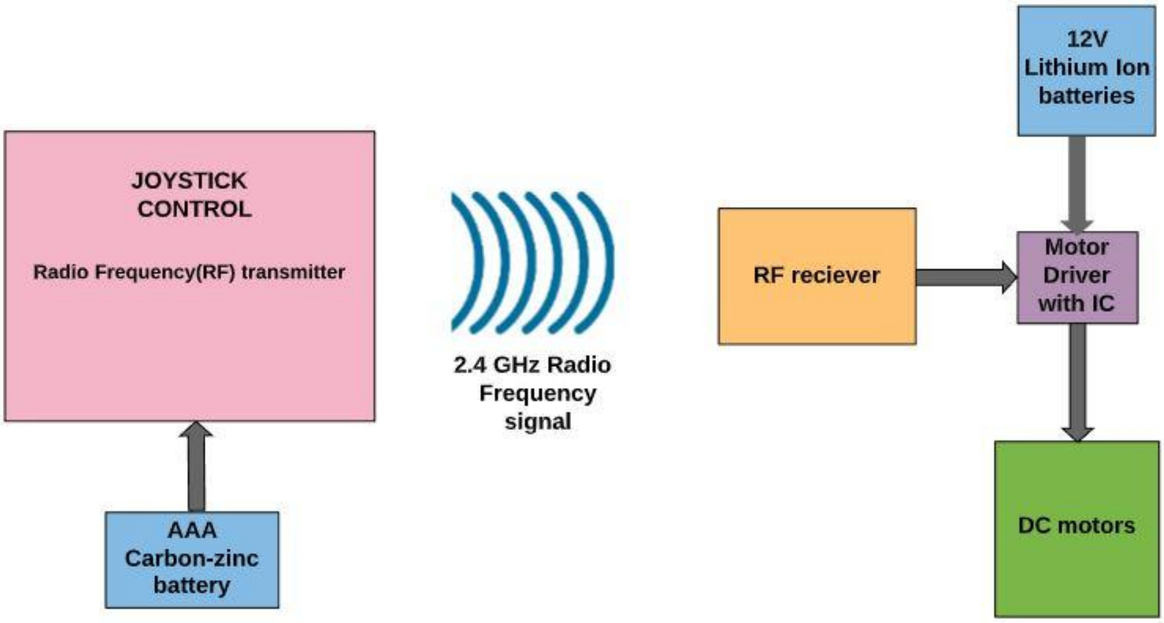

Fig. 3.1 Block diagram of RF communication

This is the block diagram of the Radio Frequency (RF) communication between RF transmitter which is a joystick and RF receiver side contains Motor driver which is powered up by lithium batteries, and it controls DC Motors with series and parallel combination, all these components on the receiver end is mounted on the rover for wireless communication media.

