Mini-Project report

On

Cable Fault Detection

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ABSTRACT

Cable fault detection is a crucial task in maintaining and optimizing the performance of power transmission and distribution systems. Timely and accurate detection of cable faults helps in minimizing downtime, reduce repair costs, and ensuring the reliability of the electrical network.

The purpose of our project is to determine the distance from the base station to the cable fault location in kilometers. In our project, we use the simple concept of Ohm's law. When a fault occurs in the system the distance is displayed on the liquid crystal display (LCD).

Adverse weather conditions such as storms, snow, torrential rains, and pollution can affect the lines, but when a fault occurs in lines it is difficult to locate the fault in the cable. Now the world has become digitized, so the project is aimed at detecting the exact location of the fault. Although the fault occurs for some reason, the repair process for this particular cable is difficult because of not knowing the exact location of the cable breakdown.

Overall, the proposed cable fault detection system offers a cost-effective, customizable, and accessible solution for detecting and monitoring faults in cables, making it a valuable tool for both professionals and educational purposes. Considering the advancement of technology and increasing demand for reliable power transmission and distribution systems, future applications of cable fault detection are promising

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LIST OF ABBREVIATIONS

ABBREVIATION	FULL FORM
LCD	LIQUID CRYSTAL DISPLAY
IOT	INTERNET OF THINGS
ADC	ANALOG TO DIGITAL CONVERTER
DWT	DISCRETE WAVELET TRANSFORM
TDR	TIME DOMAIN REFLECTOMETRY
AOC	ACTIVE OPTICAL FIBRE
ATP	ALTERNATIVE TRANSIENT PROGRAM
EMTP	ELECTROMAGNETIC TRANSIENTS PROGRAM
ULVDN	UNDERGROUND LOW VOLTAGE DISTRIBUTION NETWORK

CHAPTER 1

INTRODUCTION

Cable faults pose significant challenges in power transmission and distribution systems. These faults can be caused by insulation deterioration, mechanical damage, or environmental factors. Detecting cable faults promptly is essential for maintaining the system's integrity and minimizing power outages. Traditional methods of fault detection, such as manual inspection, are time-consuming, inefficient, and often unreliable. To overcome these limitations, various advanced fault detection techniques have been developed, aiming to improve accuracy, reduce downtime, and enhance system reliability.

This overview begins by discussing the importance of string error detection and its impact on system performance. Our project is aimed at highlighting the need for an accurate and effective error detection style to save time and minimize maintenance costs.

The main idea of this design is to detect errors and abnormalities in the line. The idea behind how this design works is Ohm's law. When a DC voltage is applied to the converging end, the current value also changes depending on the position of the fault in the string.

For short circuit faults, such as the L-L fault, the voltage change measured across the resistor is also fed to the ADC connected to the Arduino. This value is read by Arduino to calculate the error based on the distance from the base station. This value is sent to the 16x2 LCD interface which displays the exact location of the fault from the base station in kilometers for all three phases.

The design consists of a series of resistors representing the length of the string. The fault switch is triggered manually to simulate the short circuit condition. Ultimately, we can determine the fault in the cable. Finally, this summary concludes with an outlook on future trends and implicit advances in string error detection. It emphasizes the importance of consideration and development when seeking innovative approaches.

1.1 Various kinds of faults in the cables:

Open circuit error:

These faults are caused by faults in one or more conductors. The most common causes of these faults include faulty cable and overhead line connections, failure of one or more phases of circuit breakers, and blown fuses or conductors of one or more phases. An open circuit fault is also called a series fault. These are asymmetric or single-ended fault types, with the exception of three-phase open faults.

Short circuit error:

A short circuit fault occurs when there is an insulation fault between phase conductors and the ground. Other short circuit faults can be categorized into two types:

Balance error and unbalance error.

1.2 Error detection methods:

Online method:

This method uses sampled voltages and currents and processes them to identify fault points. Online methods of underground cables are less common than overhead lines.

Offline method:

This method uses special equipment to test cable integrity in the field. This offline method can be roughly divided into two methods. They are the tracer method and the terminal method. Our project uses an online method to detect short circuit faults in cables.

1.3 Motivation for the work:

Traditional methods of cable fault detection, such as manual inspection or visual observation, are labor-intensive, time-consuming, and often ineffective, particularly in large-scale networks. These methods also suffer from limitations in accuracy, especially when dealing with underground or inaccessible cables. Consequently, there is a pressing need for advanced fault detection techniques that offer higher accuracy, faster detection, and improved reliability.

The motivation lies in the need to enhance cable fault detection capabilities, reduce downtime, minimize repair costs, and improve the reliability of power transmission and distribution systems.

