PROJECT REPORT

TITLE : UNDERGROUND CABLE FAULT DETECTOR

COURSE : CONTROL SYSTEMS

COURSE CODE : ECE2010

SLOT : F2+TF2

SUBMITTED BY

DIPENDU HAZRA

REGD. NO. – 20BEC0592

PROJECT SUPERVISION

PROF. BAGUBALI A

DECLARATION

We hereby declare that the Project report entitled "Underground Cable Fault Detector" has been written by us as part of our coursework during the Fall Semester 2022-23 under the guidance of Dr. Bagubali A, Department of Electronics and Communication Engineering, Vellore Institute of Technology, Vellore. We further declare that the work reported in this report has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university.

DIPENDU HAZRA

(20BEC0592)

TABLE OF CONTENTS

ABSTRACT

Underground cables have been widely used with the development of the power system grid. Underground cables are prone to a wide variety of faults due to underground conditions, wear and tear, rodents etc. Also detecting fault sources is difficult and the entire line is to be dug in order to check the entire line and fix faults. In the urban areas, the electrical cables run underground instead of overhead lines. Whenever the fault occurs in underground cable it is difficult to detect the exact location of the fault for the process of repairing that particular cable.

The project is intended to detect the location of faults in underground cable lines from the base station in kilometres using an Arduino board. This project uses the standard concept of Ohms law.

ACKNOWLEDGEMENT

I am highly indebted to Dr. Bagubali A for his guidance and constant supervision as well as for providing necessary information regarding the project & also for his support in completing the project.

It is my privilege to express my sincerest regards to my project coordinator Dr. Bagubali A for valuable inputs, guidance, encouragement, whole-hearted cooperation and constructive criticism throughout the duration of my project.

I would like to express my gratitude towards my parents & VIT University for their kind co- operation and encouragement which helped me in completion of this project.

OBJECTIVES

My main objective is to determine the distance of underground cable faults from the base station in kilometres. I will make a prototype (a model) that makes it easy to determine the location of faults in underground power lines.

Many time faults occur due to construction works and other reasons. Cables do have some resistance. So, I are mainly focussing on that resistance, as resistance can vary with respect to the length of the cable.

INTRODUCTION

Power Transmission, an immense way to transmit data or energy from its place of generation to a location where it is applied to perform useful work. Power Transmission can be done in both overhead as well as in underground cables. Unlike underground cables, the overhead cables have the drawback of being easily prone to the effects of rainfall, snow, thunder, lightning etc. As a reason underground cable are preferred in many areas especially in urban areas.

They have reduced maintenance and operating costs such as lower storm restoration costs. Also, underground cables eliminate the menace of wind-related storm damage. They are not subjected to destruction caused by flooding which usually spoils and interrupts electric service. They ensure fewer transitory interruptions through trees falling on wires or electric poles falling down thereby improving public safety. Life-wire contact injuries are drastically reduced. It leads to the elimination of unattractive poles and wires on the streets thereby enhancing the visual range of the drivers and pedestrians on the streets.

Here in this project, I used OHM’s Law which is R = V/I to detect the underground fault in which each cable is taken as a combination of four resistors. I also used three relays to show three different lanes of the cables. An LCD was used for displaying the fault. I have done the short circuit part of the circuit. This can also be done by using the open circuit concept.

LITERATURE SURVEY

S. no.	Author name	Tile	Year of publication	Journal name	Inference
1.	Roshani Shingrut , Shubham Shelar , Dakshata Mokal, Shekar Mhatre , Dr. Sharvari Sane	Underground Cable Fault Detection	2020	International Journal of Engineering Research & Technology (IJERT)	The project determines the distance of underground cable fault from base station in Km using Arduino uno.
2.	Emmanuel Gbenga Dada, Abdulkadir Hamidu Alkali, Stephen Bassi Joseph, Umar Abba Sanda	Design and Implementation of Underground Cable Fault Detector	2019	International Journal of Science and Engineering Investigations	This paper presents a novel underground Cable fault detector that has the capacity to measure the resistance of the cable, detect the type of fault in a cable, and also accurately compute the location of the fault using cheap materials.

S. No.	Author name	Title	Year of publication	Journal name	Inference
3.	B.Bhuvneshwari , A.Jenifer, J.John Jenifer, S.Durga Devi and G.Shanthi	Underground Cable Fault Distance Locator	2017	Asian Journal of Applied Science and Technology (AJAST)	The hardware model of Underground Cable Fault Locator is implemented and favorable results were brought forward. This hardware model can locate the exact fault location in an underground cable.
4.	M. Supriya, R. N. Abdur, V. Harikrishna, N. Anupriya and K. Preetha	Underground Cable Fault Detection	2022	International Conference on Communication, Computing and Internet of Things (IC3IoT)	The hardware model can locate the exact fault location in an underground cable. Utilizing the ESP8266 Wi-Fi module, IoT is utilized to show data over the Internet. The data concerning the event of the imperfection is shown in a website page created with HTML code.
5.	R. M. Asif, S. R. Hassan, A. U. Rehman, A. U. Rehman, B. Masood and Z. A. Sher	Smart Underground Wireless Cable Fault Detection and Monitoring System	2020	International Conference on Engineering and Emerging Technologies (ICEET)	The Fault is not only detected but also located at the exact location and has been shown on website “Things peak”.

S. No.	Author name	Title	Year of publication	Journal/Conference name	Inference
6.	Samruddhi Ghadage, Neha Jadhav, Rutuja Supnekar , Pratiksha Tulsankar	Underground Cable Fault Detection Using Arduino	2022	International Research Journal of Engineering and Technology (IRJET)	This paper uses the concept of Ohm's law so that we can locate the fault. In this project, the Mega 328 microcontroller is used to identify the location in kilometers from an underground cable break from a base station to a short circuit failure.
7.	Laxmi Goswami, Manish Kumar Kaushik, Rishi Sikka, Vinay Anand, Dr. Kanta Prasad Sharma, Madhav Singh Solanki	IOT Based Fault Detection of Underground Cables through Node MCU Module	2020	International Conference on Computer Science, Engineering and Applications (ICCSEA)	In the proposed effort the difficulty of detecting the fault in underground lines is done on the basis of Node MCU Wifi Module.

S. No.	Author name	Title	Year of publication	Conference name	Inference
8.	T. N. Aminu, N. A. Algeelani, S. A. Algailani and A. Ahmed Salem	Arduino based Underground Cable Fault Distance Locator: Hardware Design	2021	International Conference on Smart Computing and Electronic Enterprise (ICSCEE)	They have designed and implemented an underground cable fault locator using Arduino Uno as the microcontroller. Software simulation is also done in Proteus software using Arduino Uno as the microcontroller. The hardware design can detect short circuit fault in underground cables at 1km, 2km, 3km and 4km from the base station.
9.	A. Pandey and N. H. Younan	Underground cable fault detection and identification via fourier analysis	2010	International Conference on High Voltage Engineering and Application	They have done underground cable fault detection and identification via fourier analysis. Accordingly, Fourier type methods can be effectively used as low cost and viable solutions to identify and detect faults in underground cables.

