Design and Fabrication of Landmine Detecting Robot for Detection of Landmines

S. Aravinth[1] S. Boopathi[2] K.V. Gnaneshwaran[3] S. Kathiresan[4]
[1]Assistant Professor [2,3,4]UG Student
[1,2,3,4]Bannari Amman institute of technology, India

Abstract— The landmine crisis is globally alarming since there are presently 500 million unexploded, buried mines in about 70 countries. Governments are looking into this situation seriously since landmines are claiming the limbs and lives of civilians every day. The purpose of this project is to design a robot vehicle prototype which is capable of detecting buried land mines and helps soldiers to demine the landmines, while enabling the operator to control the robot wirelessly from a distance. This technology interfaces the metal detector circuit in a robot to search the land mines. The metal detector circuit is interfaced with the robot and it is left on the required search area in order to detect the metallic components used in the landmines. The detection of the buried mine is done by using metal detectors since most land mines contain metal components. The demining process is done by using arm which is fixed in the robot. The main advantage in this project is that we can make this robot at low cost and more efficient. 8051 microcontroller is used to regulate the operations. Bluetooth Technology is adopted to control the directions and movement of the robot and arm remotely.

Key words: Robot, Landmines

I. INTRODUCTION

Landmines are weapons or explosives which are buried under the soil that are activated by pressure, and may kill or cause harm when stepped upon it, and also cause long term physiological effects. Landmines pose a serious threat to soldiers and civilians worldwide and also provide major challenges to agriculture, infrastructure and road development in post-conflict regions. The landmines are usually buried 10mm to 40mm below the soil and requires about minimum pressure of 9Kg to detonate them. Landmines are broadly categorized into two types of landmines Anti-Personnel and Anti-Tank landmines. The face diameter of these Anti-Personnel land mines ranges from 5.6 to 13.3cm. Anti-personnel landmines are used to injure a person since it contains fewer amounts of explosives which get activated when pressure is applied on it while Anti-Tank landmines consists of large number of explosives which can even destroy large tanks. The process of demining these mines is such a big and risky task for the soldiers. Now by using our robot we can detect and demine the landmines.

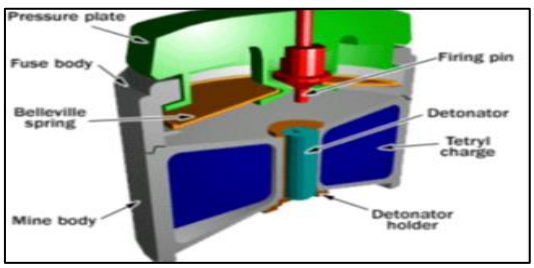

Fig. 1.2: Anti-Personnel landmine

The components of a landmine comprise a Belleville spring, which is a piece of steel curved into a doughnut-like shape; black powder, which essentially gunpowder, comprising potassium nitrate or sodium nitrate, sulphur and charcoal; a delay element, a chemical compound that burns for a finite amount of time before igniting a fuse; the detonator, which is a small amount of explosive that is used to ignite a larger portion of explosive, types of explosive can vary; the firing pin, which is a metal pin that is forced down into the detonator when the landmine is activated to force it to detonate, it is often made of pure Iron, or a Tin-Antimony alloy; the fuse, which is another combustible material which is utilized for the purpose of igniting an explosive charge; the main charge is the main explosive component in the landmine that causes it to detonate when activated, it generally made out of TNT, RDX (also known as cyclonite), Tetryl, Picric Acid, Plastic Explosive, or Nitromethane. Also, there is the percussion cap, which is a chemical compound that explodes when we apply pressure to it; it is usually made out of copper or brass; the pressure plate, which is a metal disc on top the mine that when it's stepped on, depresses and triggers the detonation mechanism in the landmine; projectiles, which are generally metal balls or glass shards, which are utilized to increase injury to victims the metal casing of the landmine can also function as a projectile; the propelling charge is the small quantity of explosive set underneath the landmine in order to propel the landmine into the air when activated; and finally, the safety pin is a piece of metal inserted in the mine in order to prevent its being activated when it's not in use. The landmine, in addition to having a wide range of chemicals, metals, and explosives in its construction, has raw materials that come from all over the world.

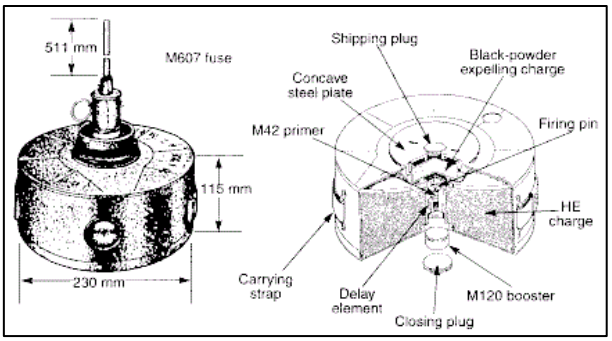

Fig. 1.1: Anti-Tank Landmine

II. LITERATURE REVIEW

The effectiveness of any technology is often evaluated by minimizing accidents to the operators specifically to those landmines that for any reason were moved away from their original position. To solve this concern, some countries nowadays performed the detection of buried landmines using several other methods, such as using dogs that sniff

the explosive contents of the mines. Various techniques used for the detection of landmines. Minesweeping and removing landmines carry certain risks and can be slow and costly.

