IMPLEMENTATION AND DEFECT IDENTIFICATION IN UNDERGROUND CABLE SYSTEM

[1]Sandeep Kumar Machavara M, [2]Geetha Boddu, [3]Manjuvani Nangunoori, [4]Matam Asha
[1,2,3]Assistant Professor, [4] UG Student, [1,2,3,4] Department of Electrical and Electronics Engineering, Rishi MS Institute of Engineering and Technlogy for Women, Kukatpally, Hyderabad.

ABSTRACT

A cable that is buried underground or inside a conduit and afterwards used for communication, power distribution, or any other intended functions is known as an underground cable. Due to their lack of needless hindrance, these cables serve as an alternative to overhead wires. One of the most fundamental practices used in metropolitan areas is the subterranean cable framework. Because the entire line must be dug up to check for cable line faults, it is very difficult to pinpoint the source of a failure. Due to tremor, wear and tear, rats, insulation failure, and other factors, underground cables are vulnerable to a wide range of defects. When an underground cable develops a fault, determining the precise location of the issue for the purpose of repairing that line is extremely difficult. The goal of the research is to detect the location of a fault in underground cable lines in kilometers from the base station. This prototype uses the simple concept of Ohm's law. It is modeled by a set of resistors representing cable length in km and false fault is created by a set of switches at every known distance to cross check the accuracy. In case of faults, the voltage across series resistor changes accordingly, which is then fed to an ADC to develop precise digital data to a programmed Arduino UNO R3. That further displays the fault occurring distance and phase on a 16X2 LCD interfaced with the Arduino UNO R3. We proposed an IOT based model for better detection of fault in the cables. It is used to display the information over the Internet using the Wi-Fi module ESP8266 about the occurrence of fault on the web service-Thing Speak Software. This is providing best result outputs and accuracy compare than other methods. This technique is also providing a very fast speed of operation, which is very necessary for the continuity and stability of power quality. We can use this technique for the detection of faults in underground power lines/cables.

Keywords: Underground Cable fault, Arduino UNO R3 , IOT , LCD, Resistance, Web Page.

INTRODUCTION

Across the country, a million miles of cables are woven through the air. However, it is now laid underground, which is a greater method than the previous method. Because subterranean cables are not influenced by unfavorable weather conditions such as pollution, heavy rainfall, snow, and storms, underground cables are the best option. However, when a cable problem occurs, it is extremely difficult to pinpoint the specific position of the defect due to a lack of knowledge about the cable's particular location. As the world becomes more digitized, the concept proposes finding the location of a fault in a digital manner; nevertheless, the process of fixing that specific wire is quite complex. A cable fault can occur for a variety of causes. They are: inconsistency, any defect, cable weakness, insulation failure, and conductor breaking. To address this issue, here is a project called underground cable fault distance locator, which is used to locate the position of an underground cable fault. As India develops as a developed country, the amount of civilized land grows. Despite the fact that most lines are installed overhead, the subterranean line approach is used in large locations such as hospitals and colleges because it ensures safety. Because of its obvious benefits, the UG cable concept emerges for power transmission. However, if a fault arises, discovery becomes difficult due to the fact that it is unseen. A method for preventing cable digging without knowing the exact location of the cable.

CAUSES OF FAULTS

When moisture enters the insulation, the majority of the defects arise. Inside the cable, the paper insulation is hygroscopic in nature. Mechanical injury during transit, the laying process, rodents or various stresses faced by the cable during its operational life are some of the other causes. The lead sheath is regularly destroyed, mainly as a result of the acts of air agents, soil, and water, or mechanical damage and crystallization of lead caused by vibration.

FAULTS IN UNDERGROUND CABLES

OPEN CIRCUIT FAULTS:

This issue is caused by an open circuit in the conductors, as the name implies. Discontinuity occurs when one or more cable conductors (cores) break. Mechanical tension causes the cable to come out of its joint, causing this discontinuity. Infinite resistance characterizes an open circuit. This is referred to as an open circuit fault.