PROBLEM STATEMENTS

1. Reference [8] have designed and implemented an underground cable fault locator using Arduino Uno as the microcontroller. Software simulation is also done in Proteus software using Arduino Uno as the microcontroller. The hardware design can detect short circuit fault in underground cables at 1km, 2km, 3km and 4km from the base station. I will try to design a system which can detect the short circuit fault in 3 cable lines simultaneously at 2km, 4km, 6km, and 8km from the base station. I will try to increase the dimensionality of the system by interfacing a RGB LED with the Arduino Uno to produce green light in case none of the cable is faulty and to produce red right when at least one of the cable is faulty.
2. Reference [6] has designed an underground cable fault detector using Arduino Uno to detect the short circuited fault in underground cables. Their work is only simulation as no design and construction work is involved. I will try to implement the hardware of the underground cable fault detector using Arduino Uno. I will try to develop the system to detect underground cable fault in multi-wired cables.
3. Reference [2] has designed, implemented a microcontroller based underground cable fault detector. Their proposed method can detect both open and short circuit fault in underground cables with a maximum distance of 2km. I will try to design and implement a system, which can successfully detect short circuited fault in underground cables. My system should be able to detect the fault in three cables simultaneously. I will try to locate the underground short circuited fault in cables with a maximum distance of 8 km from the base station. I will interface a RGB LED with the Arduino Uno, to produce green light in case none of the cable is faulty and to produce red right when at least one of the cable is faulty. I will interface a buzzer with the Arduino Uno to produce beep sound as output whenever there is a short circuited fault in at least one of the three cables.
4. Reference [9] have done underground cable fault detection and identification via fourier analysis. Accordingly, Fourier type methods can be effectively used as low cost and viable solutions to identify and detect faults in underground cables. But, it is very complicated process and also time consuming. It also depends on the robustness of the system. So, I will design a system which can easily detect the short circuited fault in three cable lines simultaneously with higher accuracy and better efficiency than the system mentioned under ref. [8]. Also, my proposed system is based on ohm's law, which makes my system easier to understand and implement and also less complicated.

REQUIREMENTS

1.HARDWARE:

a. **Arduino Uno:**
The Arduino UNO is a microcontroller board based on the ATmega328P. It has 20 digital I/O pins, a 16Mhz resonator, a USB connection, a power jack, an in-circuit system programming header, and a reset button.

b. **4 channel relay kit:**
A relay is an electrically operated switch. When the circuit of the relay senses the fault current, it energizes the electromagnetic field which produces the temporary magnetic field. As the current flows through the coil, it produces the magnetic field around it which attracts a lever and changes the switch contacts. The coil current can be on or off, so relays have two switch positions and have single pole double throw switch contacts.
A relay driver is a monolithic high voltage and high current Darlington transistor array which consists of 7 NPN Darlington pairs that features high-voltage output with common cathode clamp diode for switching inductive loads. It is used as an inverter.
I have used the 3 relays from the 4 channel relay kit and connected each relay to one cable wire. I have used relay to separate the faulty line from the non-faulty line. Basically, relays are used to represent the phases of the cable.

c. **LCD display:**
It is connected to the Arduino. It displays the distance at which the fault in the underground cable line has occurred.

d. **Resistors:**
I used resistors here as the fault when the circuit is shorted. Here, all the resisters are of 1kΩ.

e. **RGB LED:**
It is interfaced with the Arduino Uno to produce green light in case none of the cable is faulty and to produce red right when at least one of the cable is faulty.

f. **Switches :**
Switches are used for the short circuiting the circuit (stopping the current flow). They are used as fault creators.

g. **Buzzer:**
I have interfaced a buzzer with the Arduino Uno to produce beep sound as output whenever there is a short circuited fault in at least one of the three cables.

h. **Breadboard**

i. **Jumper wires**

j. **10kΩ preset :**
It is required to adjust the contrast in the LCD screen.

k. **Arduino Uno USB cable**

2.SOFTWARE:

ARDUINO IDE

BLOCK DIAGRAM

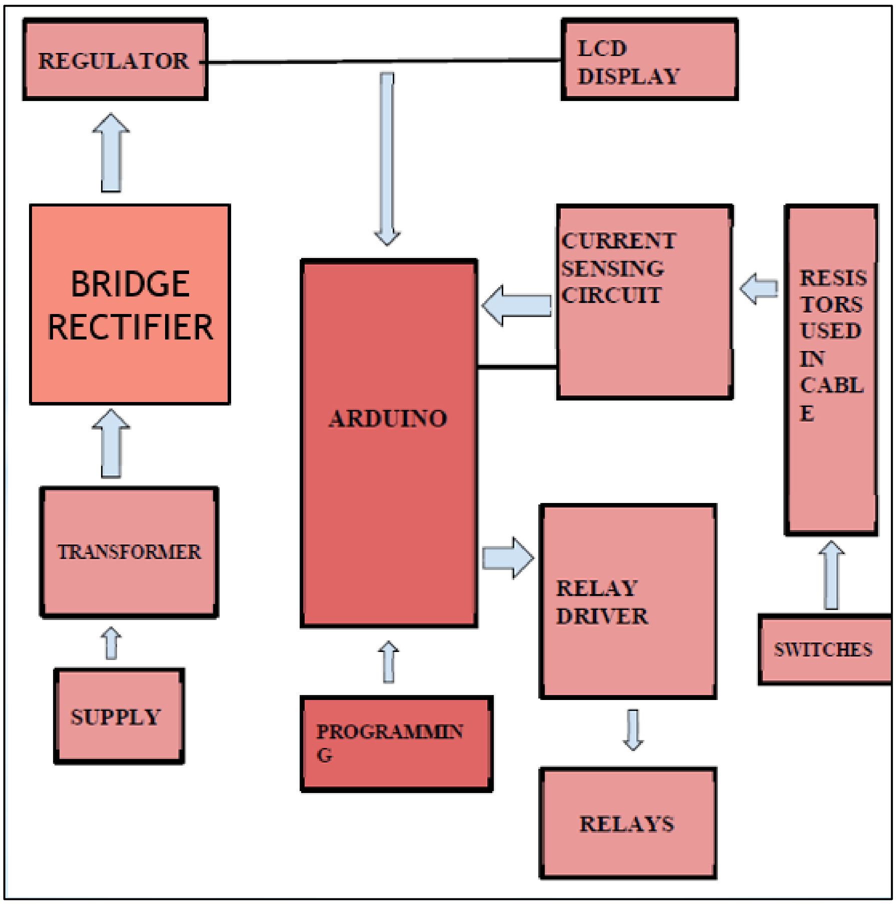


FIGURE 1 - SYSTEM MODEL

BLOCK DIAGRAM DESCRIPTION

This is proposed model of underground cable fault distance locator using microcontroller. It is classified in four parts –DC power supply part, cable part, controlling part, display part.

DC power supply part consist of ac supply of 230V is step-down using transformer, bridge rectifier converts ac signal to dc & regulator is used to produce constant dc voltage.

The cable part is denoted by set of resistors along with switches. Current sensing part of cable represented as set of resistors &switches are used as fault creators to indicate the fault at each location. This part senses the change in current by sensing the voltage drop.

Next is controlling part which consist of inbuilt analog to digital convertor which receives input from the current sensing circuit, converts this voltage into digital signal. The microcontroller also forms part of the controlling unit and makes necessary calculations regarding the distance of the fault. The microcontroller also drives a relay driver which in turn controls the switching of a set of relays for proper connection of the cable at each phase.

The display part consists of the LCD display interfaced to the microcontroller which shows the status of the cable of each phase and the distance of the cable at the particular phase, in case of any fault.

GENERIC CIRCUIT DIAGRAM

This circuit is used to develop the hardware setup of the project.

