Original Article
ISSN (Online): 2582-7472

ShodhKosh: Journal of Visual and Performing Arts
January- June 2024 5(1), 1316–1321

SMART SYSTEM FOR DETECTION OF UNDERGROUND CABLE FAULTS USING ARDUINO AND OHM'S LAW

Dr. Manjula T[1], Nagabhushan[2], Pushpanjali C H[1]

[1]HOD & Associate Professor, Department of MCA, Seshadripuram College Tumakuru, Karnataka, India
[2]Assistant Professor, Department of BCA, Seshadripuram College Tumakuru, Karnataka, India
[3]Assistant Professor, Department of MCA, Seshadripuram College Tumakuru, Karnataka, India

Corresponding Author
Dr. Manjula T,
manjulayogi23@gmail.com

DOI
10.29121/shodhkosh.v5.i1.2024.4188

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

ABSTRACT

Underground cable fault detection plays an important role in power system reliability especially in the urban areas where cables are mostly buried to avoid possible damages due to adverse weather conditions like; heavy rain, snow or thunderstorms Although these subterranean cables are susceptible to failure, pinpointing precisely where the problem occurred to perform the required repairs can be challenging. The proposed system aims to found the range of the exact location of the fault in the underground cable by using the principles of Ohm's law. Hence, when a low DC voltage is applied at the end of the feeder through a series resistor, the current flow depends on the position of the fault. The components used in this project include an Arduino microcontroller, 16×2 LCD display as a monitor, and switches to sense the open and short circuit faults of the underground cables. It is aimed at providing accurate detection of fault locations so that the necessary repairs can be made without much delay. With these components incorporated, the proposed solution thus provides an effective and economical method of observing the status of underground cables.

Keywords: Arduino, Ohm's Law, DC Voltage, Smart System

1. INTRODUCTION

Overhead power cables have become less desirable as a means of electrical distribution and several European countries make use of underground cables and this would not be possible if they were not effective and visually appealing. Nevertheless, due to various causes such as aging, environmental influences, and accidental damage, these cables could be prevailing with multiple flaws. Sleights can lead to huge financial losses, injuries and power interruptions hence it is important to minimize them. Therefore, only thorough and accurate methods of identifying faults can guarantee the dependability and integrity of subterranean cable networks.

Traditional defect detection and analysis involve laborious and lengthy processes and this would eventually translate to increased maintenance costs and time. As power distribution network systems become increasingly complex and larger, advanced fault detection technologies that can quickly and effectively detect cable issues are increasingly essential. The condition of cables installed underground is concerning as such cables often suffer from numerous issues including open circuits as well as short circuits all of which affect the reliability of distribution networks. This is why it is important to detect these issues immediately to avoid prolonged blackouts and ensure uninterrupted power supply.

By coming up with a new underground cable fault detection system that incorporates the best of sensing systems coupled with efficient algorithms for data analysis, this project aims at providing a solution to this problem. It incorporates modern technology such as Arduino, LCD and switches to come up with a fault detection system that is more efficient as compared to the past systems. The suggested system aims to significantly improve the underground cable repair process by providing an immediate monitoring and the identification of the cause of the issue.

2. LITERATURE SURVEY

The goal of this project is to calculate the distance in kilometers from the base station to an underground cable fault and then show that distance online. The majority of major metropolitan regions rely on subterranean cable networks. Because the exact location of the problem is unknown, fixing a cable that is malfunctioning for whatever reason could be difficult. By utilizing this technology, the exact location of the problem may be pinpointed and displayed on the LCD panel all at once. At the feeder end, a series resistor (cable lines) applies a low DC voltage, which causes the current to fluctuate according to the traditional theory of Ohm's law [1].

