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Underground Cable Fault Detector

Basudeb Dey

Assistant Professor, Department of Electrical Engineering

JIS College of Engineering

Uddipan Mandal, Bartik Chattopadhyay

B. tech in Electrical Engineering
JIS College of Engineering, Kalyani-741235

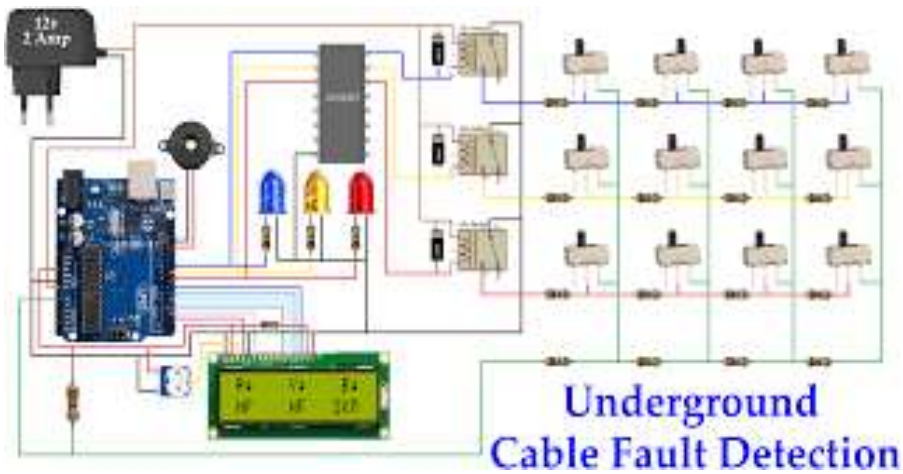
Abstract : Since the beginning of the use of electricity in the industry or domestic purpose, there has been a possibility of error in the electric wire for various reasons. Some time it is easier to repair and sometimes it's difficult. After revolution in the electrical industry, we spread our electrical network almost all over world, including inaccessible places to makes human's daily life easier. Manufacturers always strive to make long lasting electrical cables for all type of conditions. But we surrender to our nature. Implementation of different designs and materials has been in practice since ages. Some times the price of electrical wiring goes too high, which is not economical. So, we need a solution to tackle this problem. In future we may be able to find more durable material to save the electrical wire in all conditions. But in the meantime we are able to make electrical cable fault detector gadget by our observation. It can easily catch the problem of electrical wiring in remote places.

***IndexTerms* -Electrical Component, Fault Detector, Cable fault detector, Underground Cable, Intelligent fault detection system.**

I. Introduction

Now a day, electrical gadgets are getting very responsive and give quick feedback to the controller and also, in our case the fault detector is very responsive. This system consists of input, process and output. They transform one signal to another to give the desired output. This system can be interconnected to create an electronic system. This assessment describes some types of sensors used in the fault detector, which after interfacing with the microcontroller creates a reliable electronic system; also the working of sensors combined to interface with the same microcontroller is presented. The following circuit diagram of an electrical cable fault detector system interfaces a fault detector sensor and sent the data to a relay with a microcontroller and gives the information through a display. The aim of creating this system is to inform the controller where the fault was detected. It is easier to detect the fault and repair it.