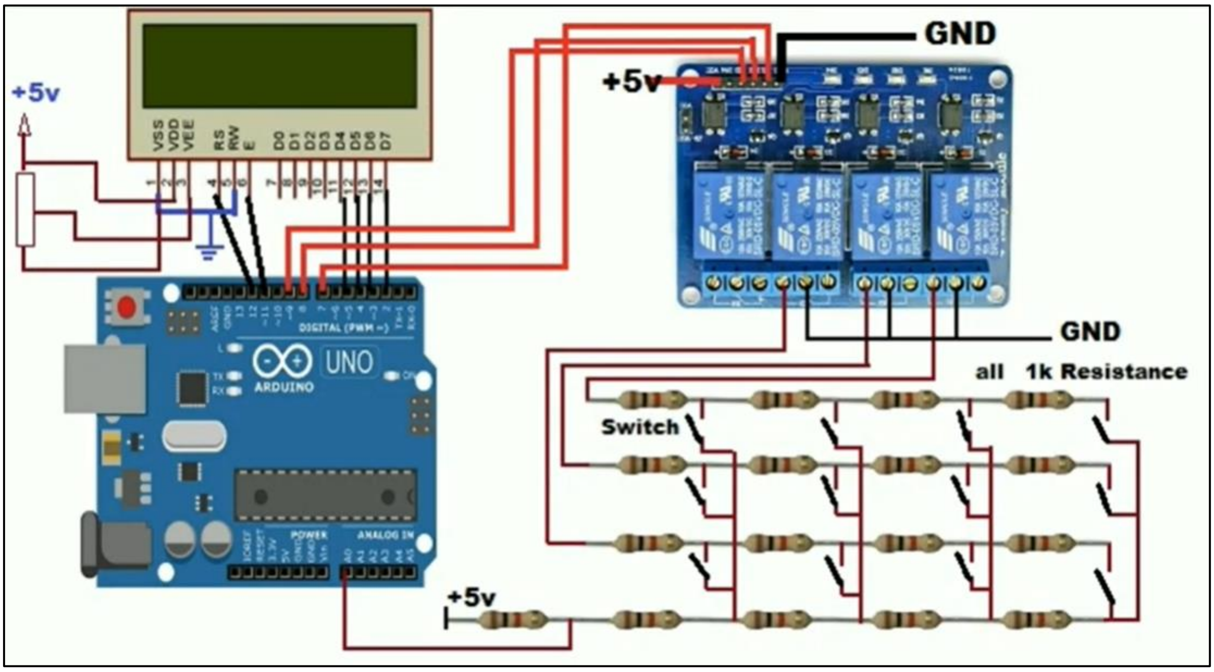


FIGURE 2 – CIRCUIT DIAGRAM

METHODOLOGY

- Cable faults are damage to cables which affect a resistance in the cable. If allowed to persist, this can lead to a voltage breakdown.
- In this project simple OHM's law is used to locate the short circuit fault. A DC voltage is applied at the feeder end through a series resistor, depending upon the length of fault, the cable current varies.
- The voltage drop across the series resistor changes accordingly, this voltage drop is used in determination of fault location.
- In case of a short circuit (line to ground), the voltage across the series resistors changes which is then fed to an ADC, to develop a precise digital data that gets displayed on the LCD.

WORKING PRINCIPLE:

Generally, 3 types of cable faults are possible:

1. Open circuit fault

2. Short circuit fault

3. Ground contact

As the odds of short circuit fault (SC fault) are more likely to happen, I have simulated this part in the circuit.

As the cable is a conductor, it exhibits all resistive, conductive, capacitive, and inductive properties along the length of the cable. So, to avoid complex circuitry, we chose to represent a cable as a series of resistors.

There are 3 relays (phases), each phase connected to one cable containing a set of 4 resistors.

Let's say, cable from 1st phase (Next to the relay kit) as C1; similarly, C2 of 2nd phase and C3 of 3rd phase. I have used red wire for C1, blue wire for C2 and yellow wire for C3.

To show the location of the fault in the simplest way, I opened all switches, so the current will follow each cable individually with respect to phases (current follows a long path). Also, I instructed the controller, to assign the first switch (S1) of every cable (near to phase) as at a location of 2Km, Switch 2 (S2) at location of 4 Km along the cable; S3 at 6 Km; S4 at 8 Km.

In figure 2, cable 1 is near to the 4 channel relay kit, followed by cable 2 and cable 3. To each cable, 4 switches are connected to create a short circuit fault at 2km , 4km , 6km and 8km from the base station. S1 corresponds to the switch at the beginning of the cable and is used to create a short circuit fault at 2km from the base station. It is followed by S2 to create a short circuit fault at 4km from the base station. It is followed by S3 to create a short circuit fault at 6km from the base station. It is followed by S4 to create a short circuit fault at 8km from the base station. In the same way, 4 switches are connected to cable 2 and cable 3.

The output of the cable network is fed to the A0 pin of the Arduino Uno. This output is further processed in Arduino ide software to produce the desired output.

ALGORITHM OF ARDUINO IDE CODE

1. Start the process.
2. Include the library file for the LCD.
3. Initialize the library with the numbers of the interface pins.
4. Define phase control pins corresponding to the pin of the Arduino Uno to which the input pins of relay kit is connected.
5. Define buzzer as 6 as the positive terminal of buzzer is connected to D6 pin of Arduino Uno.
6. Define red as 13 as the R pin of the RGB LED is connected to D13 pin of Arduino Uno.
7. Define green as 10 as the G pin of the RGB LED is connected to D10 pin of Arduino Uno.
8. Declare a function "distance" with input parameter as "inputvoltage" and return type int.
9. If "inputvoltage" is greater than 890 and less than 920, return 8.
10. If "inputvoltage" is greater than 850 and less than 890, return 6.
11. If "inputvoltage" is greater than 750 and less than 850, return 4.
12. If "inputvoltage" is greater than 600 and less than 750, return 2.
13. If none of the conditions are satisfied, else return 0.
14. End the distance function.
15. Declare a setup function with return type void.
16. Set the LCD's number of columns as 16 and no. of rows as 2.
17. Configure buzzer, red, and green as output.
18. Configure the 3 phases of the relay as output.
19. End the setup function.
20. Declare a loop function with return type void.
21. Give digital low pulse to 1st phase of the relay kit.
22. Give a delay of 500 ms.
23. Define a variable dist1 and store the value return by the distance(int) function by sending the analog value read by the A0 pin of the Arduino Uno as an input parameter to the distance(int) function.

24. If dist1 is equal to 0, set the LCD cursor at (0,0) position; Use lcd.write() to write “R:” in the LCD screen.; Set the LCD cursor at (3,0) position and write “NF”, which indicates no fault.
25. If dist1 is not equal to 0, set the LCD cursor at (0,0) position; Use lcd.write() to write “R:” in the LCD screen.; Set the LCD cursor at (3,0) position and print dist1 value in the LCD screen; Now, set the LCD cursor at (4,0) and write “KM” .
26. Give digital high pulse to the 1st phase of the relay kit.
27. Give digital low pulse to 2nd phase of the relay kit.
28. Give a delay of 500 ms.
29. Define a variable dist2 and store the value return by the distance(int) function by sending the analog value read by the A0 pin of the Arduino Uno as an input parameter to the distance(int) function.
30. If dist2 is equal to 0, set the LCD cursor at (8,0) position; Use lcd.write() to write “B:” in the LCD screen.; Set the LCD cursor at (11,0) position and write “NF”, which indicates no fault.
31. If dist2 is not equal to 0, set the LCD cursor at (8,0) position; Use lcd.write() to write “B:” in the LCD screen; Set the LCD cursor at (11,0) position and print dist2 value in the LCD screen; Now, set the LCD cursor at (12,0) and write “KM” .
32. Give digital high pulse to the 2nd phase of the relay kit.
33. Give digital low pulse to 3rd phase of the relay kit.
34. Give a delay of 500 ms.
35. Define a variable dist3 and store the value return by the distance(int) function by sending the analog value read by the A0 pin of the Arduino Uno as an input parameter to the distance(int) function.
36. If dist3 is equal to 0, set the LCD cursor at (0,1) position; Use lcd.write() to write “Y:” in the LCD screen.; Set the LCD cursor at (3,1) position and write “NF”, which indicates no fault.
37. If dist3 is not equal to 0, set the LCD cursor at (0,1) position; Use lcd.write() to write “Y:” in the LCD screen.; Set the LCD cursor at (3,1) position and print dist3 value in the LCD screen; Now, set the LCD cursor at (4,1) and write “KM” .
38. Give digital high pulse to the 3rd phase of the relay kit.
39. If dist1, dist2 and dist3 are all equal to 0, give digital high pulse to green to turn on green colour on RGB LED, and give digital low pulse to red and buzzer to turn off the red colour of the RGB LED and also turn off the buzzer.
40. Else, give digital low pulse to green to turn off green colour on RGB LED, and give digital high pulse to red and buzzer to turn on the red colour of the RGB LED and also turn on the buzzer.
41. End the loop function.
42. Stop the process.