A defect location model for underground electrical cables is suggested in this work. It makes use of the internet-based Internet of Things (IoT) and raspberry pi, which implies that data will be transmitted over internet access. Finding the location of the underground cable fault and measuring the distance in kilometers from the base station are the goals of this method. This work applies the straightforward idea of CT Theory, which stands for Current Transformer Theory. The voltage drop that results from a short circuit or other problem is proportional to the length of the affected cable; to determine this, a current transformer is employed. A microprocessor performs the required computations, while the signal conditioner controls the voltage change. in order for IoT devices to show the defect distance. After that, any access point can receive these error data via the internet and display them [3].

Finding the source of a transmission line fault is a labor- and resource-intensive process. Usually, this takes a long time, and you run the danger of ripping the insulation off the cable as you dig it. Automating the process of fault identification and placement offers a straightforward and secure option, as presented in this study. An easy way to implement OHM's law in this project is to use a series resistor to apply a low DC voltage to the feeding end. If an LL, 3L, or LG short circuit were to occur, the current would change based on the cable's fault length. As a result, the series resistor voltage droop varies, pinpointing the exact spot of the defect and facilitating the repair of that specific cable. By using the proposed technique, the precise location of the problem can be located. A rectified power source and an Arduino micro controller kit are utilized in this setup. In this case, the thermal controller receives digital data indicating the cable length in kilometers from current sensing circuits constructed with a mixture of resistors that are interfaced to an Arduino micro controller kit through the internal ADC device. The collection of switches is responsible for creating the issue. The relay driver is responsible for controlling the relays. In order to see the data, the controller is linked to a 16x2 LCD screen. In the event of a short circuit, the voltage across the series resistors will change, which will be passed on to an ADC. This will generate accurate digital data, which can be input into a pre-programmed Arduino micro controller kit. The kit will then show the exact position of the defect in kilometers from the base station. A capacitor in an alternating current circuit can detect an open circuited cable and quantify its impedance, allowing for future implementation of the project [4].

3. IMPLEMENTATION

MODULES

1. Power Supply Module Description: This module provides the necessary power to all components of the system, including the Arduino, LCD, and switches. It ensures that the system operates reliably by delivering a stable voltage and current. Components: - Power Adapter - Voltage Regulator – Capacitor.
2. Arduino Microcontroller Module Description: The Arduino microcontroller serves as the central processing unit of the system, coordinating inputs from the switches and sensors, processing the data, and controlling the LCD display.
3. Fault Detection Module Description Underground cable fault diagnosis: This module is great for finding cable issues like open circuits and short circuits. Emulating problems and generating signals that the Arduino could process is made possible through wiring and circuitry. Components: - Toggle Switches
4. LCD Display Module Description: Another means of displaying the information is the LCD module that enables the detected faults to be shown in ease and does depict the state of the underground cable.

Components: - 16x2 LCD Display

5. Description: These are used in the underground cable system for opening and closing the specific circuits and used to mimic certain failures. Every switch refers to a distinct area of the cable. Components: - SPST (Single Pole Single Throw) Toggle Switches.
6. Signal Processing Module Description: This module takes the signals from the toggle switches and decides the kind of fault and also compiles the data that should be displayed on the LCD.
   Components:
   - Signal Conditioning Circuitry
   - Analog-to-Digital Converter (if needed)
7. Fault Indication Module Description: This module provides a visual indication of the fault type and location using the LCD. The status of the underground cable can easily be relayed to the user and he/she can be made to understand the situation within a short span of time. Components: - LCD Display - Arduino Output Pins
8. System Initialization and Calibration Module Description: This local module is mainly responsible for initializing the entire system and checking its components for proper functionality before the fault detection process starts.