SHORT CIRCUIT FAULTS:

It's only found in multi-cored cables. A short circuit occurs when two or more conductors of the same cable come into touch with each other. Visual detection is impossible without dismantling the cable. When the individual insulation of the cables is destroyed, a short-circuit issue arises. Zero resistance is a characteristic of a short-circuit.

EARTH FAULTS:

An earth fault occurs when one of the cable's conductors comes into touch with the ground. This usually happens when the outer sheath is destroyed by soil chemical reactions, vibrations, or mechanical crystallization. It's comparable to a short circuit defect in that the current goes through the ground because it's the least resistance path.

PROBLEM STATEMENT

Underground cables are vulnerable to a variety of problems, wear, rodents, and other factors. Cable defects have been detected using a variety of approaches in the past. However, the issue is how to detect ground cable failures and how to get fault data when needed. This prototype was designed to locate faults in underground cable lines.

OBJECTIVE

The objective is to determine the distance of underground cable fault from basestation in kilometers. Hardware prototype will display the fault from kilo meters apart on LCD andThing Speak IoT software.

PROPOSED SYSTEM

We have introduced IOT to the underground fault detector. The hardware prototype includesa step-down transformer, a voltage regulator circuit, an Arduino board, an LCD display, and a Wi-Fi module. For demonstration purposes, we'll use a register instead of a cable. In actuality, the cable must be connected since the resistance of the wire is proportional to its length. The resistance of the cable increases as the length of the cable increases. Again, we are using switches to create a problem, but we do not need to link the switches because each switch shows a distance of 5 kilometers. Each phase can be represented by three relays: R-phase, Y- phase, and B-phase.

BLOCK DIAGRAM

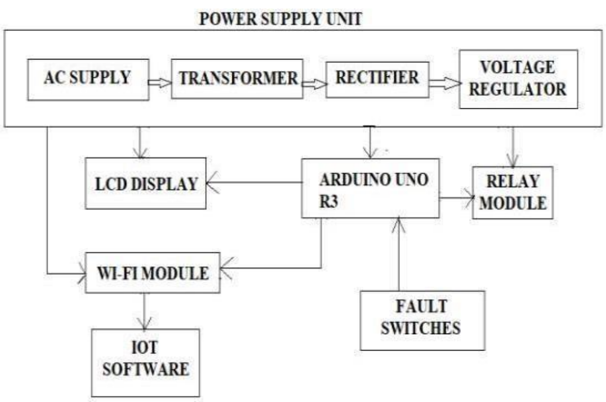


Fig 1: Block Diagram

WORKING

This prototype uses the Ohms Law concept, when a low voltage DC is applied to the feeder end through a series resistor, then the current would differ based on the location of fault occurred in the cable. Power supply unit consists of Step-down transformer, Rectifier, Input filter, Regulator unit, Output filter. The 230V AC Power supply is converted to 5V DC Power using Rectifier unit. This 5V is given to the Arduino UNO R3 through power regulators. Each phase consists of three switches which are kept for determining the fault distance. Arduino UNO R3 consists of 14 digital and analog pins. Switches, relay, LCD, Wi-Fi are connected with Arduino pins. When any fault occurs, the respective distance of fault is displayed on LCD. The available information of the LCD display will be sent to thing speak through ESP8266 WIFI. Which then stored in cloud and send all collected data and information to the thing speak software. And we can view the logged data and graph over time on the Thing speak website. Thing Speak takes a minimum of 15 seconds to update your readings.

Initially R=0 Y=0 B=0Km is displayed. If we wish to make a 10-kilometer R-phase fault. We simply lower that switch to the ground. R=10Km shows that this switch is grounded. The LED indicates that the respective R-phase relay has turned off. Then the respective data is displayed on LCD and on the website Thing Speak IoT Software.

