



Research Paper

AUTOMATIC LAND MINE DETECTION AND SWEEPER ROBOT USING MICROCONTROLLER

Bharath J^{1*}

*Corresponding Author: **Bharath J**, ✉ bharath.shivam@gmail.com

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 paper is to design a robot prototype which is capable of detecting buried land mines and changing their locations, 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 main advantage in this project is that we can make this robot at low cost and more efficient.

Keywords: Automatic Robot, Changing Place of Landmine, Landmine Detection, Microcontroller based Robot

INTRODUCTION

An automatic robot, which is capable of detecting buried landmines and taking from their locations, while enabling the operator to control the robot wirelessly from a distance (Minh Dao-Johnson Tran *et al.*, 2010). The detection of the buried mine is done by using metal detectors since most land mines contain metal components. The robot will travel in a straight line path. The system allows the operator to stay at a safe distance by enabling him to control the robot wirelessly or remotely (Kuo-Lan Su *et al.*, 2011). The

robot travels at ($2\pi \times$ (radius of wheel \times number of rotations)) 2.8 kilometer/hour. The robot detects landmine using metal detector. When the metal is detected, robot stops and move 100 mm distance and down the electromagnetic material and it gets magnetized and lift it up after attracting the landmine (Scott, 2007).

OBJECTIVES

Landmine Clearance

A land mine detection robot is needed to be designed to employ in peace support

¹ Department of Electronics and Communication Engineering, Sri Venkateshwara Institute of Science and Technology, Thiruvallur.

operations and in the clearance of contaminated areas.

Wireless Control

For the safety of the operator, the designed robot must be able to operate remotely (Kuo-Lan Su *et al.*, 2011); moreover, it is equipped with wireless data transmitting capabilities.

Low Cost and High Reliability

The robot can be constructed in low cost of some hundreds of US dollars and less complex with high reliable structure.

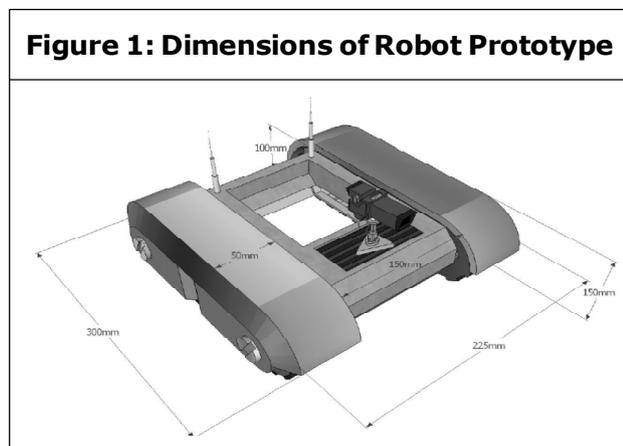


Figure 1: Dimensions of Robot Prototype

GENERAL BLOCK DIAGRAM OF ROBOTIC COMPONENTS

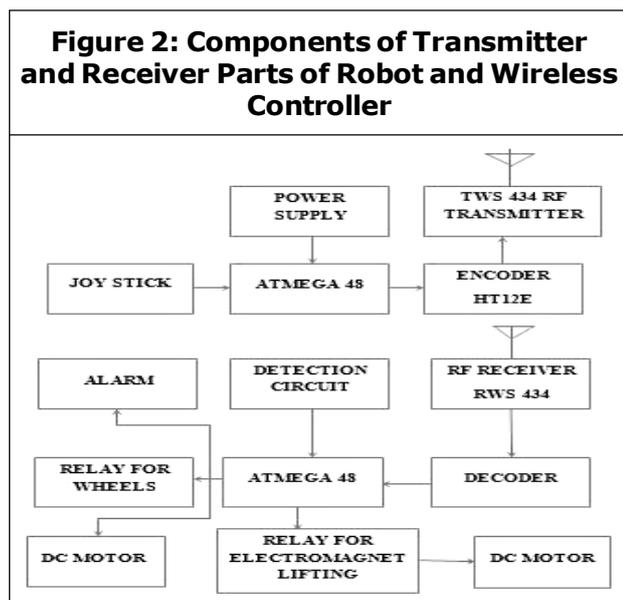


Figure 2: Components of Transmitter and Receiver Parts of Robot and Wireless Controller

COMPONENTS OF ROBOT AND ITS FUNCTIONS

Acrylic Sheets and Spacers

Acrylic sheet is used to construct the body of the robot. This material has unique physical properties and performance characteristics. Acrylic sheets are less in weight and highly durable. It is also an excellent insulator, so that the electronics and electrical parts of the robot are safe in terms of electrical hazards.