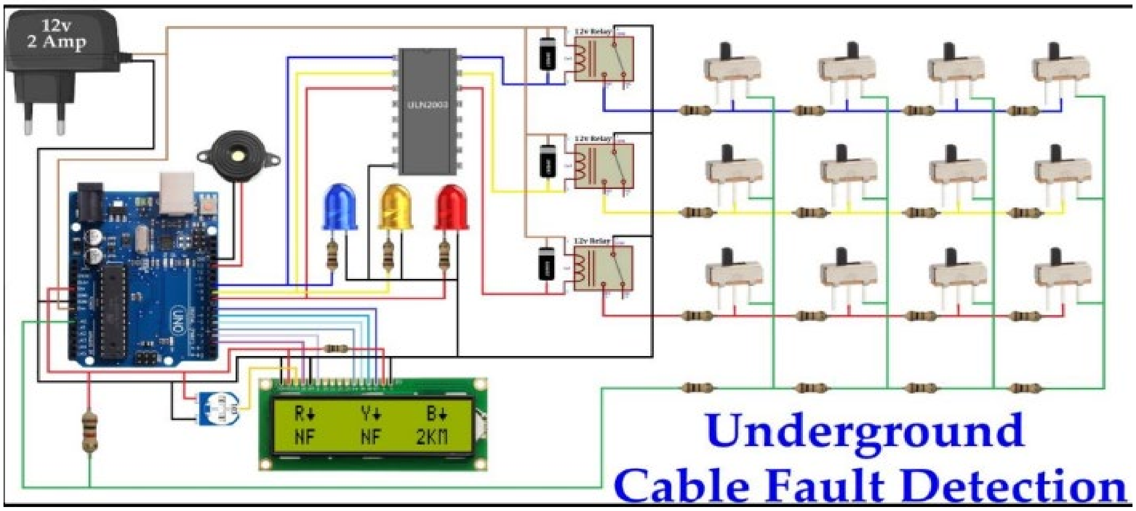

Fig1:-Circuit Diagram of Underground Cable Fault Detection

4. SYSTEM ARCHITECTURE

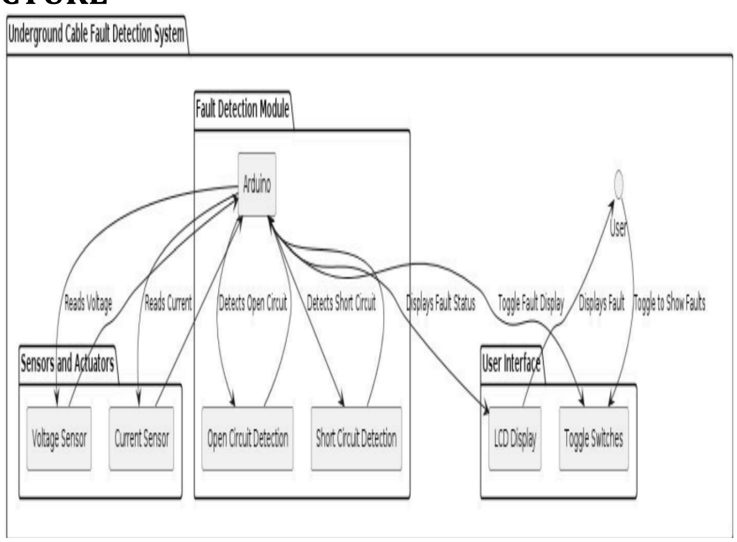

Fig2: System Architecture

The system architecture of this underground cable fault detection system consists of three main modules:

1. Sensors and Actuators
2. Fault Detection Module
3. User Interface

Sensors and Actuators are the modules that are utilized for the collection of data from the underground cable. It consists of two sensors:

- Voltage Sensor
- Current Sensor

These sensors are used to determine the voltage and current values in the cable. Any variation in these parameters is indicative of a fault. The information collected by these sensors is then fed to the Fault Detection Module.

The FD module is the core of the system. It employs an Arduino microcontroller that analyzes data collected by the sensors and identifies possible faults It performs two main operations:

- Detects Open Circuit: It provides a readout of the voltage and current to check whether the cable has an open circuit.
- Detects Short Circuit: It measures the voltage and current then checks whether there is a short circuit in the cable. The User Interface enables users to interact with the system. It has a liquid crystal display (LCD) that shows the status of the cable as well as switches for the display. Some options include switching the display to show the detected faults or display a different mode.