3.1.2 BLOCK DIAGRAM OF METAL DETECTOR CIRCUIT

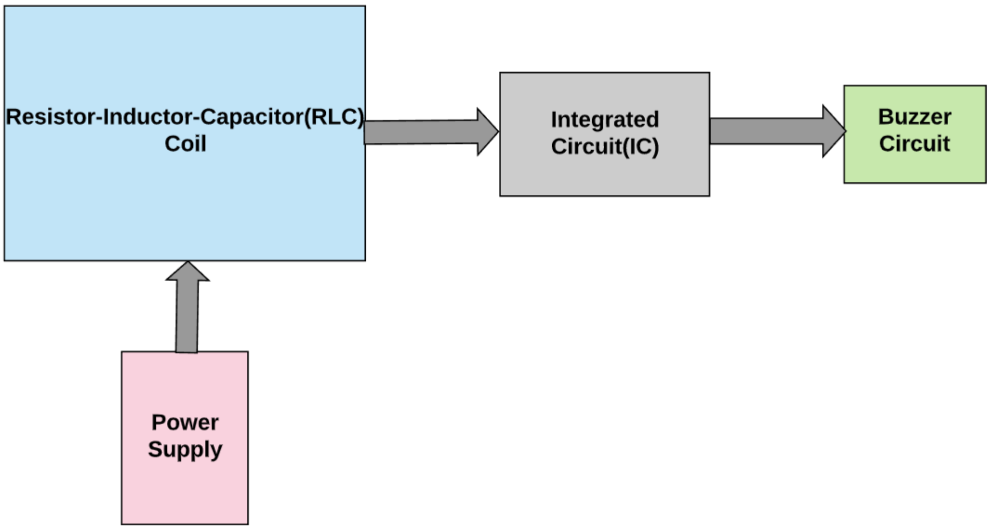

Fig. 3.2 Block diagram of metal detector

The metal detector circuit consists of R-L-C circuit which works on the principle methodology of Electromagnetic Induction. The power supply is given to the R-L-C coil and this signal is computed to the Integrated Circuit(IC) and internally, when the metal is detected the buzzer goes high and analyses the presence of land mine.

3.2 COMPONENTS USED

3.2.1 RF JOYSTICK WITH TRANSMITTER

Fig. 3.3 Joystick

Joystick is an input device which has a stick type structure that pivots on a base and reports its cardinal points to the device it is controlling. It is powered up using AAA carbon-zinc cells. The cardinals or input from the joystick is sent over radio frequency of 2.4GHz with the help of a RF transmitter that converts the data from joystick into transmittable signal for wireless communication. This joystick controls directional mobility of the rover in 4 different directions i.e., forward, backward, left and right directions.

3.2.2 RF RECEIVER

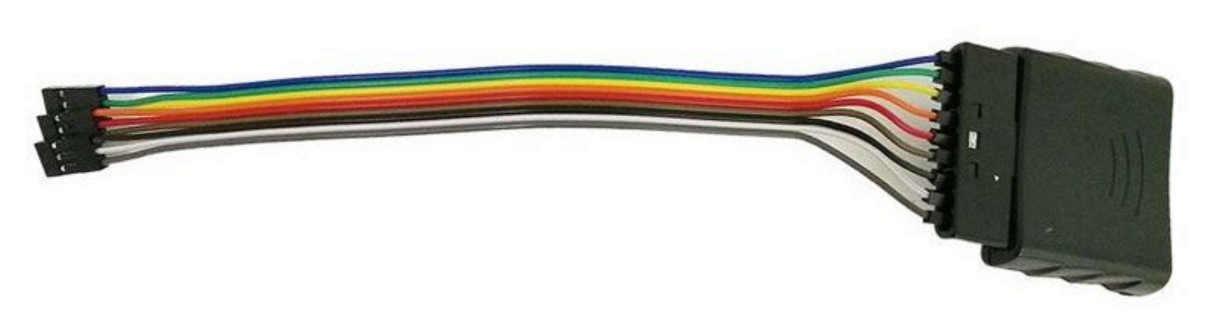

Fig. 3.4 Receiver

RF receiver receives the RF modulated signal from the transmitter and demodulates it. The output of this device is sent to the motor driver.

3.2.3 MOTOR DRIVER

Fig. 3.5 Motor driver

This module gets input from the RF receiver that controls 12V DC motors that are connected to each wheel of the rover. When the joystick is moved in upwards and downwards direction all the motors rotate in forward and backward direction respectively. When the joystick is moved left the motors on the left rotate backward and motors on the right rotate forward. When the joystick is moved right the motors on the right rotate backward and motors on the left rotate forward.

3.2.4 MOTORS

Fig. 3.6 DC motor

Motor that is used in this application is a Rhino Planetary Gear DC motor. The high quality base motors are coupled with a robust and sturdy metal gearbox with 4 stages which can withstand a massive breaking torque of 100 kg.