A. Metal Detector Method

For mine detection, the metal detector is used to measure the disturbance of an emitted electromagnetic field caused by the presence of metallic objects in the soil. The popular, basic metal detector is easy and cheap to use and has an average success rate. However, when using more sensitive detectors for plastic mines, all metallic objects are identified while the problem is heightened. Approximately 80% of all clearance accidents occur during the investigation of metal signatures. Landmines that for any reason were moved away from their original horizontal position mainly cause accidents.

B. Acoustic/Seismic Method

Acoustic/seismic methods look for mines by vibrating them with sound or seismic waves that introduced into the ground. Materials with different properties vibrate differently when exposed to sound waves. These methods are 8 complementary to existing sensors with low false alarm rates and are unaffected by moisture and weather. Existing systems are slow and they do not detect mines at depth, because the resonant response attenuates significantly with depth. An additional limitation of existing systems is that moderate to heavy vegetation can interfere with the laser Doppler vibrometers that commonly used to sense the vibrations at the ground surface.

C. Mechanical Method

Clearing minefields by modified tanks or trucks is also a common method. It does not need sensors and is efficient on a suitable ground. Chains attached on a rotating roller are hitting the ground in order to explode or destroy mines. Another possibility is to mount ploughs in front of a tank, which dig out the mines, and moves them away, mostly without exploding. Mine ploughs are slow (6.5km/h), but used in conjunction with rollers, this system can provide a virtually 100 per cent mine clearance effectiveness.

In order to clear up landmines, two major steps need to be done. The first step is to detect the location of the mines. The second step is to deactivate or destroy the mines. Searching for the location is the process that takes the most amount of time. This is because, every single inch of the land needs to be manually and carefully probed with a mine detector. There are three kinds of minesweeping strategies ranging from a manual based minesweeping, a mechanical equipment based minesweeping, to an advanced robot based minesweeping.

The manual based technique relies on trained de-miners sweeping the ground using metal detectors. Well-trained staff prod the ground with a thin steel spike every 2 cm at a shallow angle of about 30 degrees. The resistance of the probe and the reaction of the surface define where to dig the ground around and carefully remove the mine. Of course, this is a dangerous and slow task. The mine may have turned on its side and the prodder hits the pressure plate rather than the side. Prodding is however the only way of locating each mine. One man can clear 20-50 per day.

Mechanical based demining uses machinery to roll over the landmines and destroy them while they are still in the ground. This technique is known as the fastest demining technique. However, the machines employed in this approach are expensive to operate and can only be used when the terrain is suitable. Additionally, in most situations, this technique is not 100% reliable; thus, the need to employ another technique to check the minefield's clearance. Employing an independent robot in the process of detecting mines will ensure the safety of local residents and those who are engaged in the minesweeping work and the demining process.

III. DESIGN

A. Components

The landmine detecting robot consists of the following components to full fill the requirements of complete operation of the robot.

1) Metal Detector:

A metal detector is an electronic device that comprises of an oscillator which generates an AC current that passes via a coil generating an alternating magnetic field. When a part of the metal is nearby to the coil, eddy current will be induced in the metal object & this generates a magnetic field of its own. If an extra coil is used to measure the magnetic field, the magnetic field can be changed and sensed due to the metal object. The metal detectors are used to sense the weapons and also used in the construction industry to identify the steel reinforcing bars in pipes, concrete, wires, pipes buried in walls & floors. A metal detector circuit is located on the robot. The operation of the detector is to sense the presence of landmine. The robot detects the landmine and generates a buzzer sound to give an alert to the operator of a possible metal landmine near to its path.

2) Microcontroller:

Microcontroller is the brain of the robot. Which operates the robot based on the operator's command.

3) DC Motor:

Motor is used to move the robot in required directions. Four DC motors are connected with the wheels of the robot and three motors are connected with arm of the robot.

4) Motor Driver

L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers. They take a low-current control signal and provide a higher-current signal. This higher current is used to drive the motors. L293D contains two inbuilt H-bridge driver circuit using which two DC motors can be driven simultaneously, both in forward and reverse direction.

5) Battery:

Battery gives the required power to the robot.

6) Bluetooth Module

The Bluetooth module is used to control the robot. It acts as a medium between the operator and robot.

7) Arm:

This is one of the important parts of the landmine detecting robot. Which helps the robot to demine the landmine.