The system operates as follows:

1. The sensors check the levels of the voltage and current that is flowing through the cable.
2. The data collected by the sensors is fed to the Arduino.
3. Using the collected data, Arduino evaluates the existing situation to identify whether there is an open circuit or a short circuit.
4. When a fault is detected, the Arduino sends the status to the LCD display unit to be displayed.
5. This allows users to convey instructions to the system through the toggle switches and adjust the display. The user interface also facilitates the monitoring of the underground cable as well as detecting any faults that may be present. This system is useful in avoiding anything that may harm the cable and at the same time, guarantee the functionality of the cable.

5. RESULTS

It was possible to observe that the system had a high efficiency and could correctly highlight open circuit and short circuit faults. The toggle switches could accurately emulate the various fault conditions that were required. As expected, the LCD showed the appropriate status of the fault in real-time. All the unit tests and the output tests were successful, which proved the effectiveness of the system.

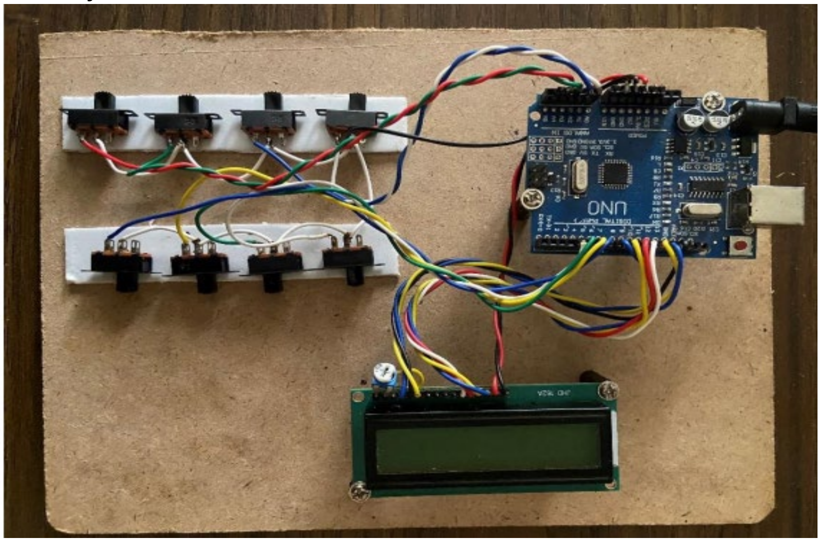

Fig3: Project Module without Power Supply

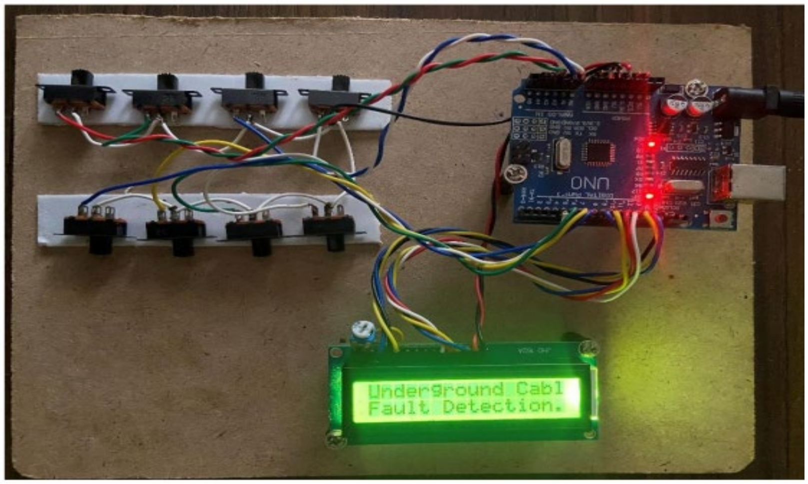

Fig4: LCD Display

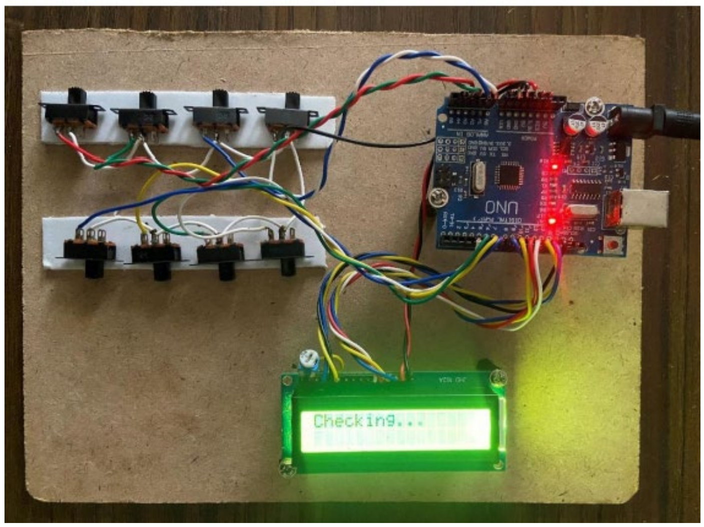

Fig5: Checking System

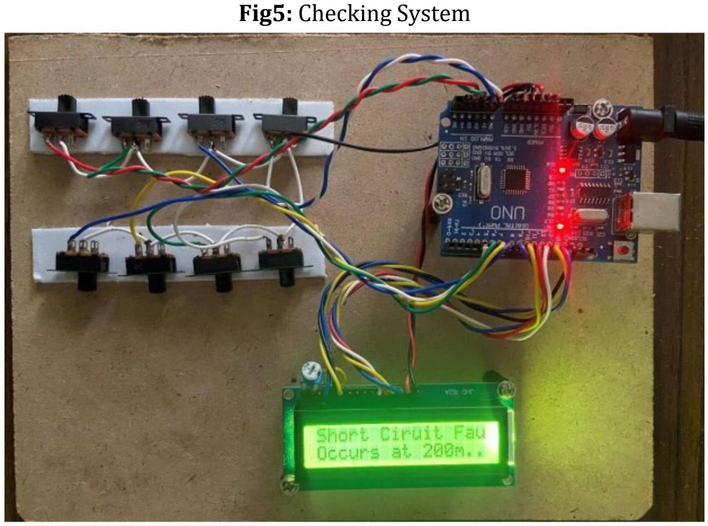

Fig6: Displaying Short Circuit Fault at 200m

6. CONCLUSION