ARDUINO IDE CODE

```
// include the library code:
#include <LiquidCrystal.h>
// initialize the library with the numbers of the interface pins
LiquidCrystal lcd(12, 11, 5, 4, 3, 2);
// define phase control pins
int phase[3] = {7, 8, 9};
#define buzzer 6
#define red 13
#define green 10
//*********************************************************
```

```
int distance(int inputVoltage)
{
 if (inputVoltage >= 890 && inputVoltage < 920) {
 return 8;
 }
 else if (inputVoltage >= 850 && inputVoltage < 890) {
 return 6;
 }
 else if (inputVoltage >= 750 && inputVoltage < 850) {
 return 4;
 }
 else if (inputVoltage >= 600 && inputVoltage < 750) {
 return 2;
 }
 else return 0 ;
}
//*******************************************************
void setup() {
 // set up the LCD's number of columns and rows:

 lcd.begin(16, 2);
 pinMode(buzzer,OUTPUT);
 pinMode(red,OUTPUT);
 pinMode(green,OUTPUT);
 // set pin mode for phase relays
 for (int j = 0; j < 3; j++) {
 pinMode(phase[j], OUTPUT);
 }
}

//*******************************************************
void loop()
{
  digitalWrite(phase[0], LOW);
  delay(500);
  int dist1 = distance(analogRead(A0));
  if (dist1 == 0)
  {
    lcd.setCursor(0, 0);
    lcd.write("R: ");
    lcd.setCursor(3, 0);
    lcd.write("NF ")
  }
  else
  {
    lcd.setCursor(0, 0);
    lcd.write("R: ");
    lcd.setCursor(3, 0);
    lcd.print(dist1);
    lcd.setCursor(4, 0);
    lcd.write(" KM");
```

```
 }
 digitalWrite(phase[0], HIGH);
 //================================================
 digitalWrite(phase[1], LOW);
 delay(500);
 int dist2 = distance(analogRead(A0));
 if (dist2 == 0)
 {
  lcd.setCursor(8, 0);
  lcd.write("B: ");
  lcd.setCursor(11, 0);
  lcd.write("NF ");
 }
 else
 {
  lcd.setCursor(8, 0);
  lcd.write("B: ");
  lcd.setCursor(11, 0);
  lcd.print(dist2);
  lcd.setCursor(12, 0);
  lcd.write(" KM");
 }
 digitalWrite(phase[1], HIGH);
 //================================================
 digitalWrite(phase[2], LOW);
 delay(500);
 int dist3 = distance(analogRead(A0));
 if (dist3 == 0)
 {
  lcd.setCursor(0, 1);
  lcd.write("Y: ");
  lcd.setCursor(3, 1);
  lcd.write("NF ");
 }
 else
 {
  lcd.setCursor(0, 1);
  lcd.write("Y: ");
  lcd.setCursor(3, 1);
  lcd.print(dist3);
  lcd.setCursor(4, 1);
  lcd.write(" KM");
 }
 digitalWrite(phase[2], HIGH);
if(dist1==0 && dist2==0 && dist3==0)
{
digitalWrite(green,HIGH);
digitalWrite(red,LOW);
digitalWrite(buzzer,LOW);
}
else
```

```
{
digitalWrite(green,LOW);
digitalWrite(red,HIGH);
digitalWrite(buzzer,HIGH);
}

}
```

EXPERIMENTAL SETUP

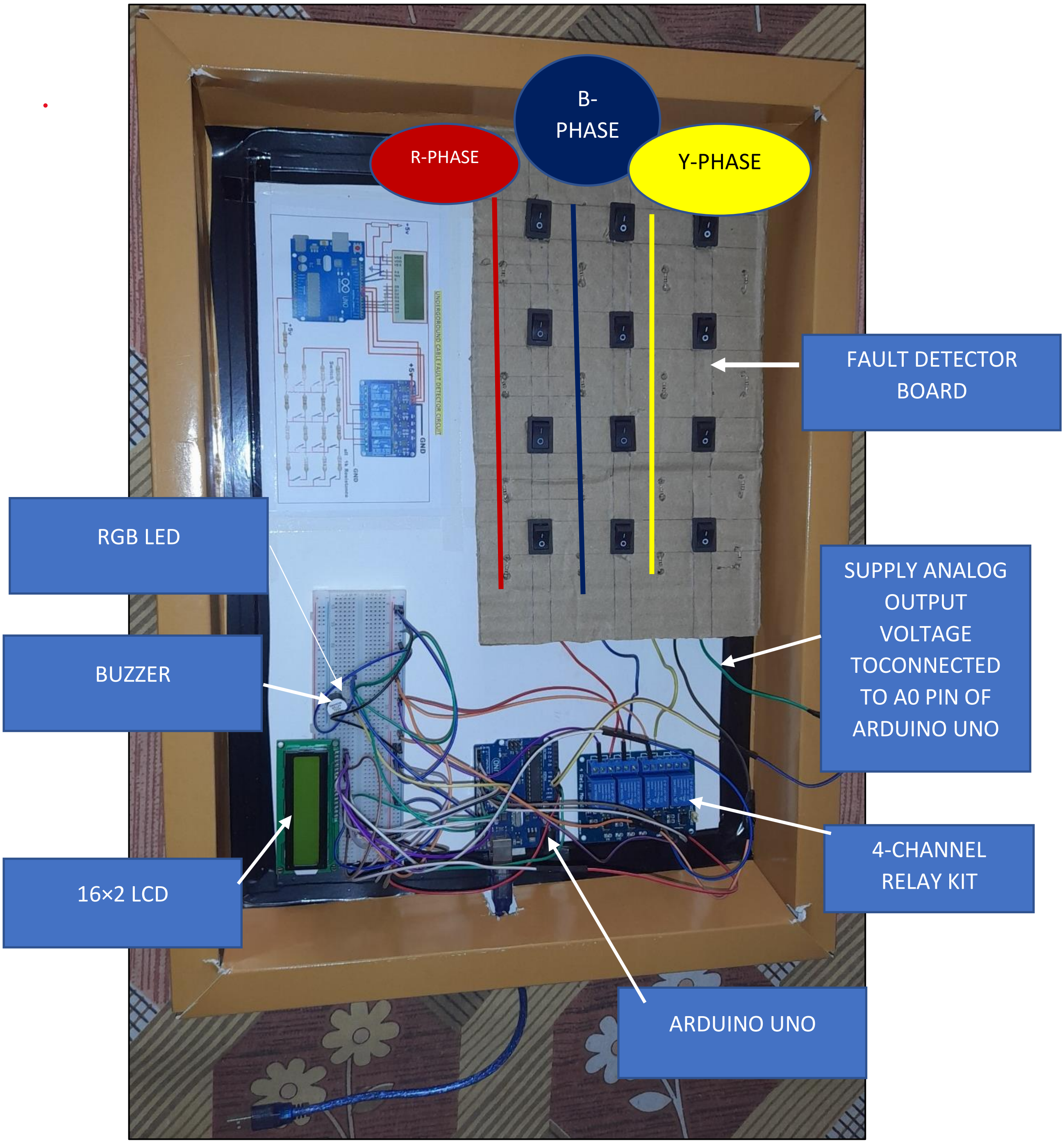


FIGURE 3 – HARDWARE SETUP

The above hardware setup is developed using the circuit diagram mentioned in figure 2. RGB LED and a buzzer is additionally added to increase the functionality of the system.

The fault detector board is also implemented based in the circuit diagram in figure 2.