CHAPTER 2

LITERATURE REVIEW

Underground Cable Fault Detection Using Arduino (International Research Journal of Engineering and Technology (IRJET)) (ISSN), **2022**

Author:- Samruddhi Ghadage

In this paper, when the system is shorted, the voltage across the series resistance will change. When a cable failure occurs, the buzzer will generate an alarm to alert field workers and take immediate action. With a series of resistors, the current sensing circuit node is now connected to the AM. A kit that supports internal AOC devices. When delivering digital data representing cable length in kilometers to a microcontroller, the 16 * 2 LCD display shows line failures and respective distances.

Gap:-The functionality of the system is driven by a microcontroller.

Underground Cable Fault Detector(International Journal of Research in Engineering, Science, **and** Management)(ISSN), **2020**

Author:- S. R. Shirdhone

This project works on the principle of Ohm's law. The feeder is fed through a resistor by a DC supply and as per the fault occurrence, the current through this resistor changes. Now depending upon this change in current the voltage across the resistance also changes. This change in voltage is fed to the microcontroller through ADC which converts this voltage signal to a readable form to the microcontroller. The microcontroller is coded to read various data given by ADC and give the signal to LCD for displaying consonant distances.

Gap:- The system's operations are enabled through the utilization of a microcontroller.

Arduino-Based Cable Fault Detector (ISSN)(International Journal on Recent and **Innovation Trends inComputing and Communication),2018**

Author:- Ingale

The project is to detect the location of the fault in a digital way. While fault occurs for some reason, at that timethe repairing process is delayed. Relays are controlling the relay driver. 16x2 LCD display connected to the microcontroller to display the information. In case of a short circuit, the voltage across series resistors changes accordingly, which is then fed to an ADC to develop precise digital data to a programmed Arduino microcontroller kit that further displays the exact fault location from the base station in kilometers.

Gap:-The current sensing technique is an integral part of the proposed system, whereas we employ a voltage-sensing technique.

Arduino-based Underground Cable Fault Detection (International Journal for Research in Engineering Application & Management (IJREAM))(ISSN),2017 [1]

Author:- Jagtap

The project uses the classic concept of the Ohms law, when a low voltage at the end of the power supply device is applied across a series resistor the current varies depending on the location of the fault of the cable. In the case of a short circuit, the voltage across the series resistors changes accordingly, then input to the ADC constructs the Arduino board to develop accurate digital data for the in-kilometer.

Gap:-According to this paper, the authors use IKD resistance for each 1 km distance. In this project, they connected 4 the resistance of km in series so that they can cover a 4km distance in each phase.

A review of faults and fault diagnosis in micro-grids electrical energy **infrastructure, 2014 [2]**

Authors:-James Hare Et Al

With the advancements in sensing, communication, and control technologies, the existing power systems have evolved with the development of Smart Microgrids.

Smart microgrids integrate information technology, communication technology, and power generation systems into one unified micropower system for robust and reliable power. Current and future microgrids are expected to have significant clean energy penetration with rising environmental concerns. A critical problem in power systems is the cascading effect of faults leading to severe failures and blackouts unless timely protective actions are taken. As a recovery mechanism, smart microgrids are envisioned to detect these critical changes and switch into island mode for continual power generation and system stability. However, their electrical energy infrastructure is also prone to faults and instabilities emphasizing the need to develop real-time algorithms for self-diagnosis that can capture failure characteristics in the early phase of their evolution using data collected from monitoring units. This paper provides a comprehensive review that focuses on faults and fault diagnosis methods in smart microgrids with clean and conventional generation systems as well as their interconnections.

Gap:-The utilization of smart Microgrids.

H. Shateri, S. Jamali Et Al., Proposed An impedance-based fault location method for three- phase faults and phase-to-phase. (ISSN),2012 [3]

Authors:- H. Shateri, S. Jamali Et Al.,

The method utilizes the measured impedance by distance relay and the superimposed current factor to discriminate the fault location. This method is sensitive to the measured superimposed current factor and impedance accuracy.

Gap:-The inclusion of a voltage factor is integral to our process

The behavior of simultaneous fault signals in the distribution of underground cable using DWT (IEEE), 2011[4]

Authors:- A. Ngaopitakkul Et Al.

The paper presents the characteristics of simultaneous fault signals in an electrical distribution underground cable using wavelet transform. The fault signal is simulated using ATP/EMTP, and the behavior analysis of signals is performed using discrete wavelet transform (DWT). The DWT is used to detect high-frequency components. The results obtained from the analysis will be useful in the development of a fault detection scheme for the electrical distribution underground cable in the future due to an effect of the other fault that occurs at the other side of the system, which leads to the malfunction of the protective relays.

Gap:-In the context of this paper, the emphasis lies on the analysis of signal behavior by means of the discrete wavelet transform technique, whereas our project relies on the principles of Ohm's law.