A spacer is a type of hardware, which is used to maintain space between two sheets in our robot. Spacer is used to maintain our robot stable on operation and we are using 3 mm bronze spacer and 150 mm aluminum spacer in our project.

DC Motors

Here, 30 rotations per minute (RPM) Centre Shaft Economy Series DC Motor are used and it is high in quality as well as low cost DC geared motor. The motor is DC type 4-12 Volts motor and gives 30 rotations per minute in 12 volts.

Wheels

Wheels are 109 mm Diameter x 21 mm Thick x 6 mm bore wheel is used.

Relays

By using relays we can control DC motor direction of rotation. So, by using series of relays we can control robot movement (Jaradat *et al.*, 2012).

Microcontroller

The ATmega8 is a low power Complementary Metal-Oxide Semiconductor (CMOS) 8-bit microcontroller based on the AVR enhanced RISC architecture used to control the operations of the robot.

Encoder

The HT-12E Encoder Integrated Circuits (IC) are series of CMOS Low Scale Integration (LSI) for remote control system applications of the robot. They are capable of Encoding 12 bit of information which consists of N address bits and 12-N data bits.

Decoder

The HT-12D Decoder ICs are series of CMOS LSIs for remote control system applications of the robot. The Decoder receive the serial address and data from its corresponding decoder, transmitted by a carrier using an RF transmission medium and gives output to the output pins after processing the data.

Colpitts Oscillator

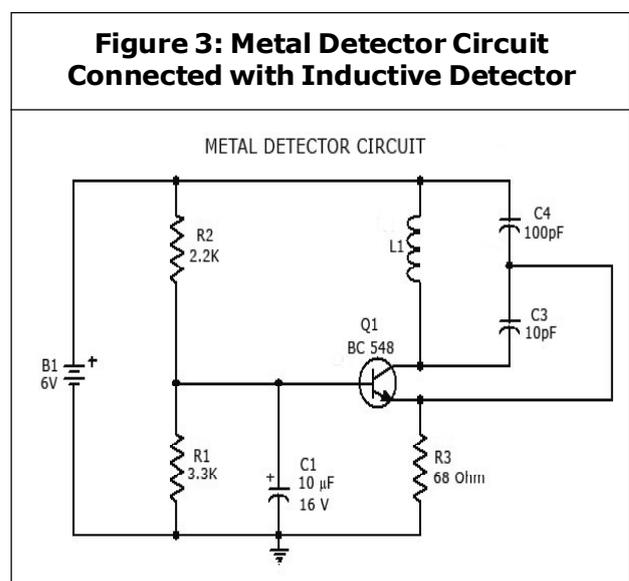
Colpitts oscillator with induction coil act as a metal detector circuit in the robot’s mine detection part. By using an inductor coil, we can detect presence of metal. When metal is kept near an inductor due to mutual inductance there will be change in frequency of oscillation (Scott, 2007). One of the advantages of this circuit is its simplicity; it needs only a single inductor. As a metal object is brought close to the inductor, the amplitude of the voltage across the tank circuit gradually begins to drop. Here, the feedback factor for the Colpitts is typically 0.1 to 0.5, or 10 to 50%. It has inductor constant value of 650henry. So the frequency of oscillation is approximately 2 kHz.

If the series combination of C1 and C2 creates the effective capacitance of the (inductance is L and Capacitance is C) LC tank circuit with one inductance, then the frequency of oscillation derived from the below equation.

$$f_0 = \frac{1}{2\pi \sqrt{L \cdot \left(\frac{C_1 \cdot C_2}{C_1 + C_2} \right)}}$$

Colpitts oscillator response to the signal from the detector coil based on mutual inductance. The signal frequency from the detector coil varies based on the contact with metal surface to activate the Colpitts oscillator to send voltage to the alarm unit.

