UNDERGROUND CABLE FAULT DETECTION ROBOT

[1]Shivang Tiwari, [2]Anand T. Bharne, [3]Mukul Verma, [4]Adarsh Nagar, [5]SHRIPAD G. DESAI

[1]B. Tech Student, [2]B. Tech Student, [3]B. Tech Student, [4]B. Tech Student, [5]Assistant Professor

[1]Department of Electrical Engineering,
[1]Bharati Vidyapeeth Deemed (to be) University College of Engineering, Pune, India

Abstract: The trend of underground cables become very popular now a day. Mostly all the companies prefer laying the cables underground because of adverse conditions of weather. Although there are some challenges to laying the cable underground and once laid it is very difficult and costly to detect the exact location of the fault. This paper is about a device that is designed by us which is capable of finding where the fault is, so the engineer can directly get the hole dug at that point and fix the issue. This device is worked under the ELECTROMAGNETIC PRINCIPLE. Using a SIGNAL INJECTOR, a high frequency signal is passed through the wire and the induced magnetic field is used to detect the fault.

Keywords – Electromagnetic Principle, Signal Injector.

I. INTRODUCTION

This project is fully based on principle of Faraday's law of Electromagnetic Induction, if the current is flowing through a wire due to the cause of that current a magnetic flux will be generated around it and mutual induced EMF would be generated, through that EMF we could able to drive motor and detect the exact location of the fault [3].

Now our robot has some features like that which has ability to detect the exact location of the fault. For more reliability we can include some other instruments like video cam, remote navigation, odometer etc. So that the observer can control and monitor the robot from the control room as well.

Most part of the world gets now shifted towards underground cables, from the given data [8] in Germany 73% of the medium voltage cables are underground and 87% of low voltage cables are underground. Since the more extend of underground cable makes it complex during faults. Currently in the most part of the world we still digging out and find the location of the fault manually which is very long process as well as costly. A cable fault can be defining as the short circuit fault or a breakage of the cable that highly effects the performance of the cable. But in our case we can detect the open circuit faults which is very usual in underground cables.

II. PROPOSED SYSTEM

There are basically two stages:

First stage consists a signal generating circuit in which we will give DC supply of 12V given to a ASTABLE Multivibrator HCF4047BE which produces high frequency AC signals through MOSFET [5].

Second stage consists a dynamic part made up of wooden material which makes it very light and work efficiently, in this part we are using two DC motors (100 rpm, 12V, 1-2A) drive with motor driver (LM293D) which is connected through the PIC18F4550 microcontroller connected with supply of 5V DC. In the bottom part of this dynamic device we use a magnetic coil which detect the magnetic field around it. When we provide AC signal in the faulty cable through signal generating circuit, then our robot which is laying onto the surface approx. 5-6 cm above form the cable can detect the high signal through a magnetic coil and further pass it to the microcontroller, which provide sufficient voltage to the motor driver and then our robot will move in forward direction. Wherever the cable is broken our robot will be stop on that location because of low voltage across it.

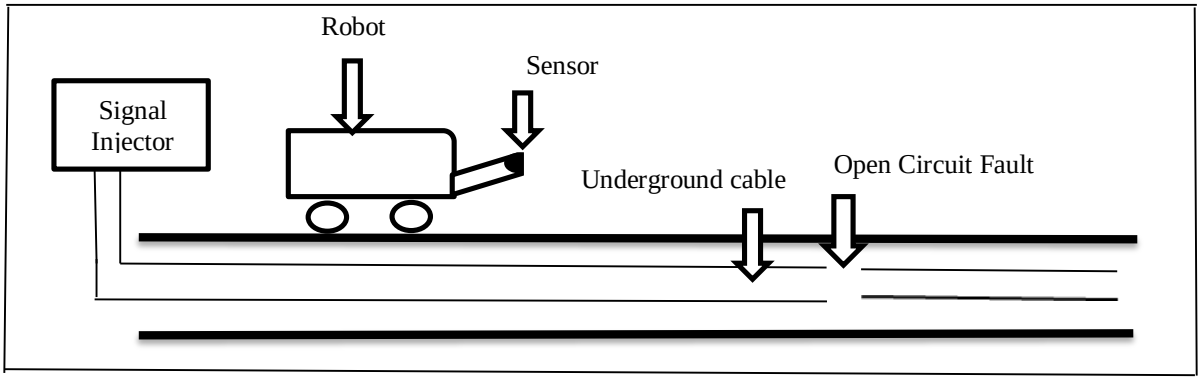

Fig 1: Schematic Representation

III. COMPONENTS

A. *Signal Injector:*

The signal injector is used to generate high frequency voltage signal (30 KHz) using a HCF4047BE multi vibrator circuit. Here the MOSFET does not gets hot easily, and the Diodes IN4148 provides protection of the circuit in case of MOSFET leakage. A LED is added for easy diagnostics.