Underground cable fault or fault location is another intricate process that utility operations personnel undertake in order to detect faults on underground power cables. This is done using the fault location equipment in order to get an exact position of the fault. There are three generic types of fault location equipment available and each has various advantages and disadvantages. The choice of equipment that should be used depends on some factors like the type of cable, the kind of fault and the environment. Using the above criteria, the most appropriate approach towards choosing the right fault locator is as follows: The primary step involves the identification of the first piece of equipment while the secondary step focuses on the identification of the equipment most appropriate for a specific fault.

CONFLICT OF INTERESTS

None.

ACKNOWLEDGMENTS

None.

REFERENCES

Manish Paul1, Raj Kamal Kakoti, International Advanced Research Journal in Science, Engineering and Technology.

D. Sharmitha, J.J.Nandhini, International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8 Issue.

Padmanaban.K1, Sanjana Sharon.G2, Sudharini.N 3 ,Vishnuvarthini.K4 International Research Journal of Engineering and Technology.

B, Amer Kumar Maheshwari, Mukhtiar Ahmed Mahar, Abdul Sattar Larik and Gul Hassan Talpur Department of Electrical Engineering Mehran University of Engineering and Technology

A.Ngaopitakkul, C.Pothisarn, M.Leelajindakrairerk, "Study of Characteristics for Simultaneous Faults in Distribution Underground Cable using DWT", 2011 IEEE