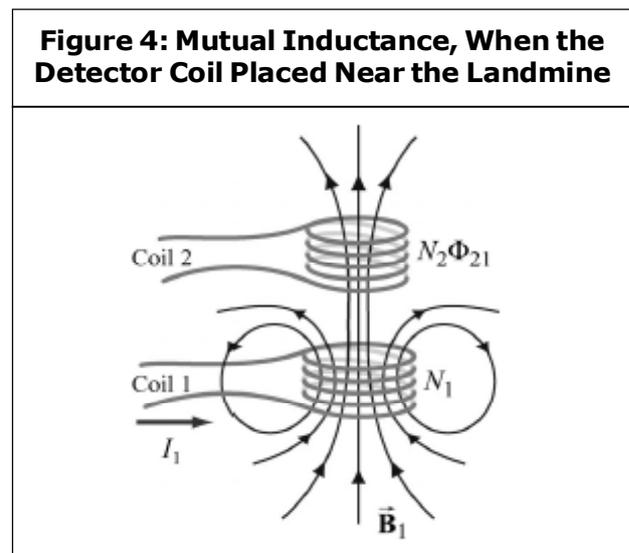
Figure 3: Metal Detector Circuit Connected with Inductive Detector



Mutual Inductance

Inductors generate an opposing voltage

Figure 4: Mutual Inductance, When the Detector Coil Placed Near the Landmine



proportional to the rate of change in current in a circuit. This property is called self-inductance. Suppose two coils are placed near each other, as shown in Figure 4. Changing current in coil 1 produces changing magnetic flux in coil. Mutual induction is current in one coil induces electromotive force (EMF) in other coil. Due to this property of inductance, when metal is kept near to the inductor it changes its value leads to change in operating frequency of Colpitts oscillator.

Controller Unit

Controller has joystick for their specific functions like forward, backward, up and downwards movement, with 2 buttons for lifting and dropping of electromagnetic material. When detection circuit detects the presence of metal it activates alarm and using control unit, so that activating the green button in the controller, we can down electromagnet near ground and lift inside the robot using red color button. We are using analog joystick, it gives analog signal for directions and microcontroller itself converts into digital and gives to encoder section.

Figure 5: Controller Unit



Using transmitter antenna, we transmit Amplitude Shift Keying (ASK) waves to receiver and signal can be decoded in decoder section in receiver. Joystick transmits 8-bit data and encoder converts into 4-bit data to microcontroller and transmitter IC converts parallel to serial data transfer to receiver.

RF Transmitter and Receiver

The RX-ASK is an Amplitude Shift Keying (ASK) Hybrid receiver module. It is an effective low cost solution for using 433 MHz's. The TX-ASK is an ASK hybrid transmitter module. TX-ASK are designed by the saw resonator, with an effective low cost, small size and simple to use for designing. The RF 433 is ideal for remote control applications where low cost and longer range is required.

The transmitter operates from a 1.5-12 V supply, making it ideal for battery-powered applications. The transmitter employs a saw-stabilized oscillator, ensuring accurate frequency control for best range performance.

Power Supply

A regulated power supply is obtained from the batteries attached in the robot. It provides 5-12 Volt supply of DC power.

Rectifier Circuit

A rectifier converts Alternating Current (AC), which periodically reverses direction, to Direct Current (DC), which flows in only one direction. The process is known as rectification. So that rectifier is used to convert the AC from the transmission lines to DC, which accepts by the electronic circuits used.

ICSP Connector

In System Programming (ISP) is a technique

where a programmable device is programmed after the device is placed in a circuit board. In-Circuit Serial Programming (ICSP) is an enhanced ISP technique implemented in Microchip's PIC micro On-Time-Programmable (OTP) and flash-Reduced Instruction Set Computing (RISC) microcontrollers (MCU). Use of only two input/output pins to serially input and output data makes ICSP easy to use and less intrusive on the normal operation of the microcontrollers. To interface with computer system and microcontroller, ICSP connector is used and also to load the program in microcontroller.

ROBOT'S OPERATION

The robot prototype placed in the field contains some landmine like metal bodies. When the detector contacts with the metal body, due to mutual inductance it activates the Colpitts oscillator to provide signal to the alarm unit. When the alarm signal is activated, the user having the controller unit press the loading button, so the robot moves some distance and down the electromagnetic material and it gets magnetized to attract the landmine without detonating it. As soon it attracts, it can be moved towards the users place using wireless controller. Then, the user pressed the unloading button to drop the landmine so that user can diffuse it safely.