SIMULATION RESULTS

TEST CASE 1: In this case, all the switches are open, so, current through all the cables follow a long path. So, the analog voltage supplied by the fault detection board for all the phases is very low which does not satisfy any of the conditions in the program, so, 0 is returned for all the phases. So, buzzer is off, green colour of RGB LED glows and "NF" is displayed for all the three phases in the LCD screen as shown in fig. 4a.

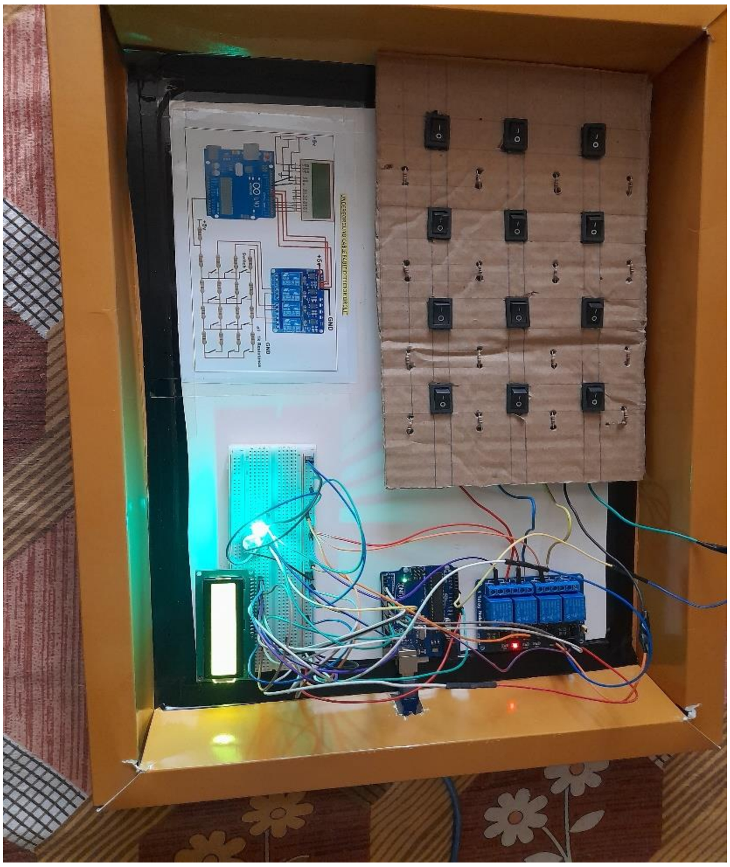


FIGURE 4A – HARDWARE SETUP

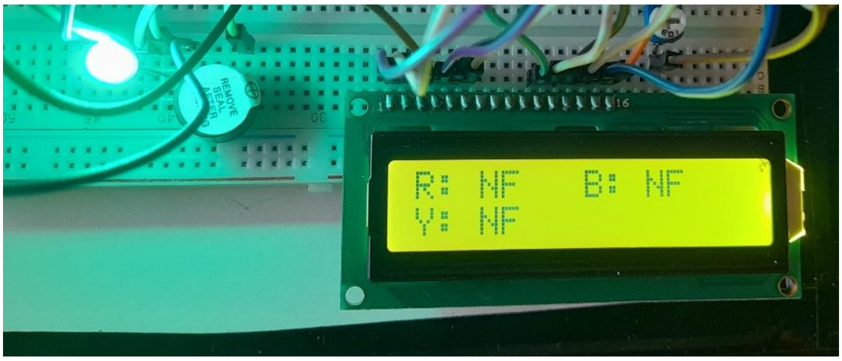


FIGURE 4B– RESULT IN LCD, RGB LED, AND BUZZER

TEST CASE 2: In this case, S1 of R phase is closed as shown in fig. 5a. Rest of the switches are open. So, for R phase, current follows a short circuited path as shown in fig. 5a, based on the voltage divider rule. So, for R phase, the analog value read by the A0 pin is between 600 and 750, distance returned is 2. So, 2KM is displayed in the LCD screen for R phase and for B-phase and Y-phase, the analog value read by the A0 pin does not satisfy any of the conditions, 0 is returned by the distance(int) function. So, NF is displayed for B-phase and Y-phase. Since, the R-phase is faulty at 2 Km from the base station, RGB LED glows red and buzzer produce beep sound as shown in fig. 5b. When S1 of R-phase is opened, then NF is displayed in LCD screen for R-phase also and RGB LED glows green and buzzer is off as shown in figure 5c.

