iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 **Issue:** X **Month of publication:** October 2024

DOI: https://doi.org/10.22214/ijraset.2024.64480

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue X Oct 2024- Available at www.ijraset.com

Underground Cable Fault Detection

Rajesh Dhamashetwad[1], Prasad Hase[2], Ritesh Borle[3], Prof. Dr. Bhausaheb Shinde[4], Prof. Shailesh Jadhav[5]
[1, 2, 3]Student, Department of Electronics and Telecommunication Engineering, Dhole Patil College of Engineering, Savitribai Phule Pune University, Pune, Maharashtra, India.
[4, 5]Assistant Professor, Department of Electronics and Telecommunication Engineering, Dhole Patil College of Engineering, Savitribai Phule Pune University, Pune, Maharashtra, India.

Abstract: Underground cables play a crucial role in delivering electricity, ensuring a dependable power supply in both urban and industrial regions. However, detecting and resolving faults in these cables can be difficult due to their hidden placement. This project aims to develop an effective underground cable fault detection system that accurately identifies fault locations, reducing downtime. The system will combine electrical principles with modern sensing technologies to detect faults such as short circuits, open circuits, and insulation issues. By injecting a small current into the cable and analyzing the resulting voltage drop, the system will calculate the distance to the fault from the measurement point. Using a microcontroller along with sensors and signal processing units, it will determine and display the fault location in kilometers.

Real-time fault detection will significantly decrease maintenance time and costs by quickly locating problem areas, enabling faster repairs and reducing power outages. This project aims to improve the efficiency and reliability of power transmission systems. Additionally, the system can be integrated with communication technologies for remote monitoring, allowing utility companies to detect and manage faults from centralized control centers.

Keywords: Underground , Fault , Detect , Money , Repairman.

I. INTRODUCTION

Underground power cables play a critical role in the distribution of electricity, especially in densely populated urban areas and regions where environmental conditions or aesthetics necessitate the burial of cables. Unlike overhead power lines, underground cables are less susceptible to environmental factors like wind, storms, or falling trees. However, they are still prone to faults due to various factors such as aging, water seepage, soil movement, and accidental digging during construction activities. When a fault occurs in an underground cable, it can lead to power outages, disruptions, and expensive repairs. One of the key challenges with underground cables is detecting and locating faults. Since these cables are buried beneath the ground, identifying the exact location of a fault can be time-consuming, requiring extensive digging and testing along the cable's path. Conventional methods of fault detection can be inefficient, leading to prolonged outages and higher maintenance costs. This project addresses the need for a more efficient and accurate underground cable fault detection system. By leveraging modern electronic principles and technologies, this system will enable quick identification and location of faults, reducing repair time and minimizing the overall impact on power transmission. The system aims to reduce downtime by automatically detecting faults, calculating the distance to the fault from a known reference point, and providing real-time information to technicians for faster response and troubleshooting. The importance of this project lies in improving the reliability and efficiency of power distribution networks. With increasing energy demand and the expansion of underground cabling systems, a reliable fault detection mechanism is essential to ensure uninterrupted power supply and reduce maintenance costs.

II. LITERATURE SURVEY

1) Presented Design & Implementation Of Fault Identification In Underground Cables Using IOT literature survey

The integration of IoT technology in underground cable fault detection has transformed traditional monitoring techniques, such as time-domain reflectometry and partial discharge analysis. While these conventional methods have been effective, they are often limited in providing real-time insights and typically require physical access to the cables, which can cause disruptions. Recent advancements have introduced the use of various sensors, including those for temperature, humidity, and vibration, in combination with microcontrollers like Arduino and Raspberry Pi for data processing.Communication protocols such as MQTT and Zigbee ensure efficient data transmission, while cloud computing enables comprehensive data analysis and predictive maintenance through machine learning algorithms.

For example, Zhang et al. (2020) developed a smart monitoring system that significantly enhanced the accuracy of fault localization, and Khan et al. (2021) proposed an IoT-based framework that integrates environmental monitoring with cable health assessment. However, challenges such as data security, energy consumption, and scalability persist. Looking ahead, future developments are expected to focus on incorporating artificial intelligence to further improve predictive analytics and enhancing communication technologies to ensure reliability in challenging environments. Overall, the application of IoT in underground cable fault detection offers significant advantages over traditional methods, supporting the evolution of smarter energy management systems.

2) The study models a 330kV transmission line using simulation techniques and the Simscape
Power Systems tool within the Simulink environment to analyze the behavior of power lines during faults. By simulating various fault scenarios, voltage and current waveforms are captured and examined to understand the transmission line's response. Distributed parameter modeling is employed, allowing faults to be injected at different locations along the transmission line, providing a more accurate representation of real-world conditions and tracking dynamic behaviors.

One of the advantages of this approach is that distributed parameter simulation offers a realistic depiction of cable behavior without the need for physical testing. Through simulation, different fault conditions, such as single line-to-ground, line-to-line, and three-phase faults, can be analyzed, offering visual insights through voltage and current waveforms. However, the limitations include the reliance on the accuracy of the simulation environment and the potential effects of assumptions made during the modeling process. Additionally, the process can be complex, requiring both expertise in simulation tools and a deep understanding of electrical systems for the proper analysis of results.

3) Arduino Based Underground Transmission Cable Fault Location System.
The literature on Arduino-based systems for underground transmission cable fault detection highlights significant progress in using affordable technology to enhance the reliability of electrical networks. Many studies focus on integrating Arduino microcontrollers with sensors like temperature, humidity, and voltage sensors for real-time cable condition monitoring. For example, Gupta et al. (2021) showcase how Arduino can detect insulation failures by measuring electrical parameters and identifying fault-related anomalies. Similarly, Sharma et al. (2022) explore how combining Arduino with signal processing techniques can improve fault localization accuracy, offering better results compared to traditional methods. Wireless data transmission through protocols such as Wi-Fi or Zigbee adds to the system's utility by enabling remote monitoring and faster response times. While challenges such as power consumption and data security are noted, solutions like energy-efficient designs and encryption methods are suggested to address these issues. Overall, the research highlights Arduino-based systems as cost-effective and efficient tools for fault detection and localization in underground transmission cables, contributing to the development of smarter, more resilient electrical infrastructure..