PROGRAMMING SECTION

The tool used to program the microcontroller is codewizard AVR studio.

An Example Program for Transmitter

```
#include <avr/io.h>
```

```
#include <util/delay.h>
```

```
#include <math.h>
#define F_CPU 16000000;
void main()
{
  DDRA = 0x00;
  PORTA = 0x00;
  DDRD = 0xff;
  PORTD = 0x00;
  while(1)
  {
    int i;
    /*Manual Mode */
    if(PORTA == 0x00)
    {
      PORTD=0001;
    }
    if(PORTA == 0x02)
    {
      PORTD=0010;
    }
    if(PORTA == 0x04)
    {
      PORTD=0100;
    }
    if(PORTA == 0x08)
    {
      PORTD=1000;
    }
  }
}
```

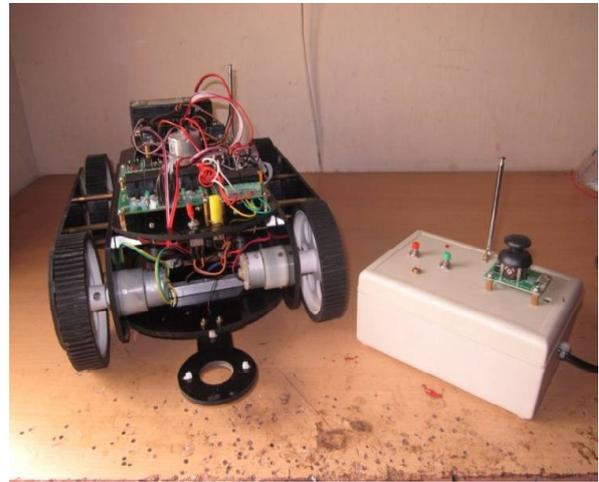

be used to avoid these problems.

- Since this prototype wireless communication is limited to some 100 meters distance. But the wireless range can be extended by adding highly developed wireless controllers in the robot.
- The detection coil unit is in fixed place in this robot prototype. So implementing a servomotor connection with the detection unit makes it to cover overall forward distance of the robots structure by implementing right/left movements in the detection coil.
- In case of plastic landmine detection, the detector can be replaced by ground penetrating radar or other detection mechanism.
- Camera can be installed in the robot to survey the minefield and gives report to the user or human controller.
- Wheels size should be increased to upload the landmine from the actual mine fields. We can install shock absorbers and adjusters to the wheel unit, so that it can run on any landmine field.

CONCLUSION

In the present investigation of the current prototype of automatic landmine detection and sweeper robot has been presented and it can be built using some hundreds of US dollars. So huge investments on landmine detection can be reduced in the countries are threatened by landmines. This prototype provides less complex structure and reduced the cost to build a landmine detection robot. It detects the uneven landmines present under the ground

Figure 6: Prototype of Automatic Landmine Detection and Sweeper Robot



and generates alarm to the user and successfully changes the place of landmine by taking safely from one place to another, without hazard of explosion. 🌀

ACKNOWLEDGMENT

I would like to convey my thanks to Mr. Lakshmi Narayanan, Mr. Vinoth Kumar, Mr. Suresh, Mr. Naresh and all of my college staffs for their support to complete my research work. I like to convey my special thanks to my parents for supporting to build this prototype and successfully completing this research paper.

REFERENCES

1. Jaradat M A, Bani Salim M N and Awad F H (2012), "Autonomous Navigation Robot for Landmine Detection Applications", 8th International Symposium on Mechatronics and its Applications (ISMA), April, pp. 1-5.
2. Kuo-Lan Su, Hsu-Shan Su, Sheng-Wen Shiao and Jr-Hung Guo (2011), "Motion Planning for a Landmine-Detection

- Robot”, *Artificial Life and Robotics*, Vol. 16, No. 3, pp. 277-280.
3. Minh Dao-Johnson Tran, Canicious Abeynayake, Lakhmi C Jain and Lim C P (2010), “An Automated Decision System for Landmine Detection and Classification Using Metal Detector Signals”, *Innovations in Defence Support Systems*, Vol. 304, No. 1, pp. 175-200.
 4. Scott W R (2007), “Broadband Electromagnetic Induction Sensor for Detecting Buried Landmines”, *Geoscience and Remote Sensing Symposium*, Vol. 99, July, pp. 22-25.