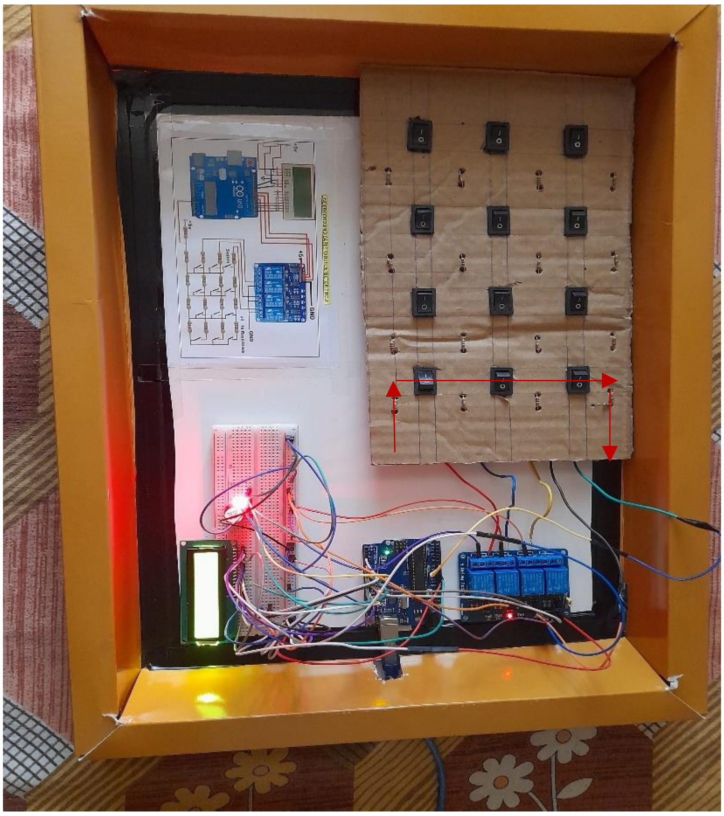


FIGURE 5A – HARDWARE SETUP

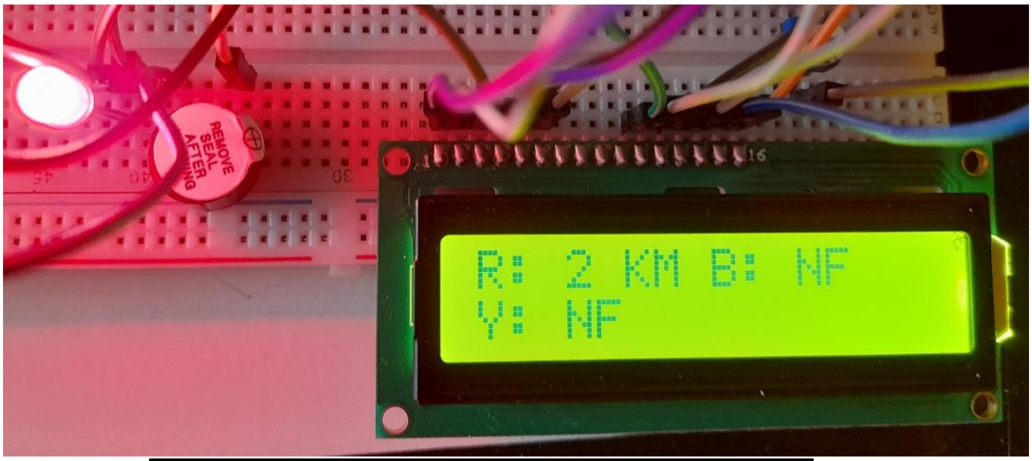


FIGURE 5B – RESULT IN LCD, RGB LED, AND BUZZER

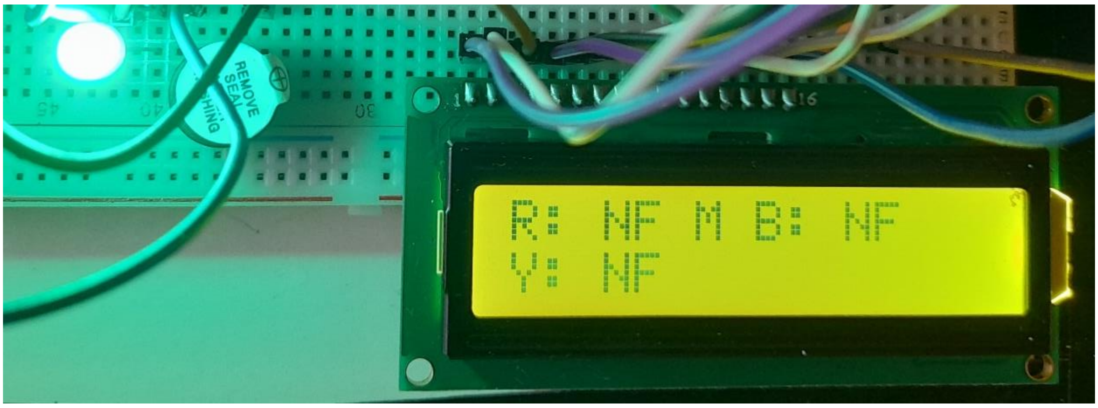
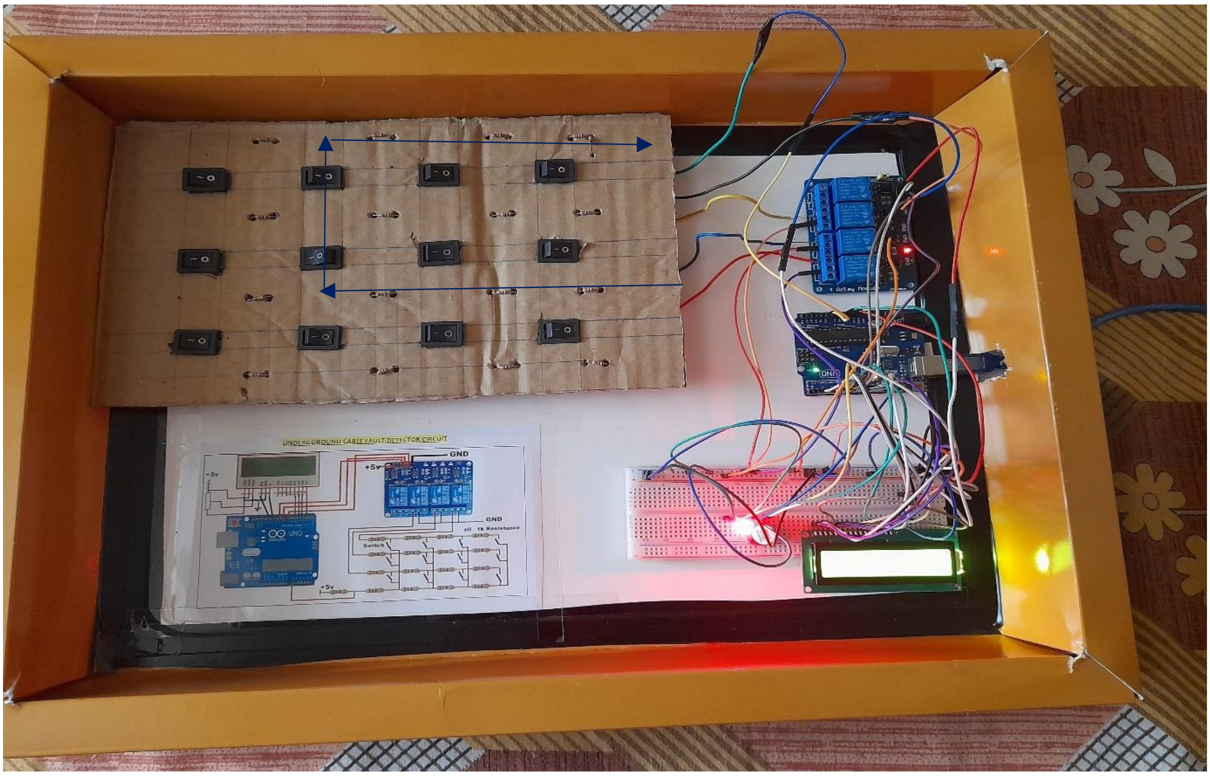


FIGURE 5C – RESULT IN LCD, RGB LED, AND BUZZER

TEST CASE 3: In this case, S3 of B-phase is closed as shown in fig. 6a. Rest of the switches are open. So, for B phase, current follows a short circuited path as shown in fig. 6a, based on the voltage divider rule. So, for B phase, the analog value read by the A0 pin is between 850 and 890, distance returned is 6. So, 6KM is displayed in the LCD screen for B phase and for R-phase and Y-phase, the analog value read by the A0 pin does not satisfy any of the conditions, 0 is returned by the distance(int) function. So, NF is displayed for R-phase and Y-phase. Since, the B-phase is faulty at 6 Km from the base station, RGB LED glows red and buzzer produce beep sound as shown in fig. 6b. When S3 of B-phase is opened, then NF is displayed in LCD screen for B-phase also and RGB LED glows green and buzzer is off as shown in figure 6c.