Features

Operating voltage - 12V

RPM - 60

No-load current - 800 mA

Load current - 7.5 A (Max)

Torque – 40 kg cm for continuous use at maximum efficiency

Weight – 300 gm

Motor Diameter – 28.5 mm

Length – 76 mm

3.2.5 WHEEL

Fig. 3.7 Robotic wheel

The wheels used here are made of rubber, provides excellent grip on various surfaces and good suspension.

Diameter – 125 mm

Width – 60 mm

Weight - 158 gm

3.3.6 ROBOTIC CHASSIS

The rover is designed based on the rocker-bogie suspension which has the reliability to ascend any object twice the size of its diameter of its front-wheels. Generative Design (GD) of rover is designed and generated by Autodesk Fusion 360 software designing tool. Where we had to consider external load forces, encapsulate and the designing of layout for mounting the electronic circuits. Once the output is generated, we select the best design based on the required parameters. These rendered files are 3-D printed using CAM software in a 3D printer.

Fig. 3.8 Robotic Arms (chassis made of nylon-6)

The rover is designed based on the rocker-bogie suspension which has the reliability to ascend any object twice the size of its diameter of its front-wheels. Generative Design (GD) of rover is designed and generated by Autodesk Fusion 360 software designing tool. Where we had to consider external load forces, encapsulate and the designing of layout for mounting the electronic circuits. Once the output is generated, we select the best design based on the required parameters. These rendered files are 3-D printed using CAM software in a 3D printer.

3.2.7 METAL DETECTOR

Circuit and working principle

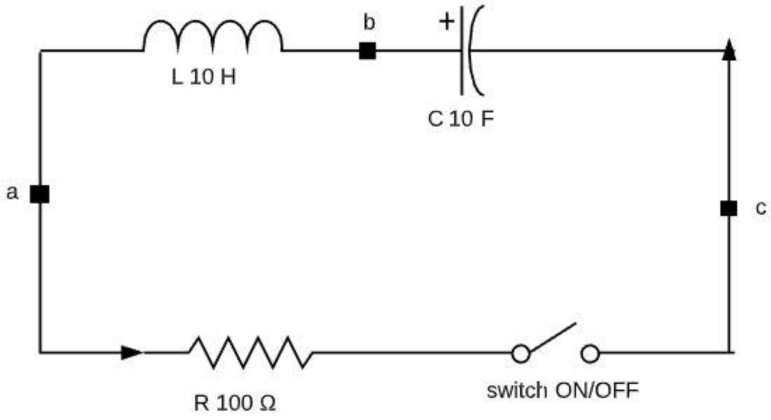

Fig. 3.9 Simple RLC circuit

Detector works on the concept of inductor and RLC circuit. Inductors are coils of enameled copper wire. The inductors used are air cored meaning there won't be any solid core. These inductors have very small value of inductance RLC circuit is shown in figure, the overall impedance between terminals "a" and "c" depends on the values of inductor and capacitor if constant signal frequency is applied. Even a small change in inductance value changes the value of reactance or impedance changes. This small change is current is triggers the buzzer.

3.3 RESULT

We have successfully implemented and demonstrated a miniature prototype for a "Land Mine Detection Rover". By stressing mainly on building a real-time embedded system which involves the integration of robotic chassis design with electronic circuits which is installed with a metal detector to detect the Land mines that are buried or implanted on the surface of the soil. Once the metal detector detects the land mine, the buzzer on the rover beeps and alerts the soldier by indicating the presence of land mine. This information about the land mine detection is conveyed by the soldier, who is controlling wireless RF signaling motion of the rover to other soldiers to prevent risking of their lives involving in some special military operation. Henceforth, by the usage of this type of technology it is beneficial in providing relevant warnings to the soldiers and equips with the fundamental line of defense in safe-guarding the soldier's life.