II. Design



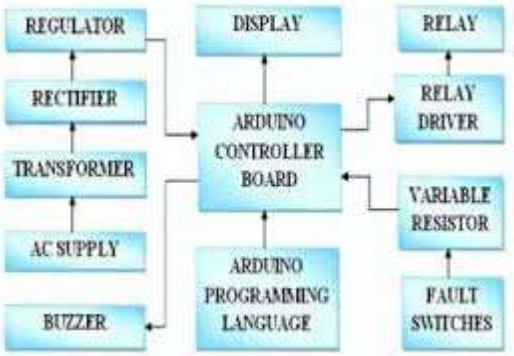
III. Software Design

```
#include <LiquidCrystal.h>
LiquidCrystal lcd(12, 11, 5, 4, 3, 2);

int sensorPin   = A0;
int sensorValue = 0;

void setup() {

  pinMode(7, OUTPUT);
    pinMode(8, OUTPUT);
      pinMode(9, OUTPUT);

  digitalWrite(7, LOW);
    digitalWrite(8, HIGH);
      digitalWrite(9, HIGH);

Serial.begin(9600);

lcd.begin(16, 2);
  lcd.print("UNDERGROUND CABLE");
  lcd.setCursor(0, 1);
  lcd.print("FAULT DETECTOR");

  delay(1000);
  delay(1000);

}
void loop()
{

 lcd.clear();
  digitalWrite(7, LOW);
    digitalWrite(8, HIGH);
      digitalWrite(9, HIGH);
       delay(350);

sensorValue = analogRead(sensorPin);
Serial.println(sensorValue);

 if( (sensorValue >= 1000) )
{
     lcd.setCursor(0, 0);
      lcd.print("R -  NF,") ;
   Serial.print("R -  NF,") ;

 }

  else if( (sensorValue >= 890) && (sensorValue <= 920)  )
{
 Serial.print("R - 2KM,") ;
   lcd.setCursor(0, 0);
  lcd.print("R - 2KM,") ;
}
  else if( (sensorValue >= 860) && (sensorValue <= 880)  )
{
 Serial.print("R - 4KM,") ;
    lcd.setCursor(0, 0);
   lcd.print("R - 4KM,") ;
}
  else if( (sensorValue >= 800) && (sensorValue <= 825)  )
{
 Serial.print("R - 6KM,") ;
    lcd.setCursor(0, 0);
   lcd.print("R - 6KM,") ;
}
  else if( (sensorValue >= 670) && (sensorValue <= 688)  )
{
```

```
 Serial.print("R - 8KM,") ;
    lcd.setCursor(0, 0);
   lcd.print("R - 8KM,") ;
}
 delay(1500);

digitalWrite(7, HIGH);
    digitalWrite(8, LOW);
      digitalWrite(9, HIGH);
       delay(350);

sensorValue = analogRead(sensorPin);
Serial.println(sensorValue);

 if( (sensorValue >= 1000) )
{

   Serial.print("Y -  NF") ;
    lcd.setCursor(8, 0);
    lcd.print(" Y -  NF,") ;
 }

  else if( (sensorValue >= 890) && (sensorValue <= 920)  )
{
  lcd.setCursor(8, 0);
 Serial.print("Y - 2KM,") ;
  lcd.print(" Y - 2KM,") ;
}
  else if( (sensorValue >= 860) && (sensorValue <= 880)  )
{
 Serial.print("Y - 4KM,") ;
 lcd.setCursor(8, 0);
   lcd.print(" Y - 4KM,") ;
}
  else if( (sensorValue >= 800) && (sensorValue <= 825)  )
{
 Serial.print("Y - 6KM,") ;
 lcd.setCursor(8, 0);
   lcd.print(" Y - 6KM,") ;
}
  else if( (sensorValue >= 670) && (sensorValue <= 688)  )
{
 Serial.print("Y - 8KM,") ;
 lcd.setCursor(8, 0);
   lcd.print(" Y - 8KM,") ;
}
 delay(1500);

digitalWrite(7, HIGH);
    digitalWrite(8, HIGH);
      digitalWrite(9, LOW);
       delay(350);

sensorValue = analogRead(sensorPin);
Serial.println(sensorValue);

 if( (sensorValue >= 1000) )
{
  lcd.setCursor(5, 1);
   Serial.println("B -  NF") ;
    lcd.print("B -  NF") ;
 }

  else if( (sensorValue >= 890) && (sensorValue <= 920)  )
{
 Serial.println("B - 2KM") ;
 lcd.setCursor(5, 1);
```

```
    lcd.print("B - 2KM") ;
   }
    else if( (sensorValue >= 860) && (sensorValue <= 880)  )
   {
   Serial.println("B - 4KM") ;
   lcd.setCursor(5, 1);
     lcd.print("B - 4KM") ;
   }
    else if( (sensorValue >= 800) && (sensorValue <= 825)  )
   {
   Serial.println("B - 6KM") ;
   lcd.setCursor(5, 1);
     lcd.print("B - 6KM") ;
   }
    else if( (sensorValue >= 670) && (sensorValue <= 688)  )
   {
   Serial.println("B - 8KM") ;
   lcd.setCursor(5, 1);
     lcd.print("B - 8KM") ;
   }
   delay(1500);

}
```

IV. FUNCTIONAL BLOCK DIAGRAM



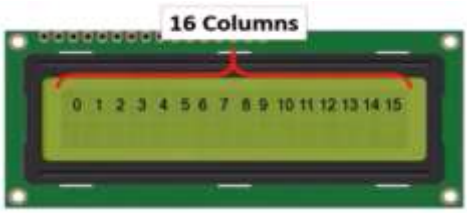
V. LIST OF REQUIRED COMPONENTS AND SENSORS

1. 5 Volt DC POWER ADAPTOR
2. 16 × 2 LCD
3. ARDUINO UNO R3
4. RELAY MODULE
5. BREADBORD
6. 1K OHM RESISTOR
7. SWITCH
8. JUMPER WIRE