FIFURE 6A – HARDWARE SETUP

FIGURE 6B – RESULT IN LCD, RGB LED, AND BUZZER

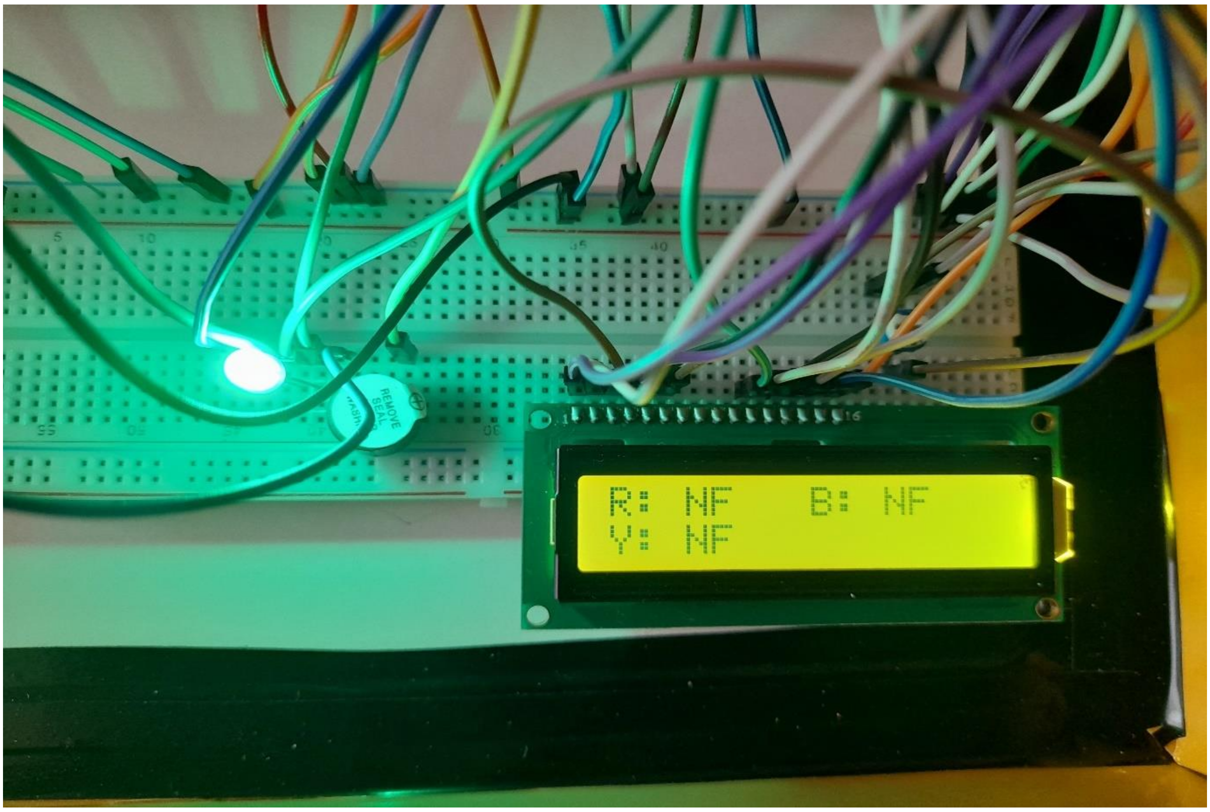


FIGURE 6C – RESULT IN LCD, RGB LED, AND BUZZER

TEST CASE 4: In this case, S4 of Y-phase is closed as shown in fig. 7a. Rest of the switches are open. So, for Y-phase, current follows a short circuited path as shown in fig. 7a, based on the voltage divider rule. So, for Y phase, the analog value read by the A0 pin is between 890 and 920, distance returned is 8. So, 8KM is displayed in the LCD screen for Y phase and for R-phase and B-phase, the analog value read by the A0 pin does not satisfy any of the conditions, 0 is returned by the distance(int) function. So, NF is displayed for R-phase and 3-phase. Since, the Y-phase is faulty at 8 Km from the base station, RGB LED glows red and buzzer produce beep sound as shown in fig. 7b. When S4 of Y-phase is opened, then NF is displayed in LCD screen for Y-phase also and RGB LED glows green and buzzer is off as shown in figure 7c.

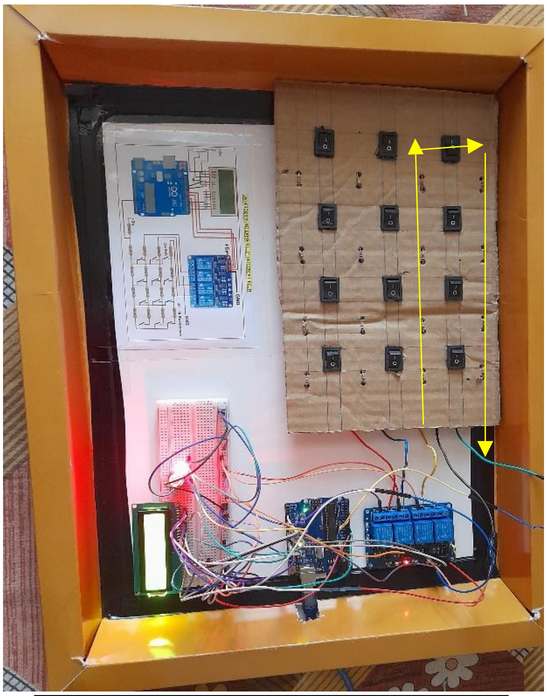


FIGURE 7A – HARDWARE SETUP

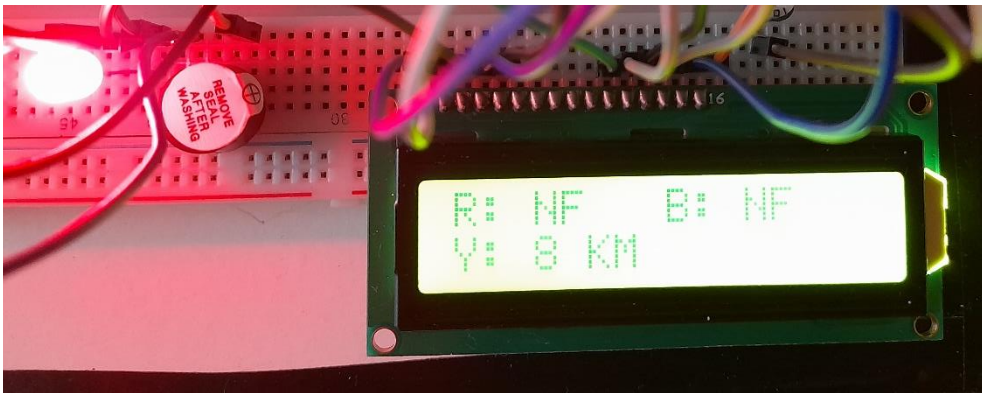


FIGURE 7B – RESULT IN LCD, RGB LED, AND BUZZER

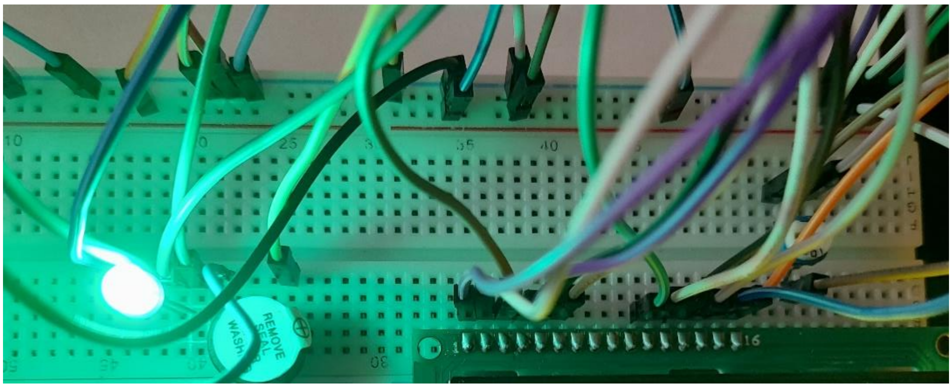


FIGURE 7C – RESULT IN LCD, RGB LED, AND BUZZER

TEST CASE 5: In this case, S3 of R-phase, S4 of B-phase and S2 of Y-phase are closed as shown in fig. 8a. Rest of the switches are open. So, for R-phase, B-phase and Y-phase, current follows a short circuited path as shown in fig. 8a, based on the voltage divider rule. So, for R phase, the analog value read by the A0 pin is between 850 and 890, distance returned is 6. So, 6KM is displayed in the LCD screen for R phase. Now, for B phase, the analog value read by the A0 pin is between 890 and 920, distance returned is 8. So, 8KM is displayed in the LCD screen for B phase. Now, for Y phase, the analog value read by the A0 pin is between 750 and 850, distance returned is 4. So, 4KM is displayed in the LCD screen for Y phase. Since, the R-phase, B-phase and Y-phase are faulty at 6 Km, 8 Km, and 4 Km,respectively, from the base station, RGB LED glows red and buzzer produce beep sound as shown in fig. 8b. When all the switches are opened, then NF is displayed in LCD screen for all phases and RGB LED glows green and buzzer is off as shown in figure 8c.