Underground cable fault detection and identification via Fourier analysis(IEEE),2010 [5]

Authors:- Abhishek Pandey and Nicolas H.Younan,

The paper presents the underground cable fault detection and identification through Fourier analysis. The method of impedance calculation by sending end voltage and differential voltage can be used for differentiating between the different types of cable defects from the phase information. It needs study to find the best way of visualizing the results and especially the magnitude response.

Gap:-This project deals with Fourier transform and impedance calculation, whereas our project relies on the principles of Ohm's law.

Fault-Location Algorithms Without Utilizing Line Parameters Based on the Distributed Parameter LineModel,2009 [6].

Authors:- Yuan Liao and Ning Kang

This paper presents a new accurate fault location algorithm for parallel transmission lines based on the distributed parameter line model. This method requires only voltages and currents from one end of parallel lines. Based on the sequence networks and boundary conditions, equations can be derived to obtain the fault location.

The new method fully considers the shunt capacitance of the line, and the mutual impedance and mutual admittance between the lines by using the accurate model for both positive and zero-sequence circuits, and obviates the need for an iterative process to compensate for the capacitance.

Gap:-This paper employs the use of mutual inductance, mutual admittance, and shunt capacitance.

Automatic fault location for the underground low **voltage distribution network,2001 [7]**

Authors:- S. Navaneethan, Et al.

The paper describes an automatic fault location technique for permanent faults in underground LV distribution networks (ULVDNs). It uses signals from an existing time domain reflectometry (TDR) instrument. It pre-processes the TDR signals to eliminate reflections due to single-phase tee-offs, and to locate 3-phase open or short circuit faults and also uses adaptive filtering to compare the TDR signals to locate faults. In essence, the procedure minimizes the interpretation skill required from a user of a typical TDR-based fault location instrument. The relative performance of the system is demonstrated using real-field data.

Gap:-This paper employs TDR signals for fault detection purposes whereas our project utilizes the Arduino to sense the voltage and default faults.

Problem Definition:

Cable faults, such as short circuits, open circuits, and cable breakages, can lead to safety hazards, operational inefficiencies, and financial losses. Timely detection and prompt maintenance of cable faults are crucial to ensure safety, prevent accidents, and minimize downtime.

However, traditional methods of cable fault detection often require manual inspection or specialized equipment, leading to time-consuming processes, increased costs, and limited scalability. There is a need for an automated, cost-effective, and efficient solution to detect cable faults accurately and in real time.

Objectives of the proposed work:

- The main objective of cable fault detection is to ensure the reliable operation of power transmission and distribution systems by promptly identifying the fault locations in cables.
- To minimize the downtime by quickly identifying the faults and that which helps in optimizing resource allocation for repair and maintenance activities.

CHAPTER 3

METHODOLOGY

COMPONENTS USED :

Arduino

Arduino UNO is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

ULN2003

The ULN2003 is an integrated circuit produced by Texas Instruments. It consists of an array of seven NPN Darlington transistors capable of 500 mA, 50 V output. It features common-cathode flyback diodes for switching inductive loads (such as servomotors). It can come in PDIP, SOIC, SOP, or TSSOP packaging.

DC relay

12V DC relay switches are the best solution for full voltage applications, as they allow a low current flow circuitto control a high current flow circuit.

Resistor

A resistor is an electrical component that limits or regulates the flow of electrical current in an electronic circuit. Resistors can also be used to provide a specific voltage for an active device such as a transistor.

Potentiometer

A potentiometer is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat.

Slide switches

A slide switch is a mechanical switch that slides from the open (off) position to the closed (on) position and allows control of a circuit's current flow without having to manually splice or cut wire.

Buzzer

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric(piezo for short). Typical uses of buzzers and beepers include alarm devices, timers, train, and confirmation of user input such as a mouse click or keystroke.

LED

A light-emitting diode (LED) is a semiconductor device that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. The color of the light (corresponding to the energy of the photons) is determined by the energy required for electrons to cross the band gap of the semiconductor.

AC Adapter

An AC adapter is an external power supply that converts alternating current (AC) from a wall outlet to a direct current (DC) needed by an electronic device. Therefore, it is an AC/DC converter.