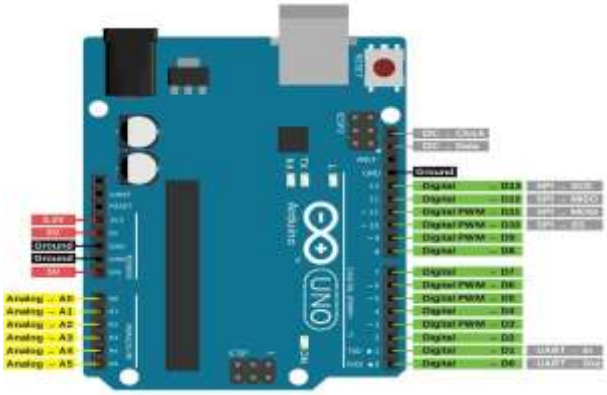
VI. ANALYSIS OF SENSORS AND COMPONENTS

1. **POWER ADAPTOR :** The power supply circuit consists of step down transformer which is 230v step down to 5v.In this circuit 4 diodes are used to form bridge rectifier which delivers pulsating dc voltage and then fed to capacitor filter the output voltage from rectifier is fed to filter to eliminate any a.c. components present even after rectification. The filtered DC voltage is given to regulator to produce 5v constant DC voltage.

2. **LCD:** Liquid crystal display are interfacing to microcontroller 8051.Most commonly LCD used are 16*2 &20*2 display. In 16*2 display means. 16 represents column & 2 represents rows. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The operating voltage of this LCD is 4.7V-5.3V. Every character can be built with a 5×8 pixel box.



3. **ARDUINO:** The **Arduino Uno** is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts.



4. **RELAY:** A **relay** is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations thereof. Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal.

5. **BREADBORD:** Breadboard is used for creating electrical connections between electronic components and single board computers or microcontrollers such as Arduino and Raspberry Pi.

6. **1K OHM RESISTOR:** 1K ohm set of resistors are used to represent the power cable (R – Y - B). DC voltage is fed at one end. When there is no fault in any phases, LCD will display as NF (No fault) because at that time, no voltage across any register of the cable. During NF – Fault switch will be open so no current will flow.
7. **SWITCH:** A **switch** is an electrical component that can disconnect or connect the conducting path in an electrical circuit, interrupting the electric current or diverting it from one conductor to another. The most common type of switch is an electromechanical device consisting of one or more sets of movable electrical contacts connected to external circuits. When a pair of contacts is touching current can pass between them, while when the contacts are separated no current can flow. Switches are made in many different configurations; they may have multiple sets of contacts controlled by the same knob or actuator, and the contacts may operate simultaneously, sequentially, or alternately.

VII. INTERFACING CIRCUIT DIAGRAM

- The circuit consists of a power supply, 4-line display, Arduino Uno and resistance measurement circuit. To induce faults manually in the kit, fault switches are used. About 12 fault switches are used which are arranged in three rows with each row having 4 switches. The 3 rows represent the 3 phases namely R, Y and B. The fault switches have 2 positions-No fault position(NF) and fault position(F). Main component of the underground cable fault detection circuit is low value resistance measurement. It is constructed using a constant current source of 2 Amps. It can measure very low value resistance as the cables have their around 1 kΩ/meter resistance. This circuit can measure resistance up 1 kΩ having maximum cable length it can check up to 8 kilometres.
- The circuit is made by using three sets of resistances connected in parallel along with some combination of faulty switches. With this circuit, when any voltage circuit is obtained across one of the phases (either R, Y, B), the fault switches get closed hence making the whole phase closed. at the same time, a reading is given in the LCD about the location of the short circuit fault created.
- One relay for each phase R, Y and B as three relays are used and the common points of the relays are grounded and the NO points are connected to the inputs of the three resistances input and being the three phase cable input. As supply needed for the relays is higher than that of the arduino, Relay driver is used to boost the supply and provide it to the relays. A 230V AC supply is applied to the transformer from where it is stepped down to 12V AC. From the transformer the alternating current gets converted into direct current when it passes through a Bridge wave rectifier. The 12V DC then goes to the voltage regulator where it gets converted from 12V DC to 5V DC Voltage regulator is used also converts the variable Dc supply into constant DC supply. This 5V DC is used to supply power to the arduino and the LCD Power supply to the LCD is given from the voltage regulator.