HARDWARE REQUIREMENTSPOWER SUPPLY UNIT:

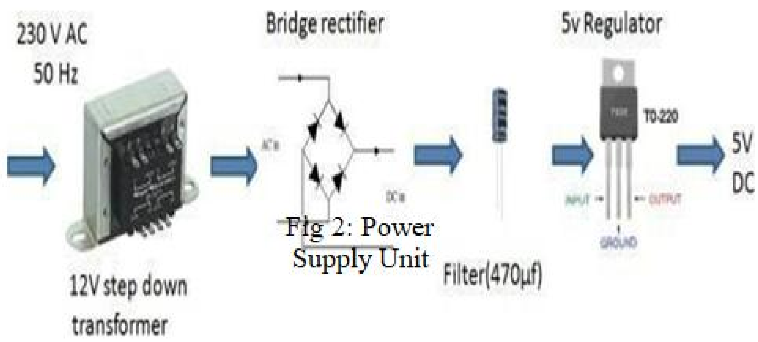


Fig 2: Power Supply Unit

The power supply unit includes a step down transformer that converts 230 volts to 12 volts. Inthis circuit, four diodes are used to create a bridge rectifier that generates pulsating dc voltage. The output voltage from the rectifier is then supplied to a capacitor filter, which eliminates any AC components present even after rectification. The regulator receives the filtered DC voltage and produces a constant output voltage.

ARDUINO UNO R3:

The Arduino platform has grown very popular among these days. Unlike most previous programmable circuit boards, the Arduino does not require a separate piece of hardware to load new code into the board; instead, a USB cable is all that is required. Additionally, the Arduino IDE makes programming easier by using a simplified form of C++. Finally, Arduino offers a standard physical factor that separates the microcontroller's tasks into a more manageable bundle.

Fig 3: Arduino UNO R3

Arduino Uno consists of ATmega328, a 28 pin microcontrollers. It consists of 14 digital input/output pins, 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

RELAY MODULE:

A relay is an electromechanical component that serves as a switch. DC energises the relay coil, allowing contact switches to be opened or closed. A coil and two contacts, such as normally open (NO) and normally closed (NC), are usually included in a single channel 5V relay module (NC). Current flowing through the curl of the transfer creates an attractive field that attracts a switch and changes its contacts.

Fig 4: Relay Module

16x2 LCD DISPLAY:

LCD (Liquid Crystal Display) is a type of flat panel display that operates primarily with liquid crystals and other electronically modulated optical devices that employ the light-modulating properties of liquid crystals in conjunction with polarizers. Liquid crystals do not directly emit light; instead, they use a backlight or reflector to create colour or monochrome images. LCDs can show arbitrary images or fixed images with minimal information content that can be displayed or hidden. LCD televisions, computer monitors, instrument panels, aircraft cockpit displays, and interior and outdoor signs are just a few examples of LCD applications.

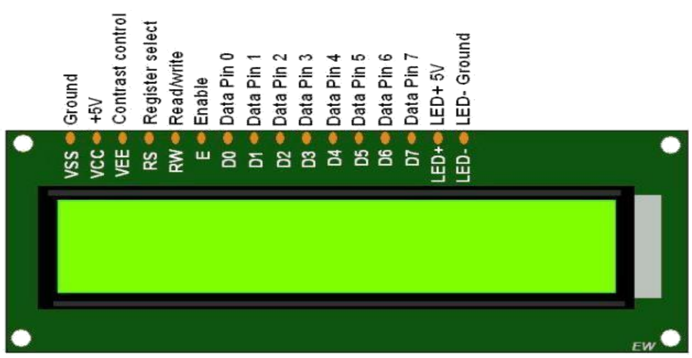


Fig 5: 16X2 LCD Display

ESP8266 WIFI-MODULE:

The ESP8266 can either host an application or offload all Wi-Fi networking functionality to a separate application processor. Each ESP8266 module is pre-programmed with AT command set software, so you can just connect it to your Arduino device and receive nearly the same amount of Wi-Fi functionality as a Wi-Fi Shield. The ESP8266 WIFI module is a self- contained SOC with an inbuilt tcp/tp 18 Protocol stack that can provide access to your Wi-Fi network to any microcontroller.