BLOCK DIAGRAM:

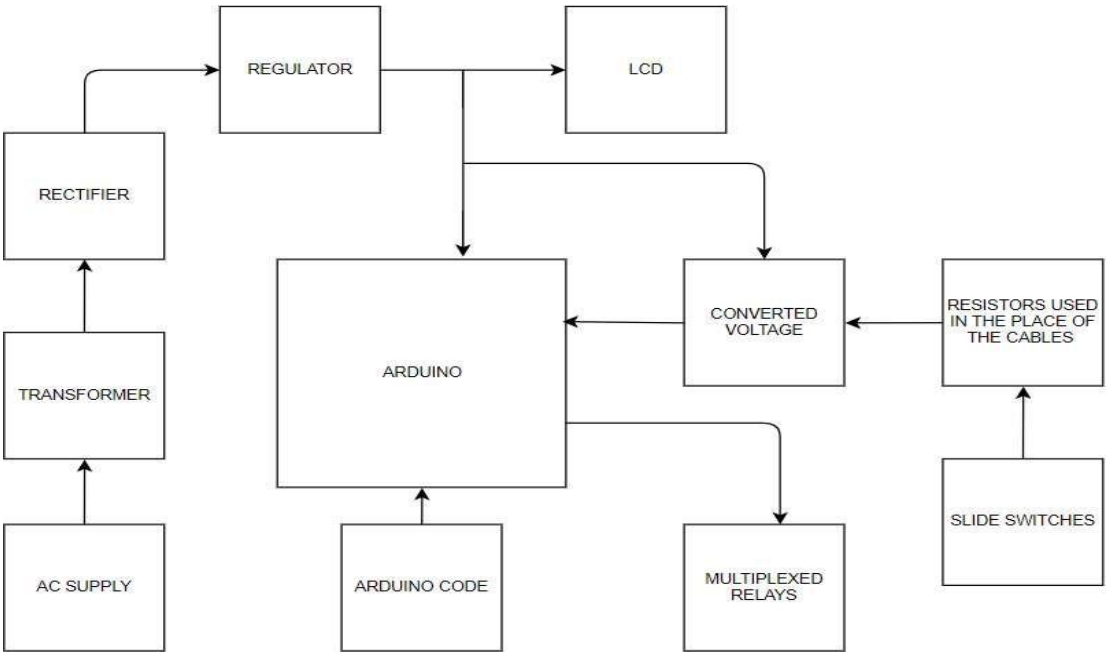

Figure 3.2 Block Diagram of cable fault detection

CIRCUIT DIAGRAM.-

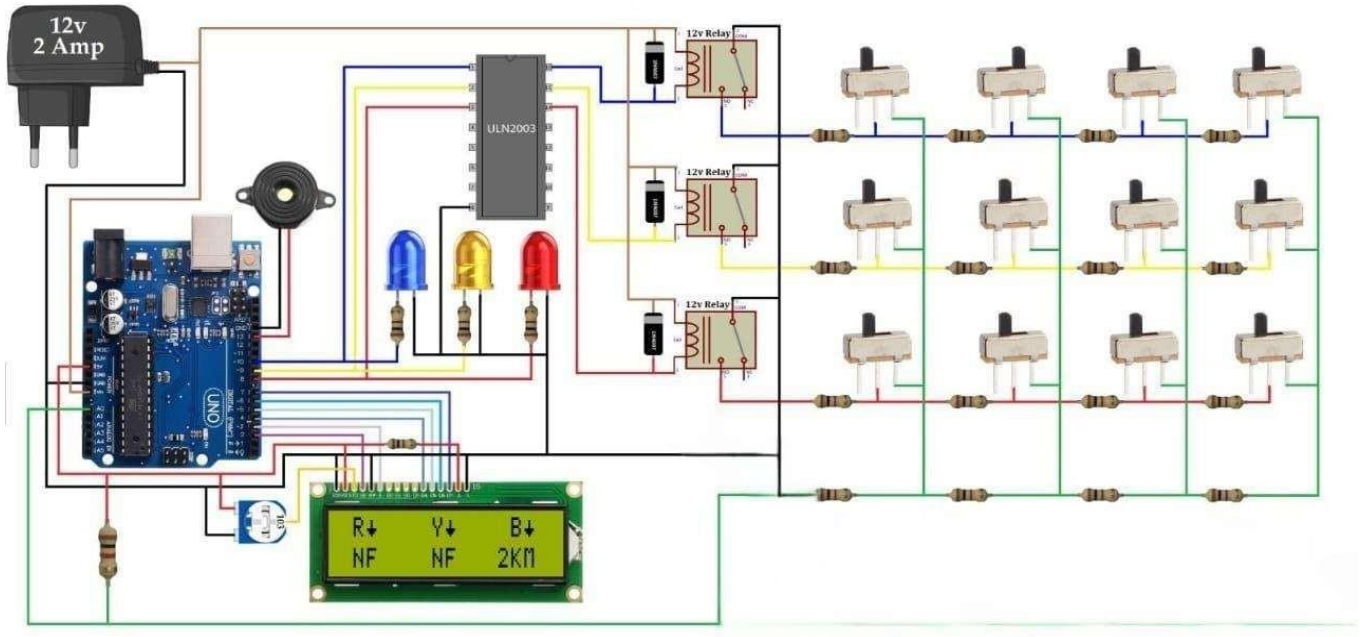

Figure 3.3 Circuit Diagram of cable fault detection

Working:

In the circuit, an adapter is used that gives a constant output of 12V,5 amps. This is used to supply power to the Arduino and the LCD. To induce faults manually in the kit, slide switches are used. About 12 slide 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 slide switches have 2 positions-No fault position (NF) and fault position (F). Each series resistor represents the resistance of the cable for a particular distance, so four resistances in series represent 1-4 kilometers. The value of each resistance is 100a. Each phase R, Y, and B has its own relays.