VIII. FUNCTIONING OF SYSTEM

As stated earlier that any fault in the transmission system requires many human effort and resources. Normally, the traditional process of locating and correcting a fault is very time consuming and there is a risk while digging the ground because the insulation of the cable may break resulting into damaging the whole cable. Hence this project is a simple alternative of the traditional method

which is quite time-saving and reliable. It actually works upon the fundamental engineering law OHM'S LAW in which a low DC Voltage is applied at the feeder end through a series resistor.

In this method, if there is any kind of short circuit fault of either LL, 3L OR LG type. Using this method, the location of the fault can be easily detected based upon the voltage drop across the series resistor which finds the exact location of the fault. This system uses an Arduino micro controller kit and a rectified power supply. Here the current sensing circuits actually consists of a circuit board made with a combination of resistors and switches so as to make a three phase circuit which are interfaced to Arduino micro-controller kit to help of the internal ADC device for providing digital data to the microcontroller representing the cable length in kilometres and the fault distance with location.

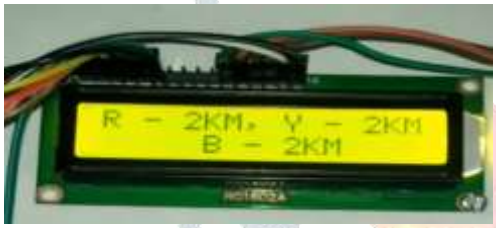
The fault creation is made by the set of switches. The relays are controlled by the relay driver. A 16x2 LCD display connected to the microcontroller to display the information. In case of short circuit, the voltage cross series resistors changes accordingly, which is then fed to an ADC to develop precise digital data to a programmed Arduino micro-controller kit that further displays exact fault location from base station in kilometres. The project in future can be implemented by using capacitor in an AC circuit to measure the impedance which can even locate the open circuited cable.

Let's explain the working of this project:
In the urban areas, the electrical cable runs in undergrounds instead of overhead lines. Whenever the fault occur the repairing process becomes difficult. It is very difficult to identify the exact location of the fault in underground power cable line. This project will ensure a shorter response time for technical crew to rectify these faults. Fault occur due to short circuit fault, low voltage fault ,high voltage fault.

IX. RESULTS

CASE-1: When the fault is located at all the phases of the board

and the distance of fault measurement is 2km

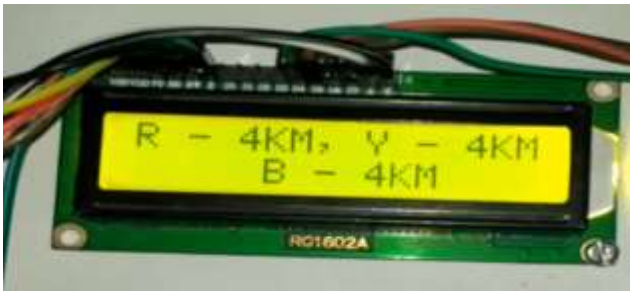


CASE-II: When the fault at only the phase B and the other phases are closed

Fault measurement is 6 km.

CASE-III: When the fault is located at all the three phases (R , Y , B) and the distance of fault measurement is 6 km.

CASE-IV: When the fault is located at all the three phases and the distance is 4 km



CASE-V: When the fault is observed at R phase but the others are closed

X. DISCUSSION

So from the detailed description of the project so far, it can be concluded that the traditional method of locating and dislocating of a short circuit fault is replaced by a new model. Its working principle is quite simple and the calculation of the fault is very easier rather than other methods. From its circuit diagram, we get to know about the details of circuitry covering about, the value of resistors used, maximum distance of detection, making of the board having phases. Block diagram of this project represents its working process flow through all the components. This project is very cheaper in cost for having many simpler components and very easily durable .

XI. Ease of Use

i. It is easy to use and low cost maintenance with higher efficiency.
ii. Cable fault detector takes less space to install and it survives in all weather conditions.
iii. It always provides pinpoint fault location very accurately and it provides accurate information in all weather conditions.
iv. The fault detector calculates distance in KM in long distance wire.

XII. Acknowledgment

At first, I would like to give thanks to our mentor sir Mr. Basudeb Roy for helping us to publish the paper. He has helped us a lot in making this paper. Then I would like to acknowledge my team members for helping in collecting all the topics and helping in writing on the topic.

XIII. References

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