Fig 6: ESP8266 Wifi-Module

SLIDING SWITCH:

These small single-pole, double-throw (SPDT) slide switches are rated for 300 mA at 50 VDC and make great on/off power switches for low power electronics. They can also be used as a convenient way to choose between two analog or digital input signals. The three pins have a 0.1″ spacing that works with standard solderless breadboards.

Fig 7: Sliding Switch

JUMPER WIRES:

A jumper wire is an electric wire that connects remote electric circuits used for printed circuit boards. By attaching a jumper wire on the circuit, it can be short-circuited and shortcut (jump)to the electric circuit. By placing the jumper wire on the circuit, it becomes possible to controlthe electricity, stop the operation of the circuit, and operate a circuit that does not operate withordinary wiring. Also, when specification

change or design change is necessary on the printedcircuit board, reinforcement of the defective part, partial stop of the unnecessary function, andchange of the circuit configuration of the unnecessary output part by attaching or detaching the jumper wire can do.

Fig 8: Jumper Wires

ZERO PCB BOARD:

Zero PCB is basically a general-purpose printed circuit board (PCB), also known as perfboardor DOT PCB. It is a thin rigid copper sheet with holes pre-drilled at standard intervals acrossa grid with 2.54mm (0.1-inch) spacing between holes. Each hole is encircled by a round or square copper pad so that component lead can be inserted into the hole and soldered around the pad without short-circuiting the nearby pads and other leads. For connecting the lead of component with another lead, solder these together or join these using a suitable conducting wire.

Fig 9: Zero PCB Board

RESISTOR:

A resistor is a two-terminal electronic component that opposes an electric current by producing a voltage drop between its terminals that is proportional to the current, as defined by Ohm's law. Electrical networks and electronic circuitry both employ resistors. They're found in almost every piece of electrical equipment. Resistance wire (wire constructed of a high-resistivity alloy, such as nickel/chrome) and different compounds and films can be used to make practical resistors.

Fig 10: Resistor

SOFTWARE REQUIREMENTS THINGSPEAK IOT SOFTWARE:

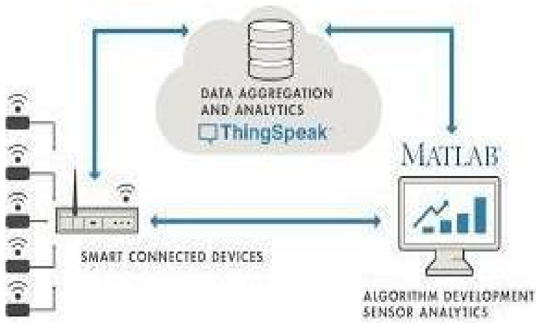


Fig 11: ThingSpeak IoT Software

Thing Speak is an open-source software written in Ruby which allows users to communicate with internet enabled devices.It facilitates data access, retrieval, and logging of data by providing an API to both the devices and social network websites. Thing Speak was originally launched by Io Bridge in 2010 as a service in support of IoT applications. Thing Speak has integrated support from the numerical computing software MATLAB from Math Works, allowing Thing Speak users to analyze and visualize uploaded data using MATLAB without requiring the purchase of a MATLAB license from Math Works.

ARDUINO IDE:

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for commonfunctions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

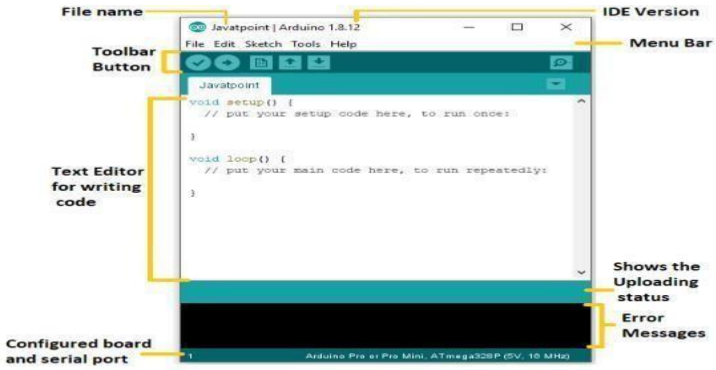


Fig 12: Arduino IDE

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension .ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom right hand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