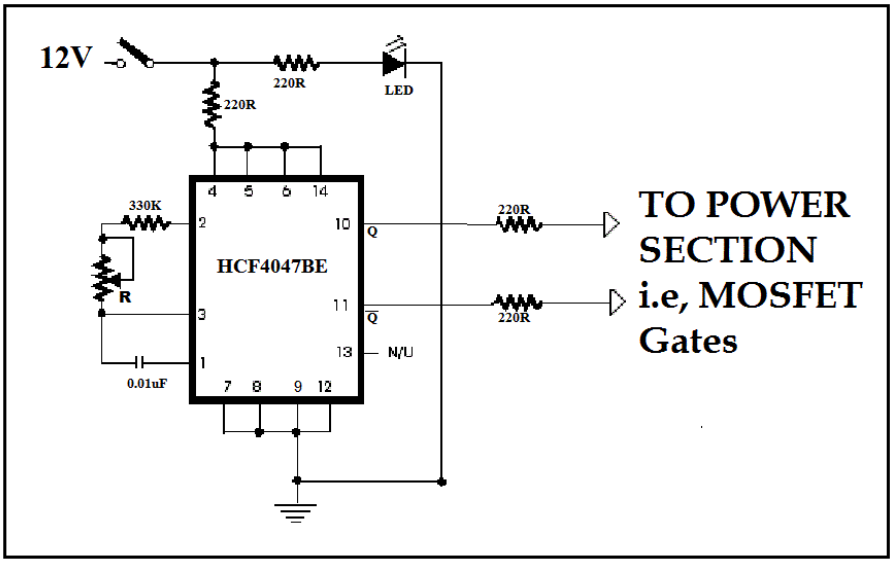

Fig 2: Signal Injector Circuit

B. *Wire Detector (CD4017):*

When we hold the sensor (metallic conductor or copper wire) close to the live wire, electric field from mains activates the circuit. As the input impedance of the CMOS IC is high, the electric field induced in the sensor is sufficient to clock it. The output obtained at pin 11 of CD4017 drives the LED. Flashing of the LED2 indicates the presence of mains, while LED1 indicates that the scanner is active.

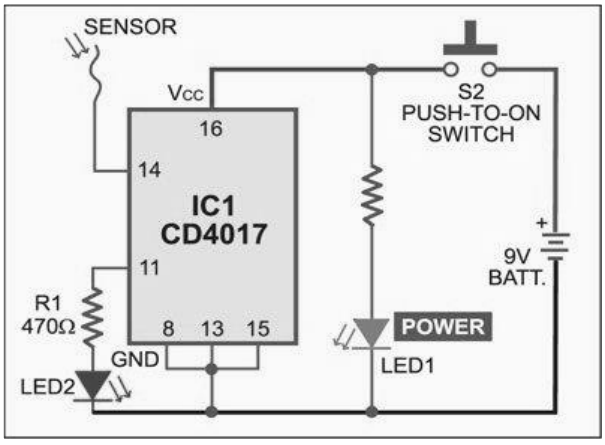

Fig 3: Wire Detector Circuit

C. *PIC 18F4550:*

PIC18F4550 is an 8-bit microcontroller of PIC18 family. PIC18F family is based on 16-bit instruction set architecture. PIC18F4550 consists of 32 KB flash memory, 2 KB SRAM and 256 Bytes EEPROM.

D. *DC Motor:*

In this project we are using Brushless DC motor to minimize the heat in the rotor part of the motor and that will increase the motors life.

E. *Microcontroller Circuit:*

This circuit estimates motor interfacing to the microcontroller with the help of L293D motor driver. Pin 19 connects oscillator circuit to the microcontroller and we given the supply of 5V from the PIN 31.