When a fault is induced by operating any of the 12 switches (to F position), they impose the condition Line to Line fault as per the switch operation. As a result of the fault, there is a change in the voltage value. This voltage value measured across the resistance is fed to the Analog to Digital Converter of the Arduino. Using this value, the Arduino computes the distance. Finally, the distance of the fault from the base station is displayed n kilometers.

RESULTS & DISCUSSION

CHAPTER 4

Cable fault detection is an important aspect of maintaining and troubleshooting electrical systems. Arduino, a popular open-source electronics platform, can be a useful tool in detecting cable faults. It's a difficult task to identify the faults in cables, hence by using the Arduino controller, exact location of the fault can be identified. This project can be applied to underground cables, overhead power line fault detection, and network cable fault.

PICTURES:

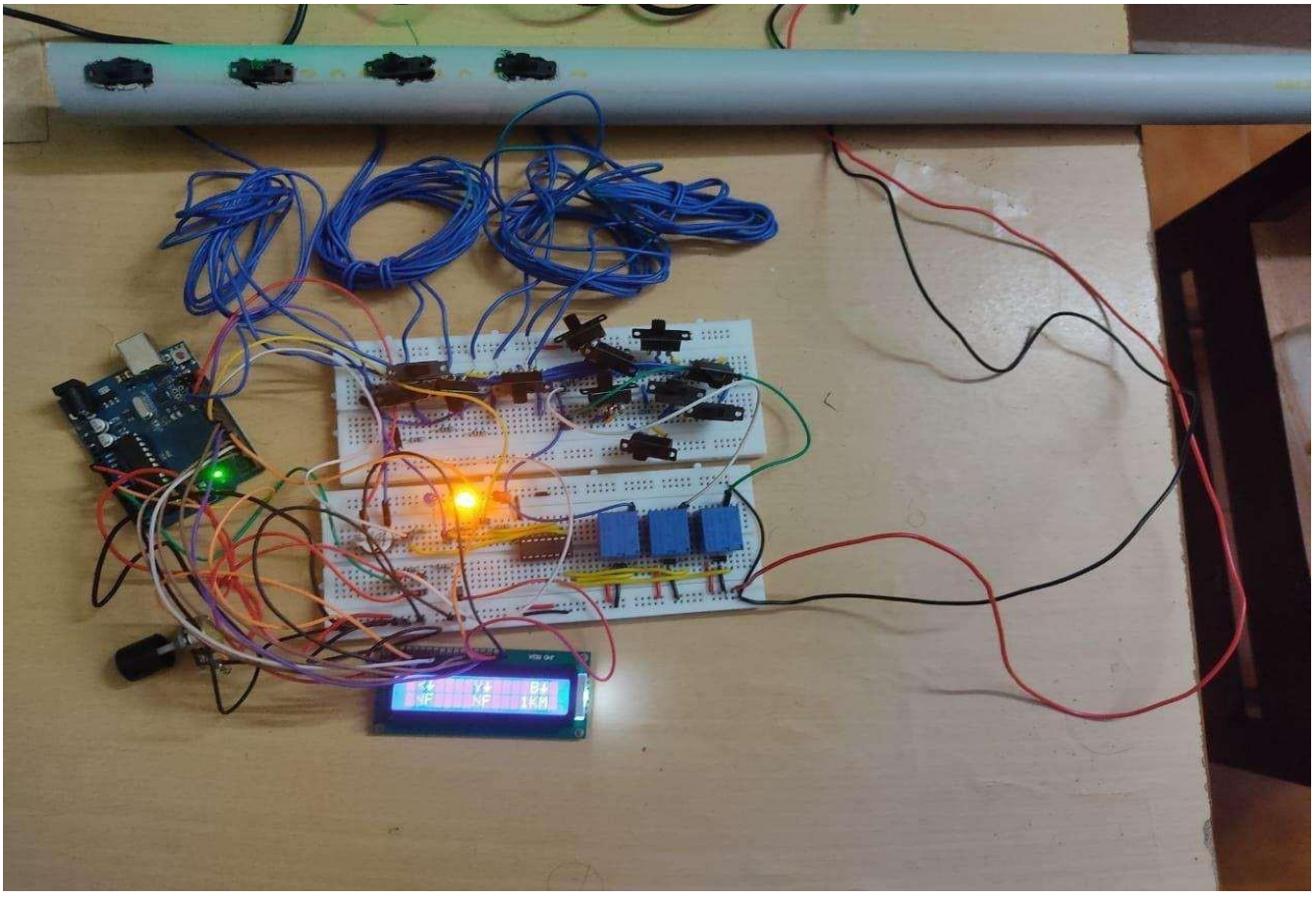

Figure 4.1 Output when there is a fault in the blue phase

By sensing the voltage change in the blue phase, the Arduino will identify the fault which occurred at a distance of 1km in the blue phase and present the output on a 16x2 LCD display.