RESULTS AND DISCUSSION

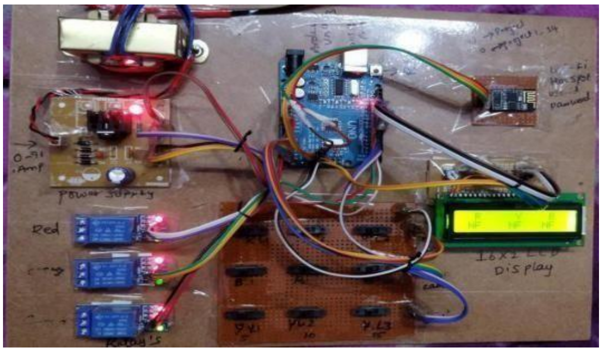


Fig 13: Hardware Model

Under R-phase Fault condition at a distance 5km:

If we make a 5-kilometer R-phase fault. We simply lower that switch to the ground.R=5Km shows that this switch is grounded. The LED indicates that the respective R-phase relay has turned off. Then the respective data is displayed on LCD and on the websiteThingSpeak IoT Software as shown in below fig 14.

(a)

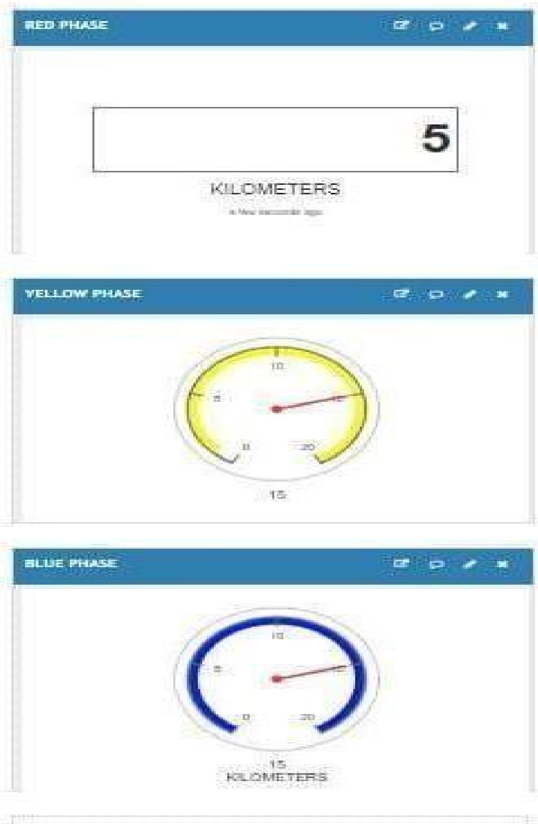
(b)

Fig 14: Fault at R=5km output display on (a) LCD and (b)ThingSpeak software

Under All 3 Phases Fault R=5KM,Y=15KM,B=15KM:

We make a 5km R-phase fault, 15km in Y phase fault and B-phase fault . We simply lower that switch to the ground. The LED indicates that the respective phases relay has turned off. Then the data is displayed on LCD and on the website ThingSpeak IoT Software as shown in below fig 15.

(a)



(b)

Fig 15: Fault at R=5km,Y=15km and B=15km output display on (a) LCD and (b)ThingSpeak software

CONCLUSION

The paper IOT-based underground fault detector proposed in this research is utilised to identify any defects in an underground cable system. This technology can determine the precise location of the defect and send the coordinates to the user for monitoring. The line to ground fault in the subterranean cable is located to efficiently resolve the fault applying simple Ohms law techniques. With the help of an Arduino Uno R3 and an ESP8266 Wi-Fi module, the work automatically displays the phase and distance of the fault's occurrence respectively on LCD as well as Think Speak IoT software. Faster fault repair restores powerto the system, improves system performance, and decreases operating costs and time spent locating faults in the field are all merits of accurate fault location. As a result, the method used in this study is rational and proven to be useful in detecting and locating places with underground cable shortages.