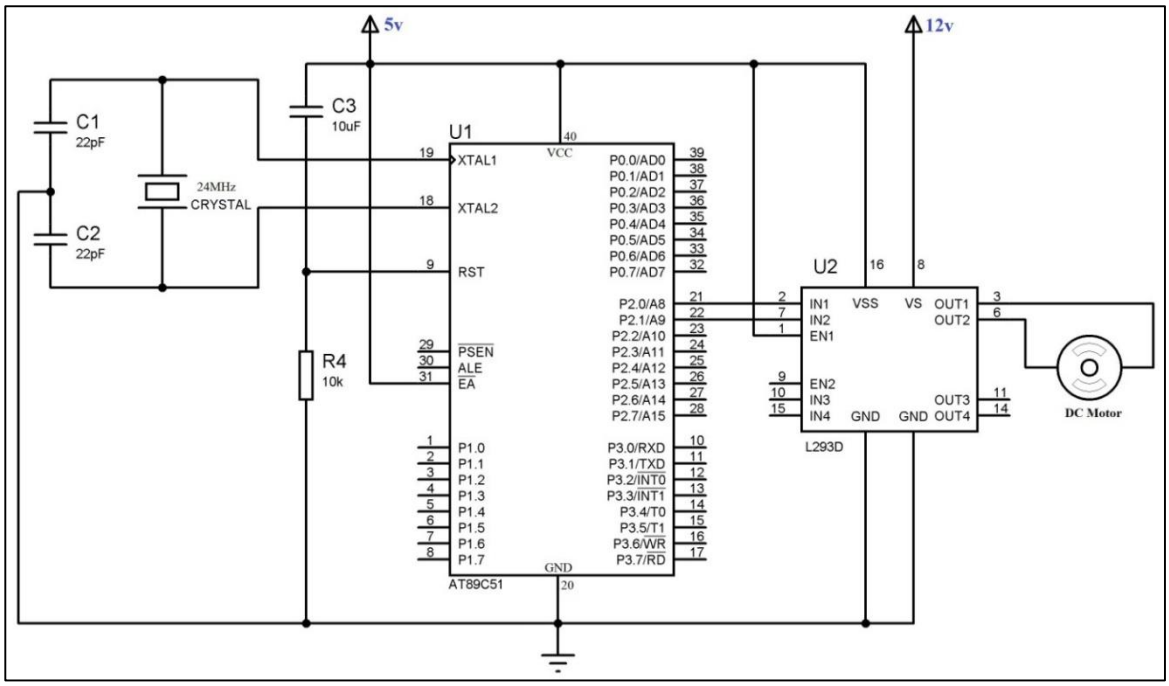

Fig 4: Microcontroller Circuit

F. Motor Driver (L293D):

In the field of Robotics, the control of motor is very crucial which varies according to type of DC motors (a small plastic gear motor or a large metal gear motor). We make use of plastic gear motor in which its rotation is controlled with a L293D motor driver IC and that allows the motor to rotate in both the direction. Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors.

L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction. The motor operations of two motors can be controlled by input logic at pins 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively.

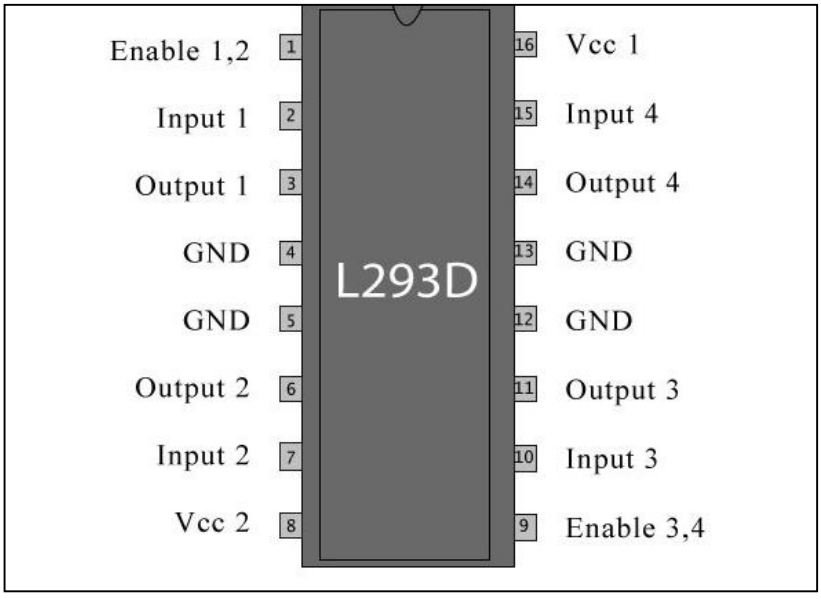

Fig 5: Pin diagram of L293D

IV. WORKING PRINCIPLE

The working of this project is very simple, we set the PINS in the microcontroller circuit on the basis of sensors rating, as a prototype we consider a low rating wire with a voltage rating between 50 to 1000V for alternating current. Since for high tension cable we need bulkier robot but this is just a model that's why we built a small sensing robot.