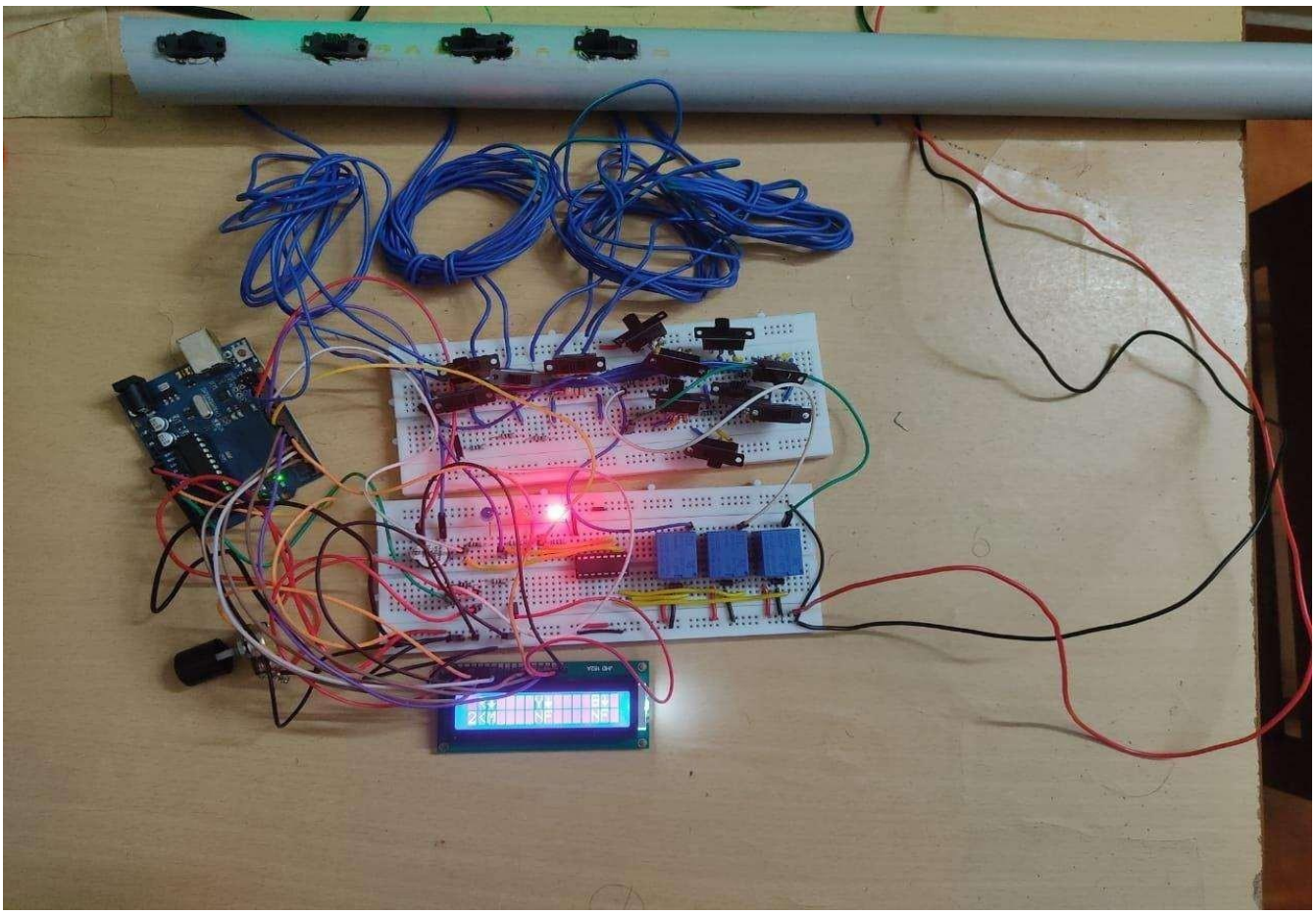

Figure 4.2 Output when there is a fault in the red phase

By the voltage change, the Arduino will identify the fault occurrence 2 km away and showcase the results on a l6x2 LCD display.