B. Working Principle

The purpose of this project is to detect the presence of landmines in a specific area. Since landmines contain metal part in it, we are using metal detector for finding it. The robot will be kept in the area and there will be a human operator at a safer distance away from the robot. The human operator will control the operations of robot through Bluetooth module. The human operator will control using the android phone application. The robot moves along the area slowly with three metal detectors placed in front for sensing the landmine. A metal detector is an electronic device that comprises of an oscillator which generates an AC current that passes via a coil generating an alternating magnetic field. When a part of the metal is nearby to the coil, eddy current will be induced in the metal object & this generates a magnetic field of its own. If the detector moves close towards the mine, the controller senses it and alerts the human operator about the presence of mine through buzzer. The robot will stop moving and waits for further instruction by the operator. If the motor is enabled, then robot continues to move in specified direction. For example if we need to check a particular land, the robot will be placed in the land and the operator will be in safer distance from the robot. He will operate the robot by using controller device and check the land. Once the robot find the presence of landmine, then it will start to alert the operator by using buzzer sound. Then he will stop the robot and starts to demine the landmine by using the arm of robot.

According to the proposed model, the dimension of the robot is 60 cm x75 cm x 5 cm. This robot detects landmines which is fabricated by more metal parts and indicates as soon as possible. This robot is controlled by human.

C. Program

```
#include <reg52.h>
#include <lcd.h>
void del();
void ser_init();
void ser_out(unsigned char);
void ser_dis(unsigned char*da,unsigned char no);
unsigned char c,v[30],s,j,a,da;
sbit relay1=P2^0;
sbit relay2=P2^1;
sbit relay3=P2^2;
sbit relay4=P2^3;
sbit relay5=P2^4;
sbit relay6=P2^5;
sbit relay7=P2^6;
sbit relay8=P2^7;
void sms_rec();
void disp_on(unsigned char no);
void disp_off(unsigned char nos);
void main()
{
relay1=0;
relay2=0;    //off
relay3=0;
relay4=0;
relay5=0;
relay6=0;    //off
relay7=0;
relay8=0;
j=1;
lcd_init();
ser_init();
read(0x01);
read(0x80);
lcd_disp(" LANDMINE    ",16);
read(0xc0);
lcd_disp(" DETECT ROBOT  ",16);
del();
ser_init();
while(1)
{
sms_rec();
}
}
void sms_rec()
{
if(da=='A')
{
read(0x80);
lcd_disp(" LANDMINE      ",16);
read(0xc0);
lcd_disp("ROBOT  FORWARD         ",16);
//  disp_on('1');
relay1=1;
relay2=0;    //off
relay3=1;
relay4=0;
da=0;
}    //1 ON
if(da=='B')
{
read(0x80);
lcd_disp(" LANDMINE       ",16);
read(0xc0);
lcd_disp("ROBOT  REVERSE       ",16);
//  disp_on('1');
relay1=0;
relay2=1;    //off
relay3=0;
relay4=1;
da=0;
}    //1 Off
if(da=='C')
{
read(0x80);
lcd_disp(" BLUE TOOTH       ",16);
read(0xc0);
lcd_disp(" ROBOT LEFT         ",16);
//  disp_on('1');
relay1=1;
relay2=0;    //off
relay3=0;
relay4=0;
del();
//  del();
relay1=0;
relay2=0;    //off
relay3=0;
```

```
relay4=0;
da=0;
}    //1 Off
if(da=='D')
{
read(0x80);
lcd_disp(" LANDMINE      ",16);
read(0xc0);
lcd_disp(" ROBOT RIGHT          ",16);
//  disp_on('1');
relay1=0;
relay2=0;     //off
relay3=1;
relay4=0;
del();
// del();
relay1=0;
relay2=0;     //off
relay3=0;
relay4=0;
da=0;
}    //1 Off
if(da=='E')
{
read(0x80);
lcd_disp(" LANDMINE",16);
read(0xc0);
lcd_disp(" ROBOT STOP           ",16);
//  disp_on('1');
relay1=0;
relay2=0;     //off
relay3=0;
relay4=0;
del();
del();
relay1=0;
relay2=0;     //off
relay3=0;
relay4=0;
da=0;
}    //1 Off
EA=1;ES=1;
}
void del()
{
delay(65535);
delay(45000);
}
```

IV. CONCLUSION

This project considered the advancement in landmine detection robot development with the developed methodology. This model is best suited for various surfaces to detect the destructive materials. The landmines can be demined by the robotic arm. The results proved that the developed model can be implemented for military application to safeguard the military authorities. The greatest advantage that this robot offers is the safety for the soldiers on war field. The usage of metal detector was also proved to be good, low cost and efficient for landmine detection. Huge investments on landmine detection can be reduced in the countries that are threatened by landmines. The robot is able to move in all the four directions using mobile keys and the landmine is detected using a metal detecting sensor placed on the robot. The proposed model can only detect the landmines which are metallic in nature and is unable to detect the non-metallic mines (plastic mines).

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