The main aim of the robot is designed for open circuit detection, the robot is made over the surface where all the cables are laid underground, considering low rating wire we set the gap about 3-4 cm form the surface to the wire. When we start generating the high frequency signals from signal generating circuit, the magnetic field will be induced across the wire but at the point where the wire is broken there will no sufficient voltage to induce the magnetic field. As the electric field induced in the sensor is sufficient to clock the CD4017 HIGH and the wire sensor gives the HIGH input to the microcontroller which further clock the

motor driver and the robot moves in forward direction, if the wire is broken the sensor will stop sending the input to the microcontroller and the motor will stop at that point, which further trigger the buzzer and the personnel get aware of the exact location of the fault [4].

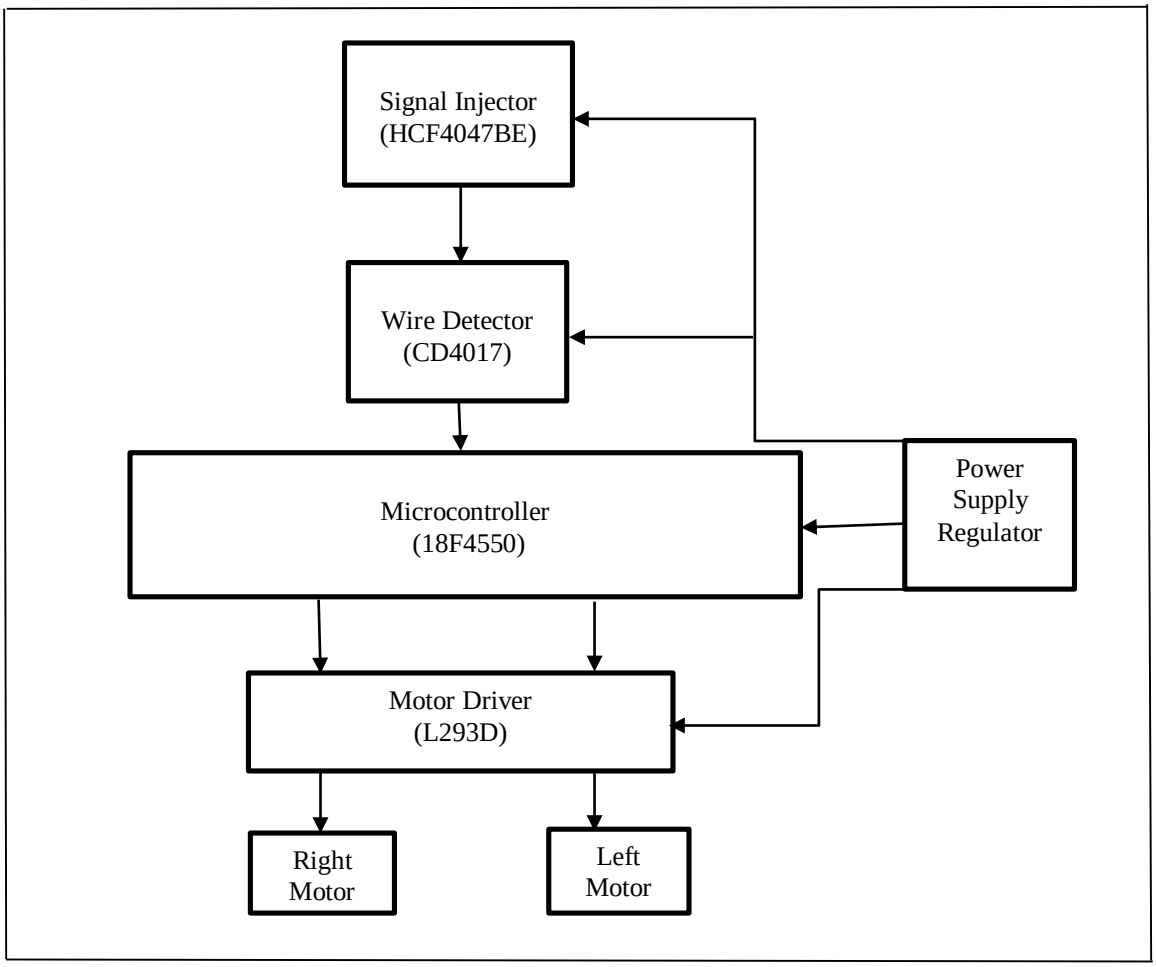

Fig 6: Block Diagram

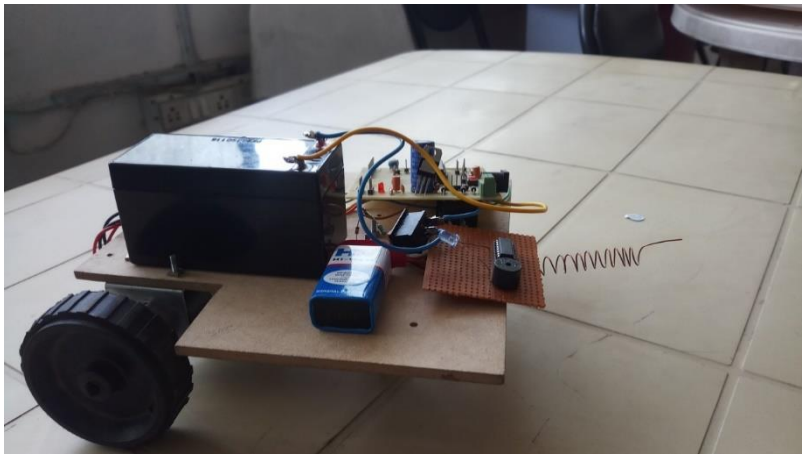

Fig 7: Side view of the Robot

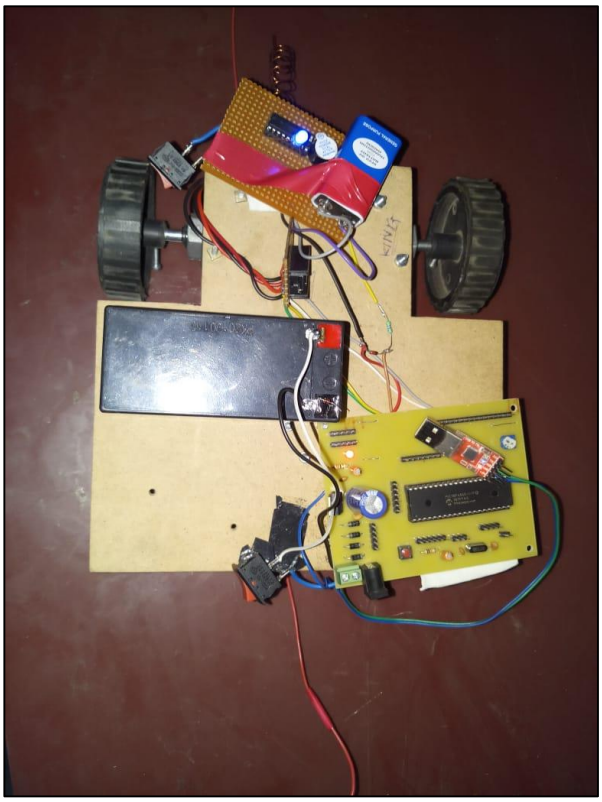

Fig 8: Upper View of the Robot

V. RESULTS AND DISCUSSION

From the Underground cable fault detection robot, we found that the Inductor coil sensor detects the fluctuations from the supply and perform to operate at an ADC value '0581' (i.e. 2.5V). This is the minimum required value for the robot to operate & sense the fault. As the wire detector sense the value in analogue so we need to convert it in binary also with the help of Hercules software, we interface the wire detector circuit to the computer and observe the binary value through Hercules software.

As the supply is AC in nature, the signal oscillates between 0000 – 0581 (ADC value's) and the motor runs. At point where there are no fluctuations (i.e. discontinuity of supply) the ADC value read is '0000' in which the motor stops & that point is treated as a fault point.

Readings Obtained

NATURE OF SUPPLY	VOLTAGE SENSED	MICROCONTROLLER READ VALUE	OPERATING CONDITION
AC	0 V	0000	OFF
	2.5 V	0581	ON

VI. ACKNOWLEDGMENT

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VII. CONCLUSION

The aim of the project is realized by testing the inspection of a mobile robot in a virtual environment conducive in producing real time operating atmosphere of an underground cable which can accurately spot the fault point. The wastage of time and money in digging out the cable and then clear the fault is very complicated, but from our robot we easily deal with this type of situations and also it is very reliable and cost effective.

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