FUTURE SCOPE

The proposed system in this detects only the location of open circuit fault in underground cable line, and detect the location of open circuit fault, to detect the open circuit fault capacitor used in circuit which measure the change in resistance & calculate the distance of fault. For future research, the system would proceed with similar neural networks structure for different types of fault section and fault location estimation.

REFERENCES

1. Anurag. D. Bork hade (2014) 'Transmission Line Fault Detection Using Wavelet Transform'- International Journal on Recent and Innovation Trends in Computing andCommunication.
2. Abhishek Pandey and Nicolas H. Younan (2010) 'Underground cable fault detection and identification via fourier analyses- International Conference on High Voltage Engineering and Application, 11-14 Oct. 2010.
3. Abhishek Pandey, Nicolas H. Younan, "Underground Cable Fault Detection andIdentification via Fourier Analysis", 2010 IEEE.
4. A. Ngaopitakkul, C. Pothisarn, M. Leela jin dakrairerk, "Study of Characteristics forSimultaneous Faults in Distribution Underground Cable using DWT", 2011 IEEE.
5. Ashlesha A. Patil and Dr. S. R. Suralkar. "Reviewer-IOT Based Smart Healthcare System".International Journal of Advanced Research in Engineering and Technology.
6. E. C. Bascom, -Computerized underground cable fault location expertise, line Proc. IEEE Power Eng. Soc. General Meeting, April, 1994. J. Clerk Maxwell, a Treatise on Electricity and Magnetism, 3rded, vol. 2. Oxford: Clarendon, 1892.
7. Gilani, Mahmoud, Dona Khalil Ibrahim, and El Sayed Tag Elden. "Traveling-wavebased fault location scheme for multi-end-aged underground cable system." Power Delivery, IEEE Transactions in January 2007.
8. H. Shateri, S. Jamali, "Impedance Based Fault Location Method for Phase to Phase and Three Phase Faults in Transmission Systems", IEEE 2010.
9. K.K. Kuan, Prof. K. Warwick, "Real-time expert system for fault location on high voltage underground distribution cables", IEEE Proceedings-C, Volume. 139, No. 3, MAY 1992.
10. M.S. Choi, D.S. Lee, and X. Yang, "A Line to Ground Fault Location Algorithm for Underground Cable System", Korean Institute of Electrical Engineers International Transactions on Power Engineering, pp. 267 – 273, Jun 2005.
11. Mr. Kiran Wadiyar, Mr. Vaibhav Borkar, Mr. Rahul Ghul, Prof. Manish Patel -IoTUnderground Cable Fault Detection, IEEE PROCEEDINGS, vol-3 Issue-3 2017.
12. Mr. N. Sampath raja, Dr. L. Ashok Kumar, Ms. V. Kuribayashi and Ms. C. Muthumaniyarasi, Mr. Vishnu Murthy-IoT Based Underground Cable Fault Detector, IJMET Publication, vol-8, Issue-8, August 2017.
13. Manish Paul, Raj Kamal Kakoki, "Underground Cable Fault Locator", IARJSET, Vol.3, Issue 9, September 2016. 41

14. Md. Fakhru Islam, Amanullah M T Oso, Salahuddin. A. Azal, “Locating Underground Cable Fault: A Review and Guideline for New Development”, 2013, IEEE.

15. Ms Pandya, A. Hunker, Mr. P. B. Ghelani, “Paper on IOT Based technology” in IRJET, Vol 4,Issue: 01, pp 1580-1582, Jan 2017.

16. M. Jaya Bharata Reddy, D. Venkata Rajesh, D.K. Mahanta, “Robust transmission line fault classification using wavelet multi-resolution analysis.", Computers & Electrical Engineering, Volume 39, Issue 4, Pages 1219-1247 , May 2013.

17. Pooja P.S and Lekshmi M (2015) ‘Fault Detection Technique to pinpoint Incipient Fault for Underground Cables’-International Journal of Engineering Research and General Science May-June 2015.