Fig. 3.10 Photo image of land-mine detection rover

CHAPTER 4
CONCLUSION

4.1 SUMMARY

This project work concludes how rocker bogie suspension is efficient in different terrains such as marshy-terrains, irregular land slopes and various other regions. This rover is useful in real-time application be manually controlled in remote arenas, just by maintaining in the rover's radius-range. This can detect metal related objects with buzzer sensor to prevent the soldier's accidental death. By assuming accurate dimensions of the rover and by detecting the metals, we assume that it can detect land mine too. To conclude, saving a soldier's life by a simple replacement with a metal detection expandable rovers would ease the arduous task of the manual mine detectors with a slightest mistake can lead to suicide activity, as this would be awful for the nation. This rover enables us to detect the land-mines and save a precious life, worth living!

4.2. ADVANTAGES

• The purpose of the project is to give an eminent solution for the eradication of landmine issues.

• By using rover that are capable of exploring and detection of buried landmines.

• We also aimed to make the proposed system with simple components to provide the soldiers and local landmines environments citizens with an effective solution that they can use to save their lives.

• This rover is cost-effective and reliable in operating at any unpredictable environments.

• This rover can be exposed in hazardous environments where human entrance to these ambiences in strictly restricted.

• This application can be operated in the wild forest areas where mobile cellular network is unavailable.

4.3 LIMITATIONS

• The transmitter of RF module is only operated in the radius of 50 meters from the user control. This is a mere drawback that is restricting the operation and control of the rover that is controlled.

• Presently, our application for the project will only be implemented onto a smaller group of soldiers, for an ideal condition and henceforth, the range of the Radio Frequency (RF) must be increased on a larger scale in order to control on a wide arena.

• This project is only implementable in hazardous environments where it cannot be used frequently used in other cities. This cannot be implemented for other regions where detection is not required.

• This embedded system could have been implemented with better RF module which has better upgrades.

• This project involves arduous human task that involves soldiers to spontaneously detect the land on every scale or acre of land in which the rover needs to be physically handled.

• The rover uses the same principle to detect mine as that of the metal detectors, both of them work on the principle of electromagnetic induction hence the performance depends on various factors like type of mine, material of which it is made of, depth of burial and also on type of soil.

• A study shows that detectors were found 91 percent effective for the mines that were tested in clay soil, and just 71 percent in the soil that is iron rich. The rover in these soils detects iron in the soil as a mine and gives false alarms causing unnecessary panic among jawans.

4.4. FUTURE SCOPE

- Our project is currently has only the detection of the land mine through metal detector which is only controlled using short range Radio Frequency(RF) of 2.4GHz frequency with can be controlled by a manual control of 50 meters away from the detected land mine. This project only has a limited range of radio frequency communication that has to be improved by implementing a better radio frequency range for wider range with particular frequency range.
- Further on, implementing a high resolution 360 degree camera module with a microcontroller would enable long distance communication with rover for live video stream that can be viewed from the base camp while the rover is surveilling remotely, kilometres away from the spectator. This unique characteristic will ensure the supervision monitoring of the rover activity.
- With the interface of Global Positioning System (GPS) exact co-ordinates could be mapped that gives latitude and longitude of the rover that has detected a Land-Mine. These co-ordinates are stored or collected, analysed, processed and then sent to the military base so that they assign a soldier to demine the mine.
- With the help of a structural arm which is used for physical marking of the mine can be achieved with further advancements that could even disarm the Land-Mine without human synergy. This arm could have 6 degrees and above of freedom by interfacing servo motors for dynamic action of the arm. This robotic arm has high precision for disarming the land mine soon after it is detected and when the

communication of the soldier’s action for controlling the diffusion of the land mine, in co-ordination with the rover.

- Further on this rover can be upgraded as autonomous vehicle that uses inputs from various sensors that allow it to patrol a particular area of land autonomously taking independent decision.
- For the mechanical design, different material of chassis can be used to fabricate the rover suiting the ambience of the place where rover is operating, for example camouflage skin on rover hard to spot by the enemy.

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