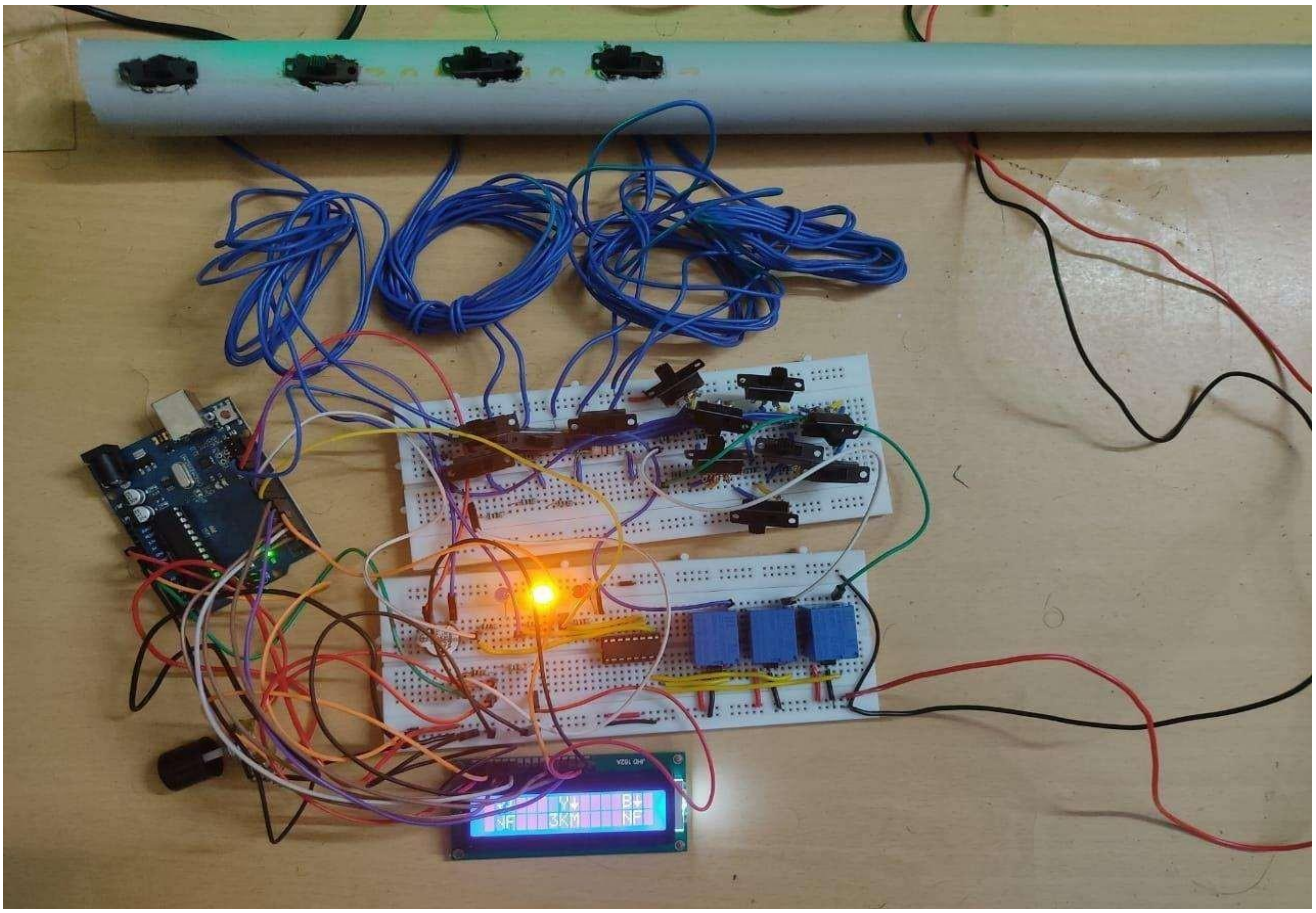

Figure 4.3 Output when there is a fault in the yellow phase

Through voltage monitoring, the Arduino will detect the fault that transpired at a distance of 3km in phase yellow and display the corresponding results on a 16x2 LCD display.