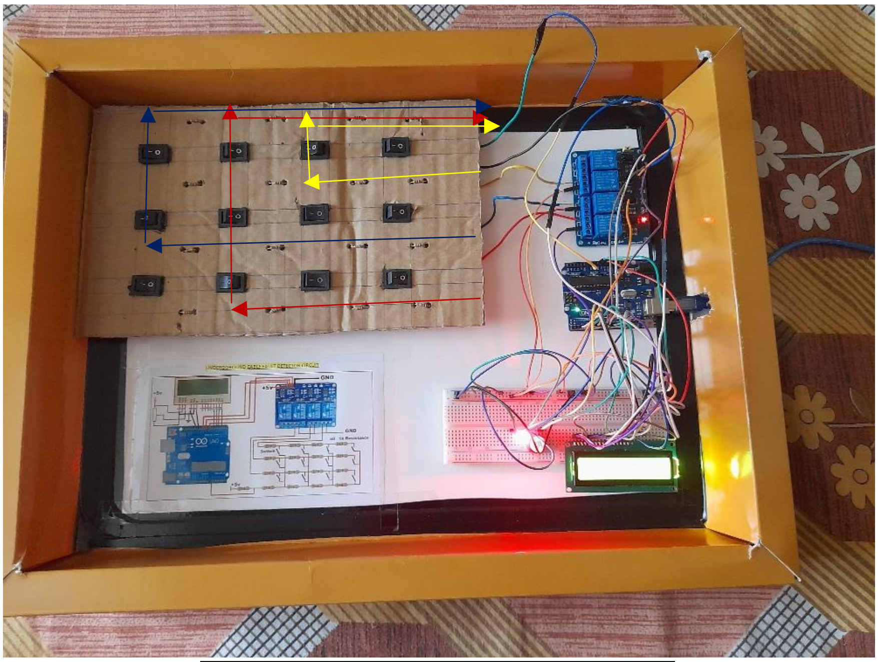


FIGURE 8A – HARDWARE SETUP

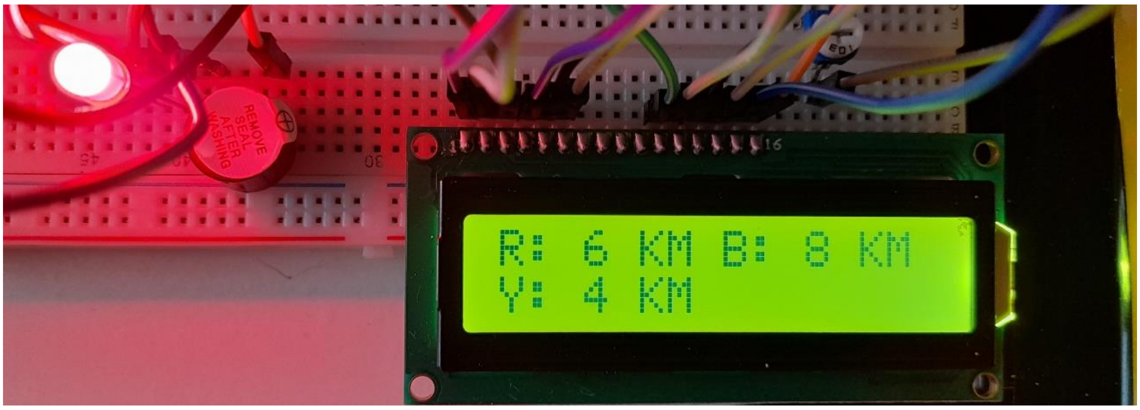


FIGURE 8B – RESULT IN LCD, RGB LED, AND BUZZER

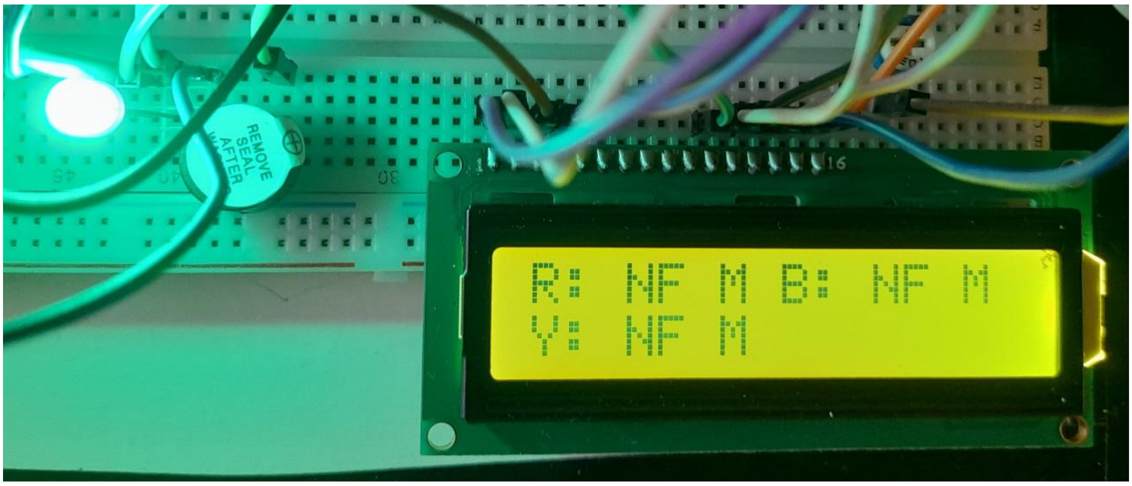


FIGURE 8C – RESULT IN LCD, RGB LED, AND BUZZER

INNOVATIONS IMPLEMENTED

1. Reference [8] have designed and implemented an underground cable fault locator using Arduino Uno as the microcontroller. Software simulation is also done in Proteus software using Arduino Uno as the microcontroller. The hardware design can detect short circuit fault in underground cables at 1km, 2km, 3km and 4km from the base station. My system can detect the short circuit fault in 3 cable lines simultaneously at 2km, 4km, 6km, and 8km from the base station. I have increased the dimensionality of the system by interfacing a RGB LED with the Arduino Uno to produce green light in case none of the cable is faulty and to produce red right when at least one of the cable is faulty.
2. Reference [6] has designed an underground cable fault detector using Arduino Uno to detect the short circuited fault in underground cables. Their work is only simulation as no design and construction work is involved. I have done the hardware implementation of the underground cable fault detector using Arduino Uno. Additionally, I have also interfaced a RGB LED with the Arduino Uno, to produce green light in case none of the cable is faulty and to produce red right when at least one of the cable is faulty. My system is also able to detect the short circuited fault in three cables simultaneously.
3. Reference [2] has designed, implemented a microcontroller based underground cable fault detector. Their proposed method can detect both open and short circuit fault in

underground cables with a maximum distance of 2km. I have designed and implemented a system, which can successfully detect short circuited fault in underground cables. My system can detect the fault in three cables simultaneously. My system can also detect the short circuited fault in underground cables with a maximum distance of 8 km from the base station. I have also interfaced a RGB LED with the Arduino Uno, to produce green light in case none of the cable is faulty and to produce red right when at least one of the cable is faulty. I have also interfaced a buzzer with the Arduino Uno to produce beep sound as output whenever there is a short circuited fault in at least one of the three cables.

4. Reference [9] have done underground cable fault detection and identification via fourier analysis. Accordingly, Fourier type methods can be effectively used as low cost and viable solutions to identify and detect faults in underground cables. But, it is very complicated process and also time consuming. It also depends on the robustness of the system. But, my proposed system can easily detect the short circuited fault in three cable lines simultaneously with higher accuracy and better efficiency than the system mentioned under ref. [8]. Also, my proposed system is based on ohm's law, which makes my system easier to understand and implement and also less complicated.

APPLICATIONS

The proposed system can be used in various ways. Some of them are as follows:

- It can used to monitor short circuit fault in underground cable line.
- It can be used to monitor short circuit fault in industrial line.
- It can monitor fault in residential line.
- It can monitor fault in overhead cable line.

ADVANTAGES:

Some of the important advantages of the proposed system are as follows:

- It helps in reducing human effort.
- It can detect accurate short circuit fault sub location.
- It saves time and provides better maintenance.
- It involves less software requirements.
- It is cost effective.
- It involves less complexity.
- It is applicable to all types of cable.

CONCUSION

As intended, the exact location of circuit fault in the underground cables from the feeder end in km is detected by using an Arduino microcontroller. The circuit works for different resistor values as well. The relay helps in separating the faulty line from the healthy line as expected. The fault occurs at a specific distance and the respective phase is displayed on an LCD interfaced to the Arduino board. The system functionality is increased by interfacing RGB LED and buzzer with Arduino Uno.

FUTURE WORK

In this project we detect only the location of short circuit faults in underground cable lines, but we can also detect the location of open circuit faults, to detect the open circuit fault capacitor is used in ac circuits which measure the change in impedance & calculate the distance of fault. It is used in neural network structure for fault section and fault location estimation.

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