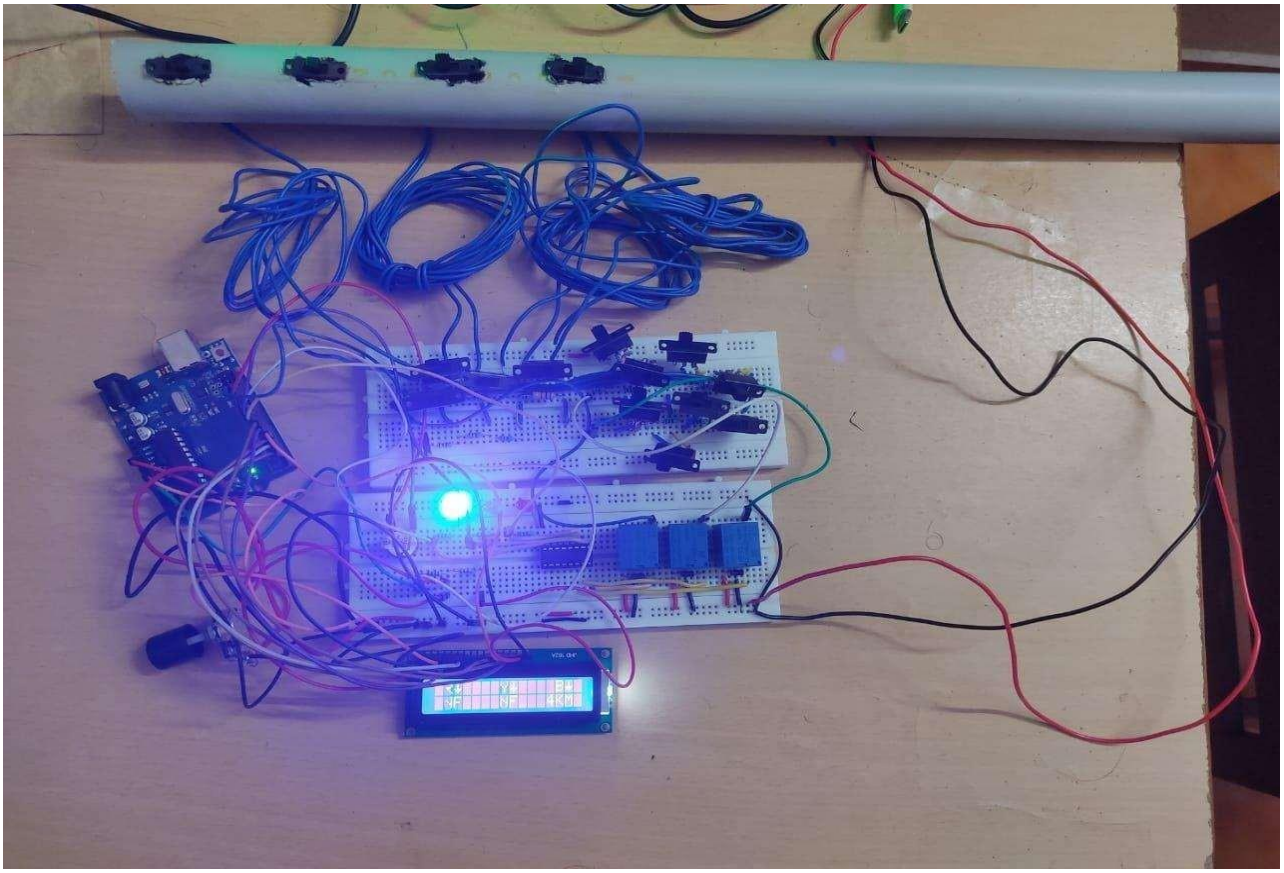

Figure 4.4 Output when there is a fault in the blue phase

Through voltage monitoring, the Arduino will detect the fault that transpired at a distance of 4km phase blue and display the corresponding results on an l6x2 LCD display.

DISCUSSION AND FUTURE SCOPE

In the future, advanced algorithms and machine learning techniques can be used. Also, the Internet of Things (IoT) and sensor technology to enable real-time cable monitoring can be used. Then there is integration with a smart grid. The cable fault detection system can be integrated into smart grid infrastructures to improve coordination and communication between various components of the energy system. Later this project can be implemented to calculate the impedance by using a capacitor in an AC circuit to measure the Open Circuit faults.

Overall, the future of cable fault detection holds great potential for increased reliability, reduced downtime, and streamlined maintenance strategies.

Advantages:

Real-time monitoring: The project facilitates real-time fault detection, enabling prompt response and minimizing downtime in case of cable failures.

Scalability: The concept can be extended to detect faults in various types of cables, including power cables, network cables, and communication cables.

Increased system scalability: Timely detection and repair of cable faults contribute to the overall longevity of the electrical system.

Enhanced safety: Faulty cables can pose some risks like electrical shocks, fires, and equipment malfunctions. This technique will help in identifying these problems so that necessary safety measures can be taken.

CHAPTER 5

CONCLUSION

In conclusion, cable fault detection is a crucial aspect of ensuring the reliability, safety, and efficiency of electrical systems. By using effective fault-detecting techniques like utilizing Arduino or any other methods, it is possible to detect and address the faults promptly. This also enhances the overall reliability of electrical systems by minimizing risks and failures in cables.

The project "Cable Fault Detection using Arduino" has significant potential in various industries and applications. Combining Arduino boards with appropriate sensors and fault localization techniques enables real-time monitoring and detection of faults in cables.

Ultimately, cable fault detection projects are vital investments in the long-term performance and sustainability of electrical systems, ensuring compliance with regulations and industry standards while maximizing system reliability and minimizing risks.

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