4) Underground Cable Fault Detection using Raspberry Pi and Arduino.
This paper presents a fault location model for underground power cables using Raspberry Pi and the Internet of Things (IoT), where information is transmitted via internet connectivity. The goal of this approach is to determine the distance of a cable fault from a base station in kilometers and to pinpoint the location of the fault. The method is based on the principles of Current Transformer (CT) Theory. When a fault such as a short circuit occurs, the voltage drop changes depending on the fault's distance along the cable. Since the current fluctuates during a fault, a Current Transformer is employed to measure the varying current. A signal conditioner processes the voltage change, and a microcontroller performs the necessary calculations to display the fault distance via IoT devices. These fault details are then transmitted to any access point through the internet and displayed remotely for monitoring and response.

5) Presented Underground Cable Fault Detector Using GSM
The primary objective of this project is to detect and locate faults in underground cables. In urban areas, electrical cables are often installed underground rather than using overhead lines. When a fault occurs, the repair process can be challenging, as identifying the exact location of the fault in underground power cables is difficult. This project aims to reduce the response time for technical teams to address these faults. Faults may occur due to short circuits, low voltage, or high voltage issues. Unlike previous techniques that focused solely on identifying short circuit faults, this project is designed to detect multiple fault types, including low voltage and high voltage faults. The system operates based on Ohm’s law, and the proposed approach not only identifies faults but also sends detailed fault information to the authorities via GSM. Additionally, it automatically cuts power to the affected location to ensure safety. The type of fault is displayed on an LCD screen, and a buzzer is triggered to alert the team, prompting immediate action.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue X Oct 2024- Available at www.ijraset.com

III. WORKING MECHANISM

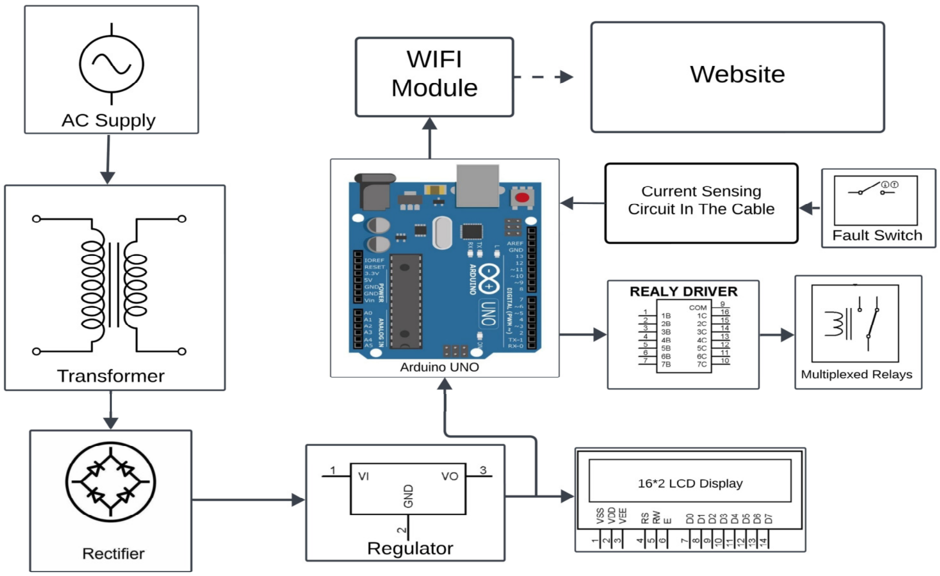


Fig 1- Block diagram

This project involves designing an underground cable fault detector with IoT integration. The hardware includes components like a step-down transformer, voltage regulator circuit, Arduino board, LCD display, and a Wi-Fi module. For demonstration purposes, resistors are used instead of cables, but in a real-world scenario, actual cables would be used. The resistance of the cable is directly proportional to its length, meaning that as the length increases, so does its resistance.

To simulate a fault in the demo, switches are used to represent different distances. Each switch corresponds to a 5 km section of the cable. In practice, the cable itself would create the resistance, so switches would not be needed. The system will use three relays, each representing a phase: R-phase, Y-phase, and B-phase.

The key task is to extend the cables, and the resistors and switches are not required in the real application. The system measures cable resistance to determine the distance at which a fault has occurred. When the system is powered on and a fault is detected, the fault distance is shown on the LCD screen, and the system connects to Wi-Fi, indicating that it is online.

Initially, the LCD will display R=0, Y=0, and B=0 Km. To create a fault in the R-phase at a distance of 10 km, the corresponding switch is toggled, grounding the circuit and indicating R=10 Km. This triggers the R-phase relay, and an LED lights up to show that the phase has been disconnected. Similarly, faults can be simulated for the Y and B phases at different distances by using the switches.

Whenever a fault is detected in a specific phase, the corresponding relay disconnects, and the status is indicated by LEDs (red, yellow, green for R, Y, B phases). The fault data is then uploaded to an IoT platform such as ThingSpeak, where it is displayed in both graphical and pointer representations. For example, when a fault occurs in the R phase at 10 km, the graph will update, and the pointer will show 10 km.

A. Advantages

1) Accurate Fault Location: The system provides precise fault location, allowing technicians to identify the exact distance of the fault from a known point, which minimizes unnecessary digging and reduces the time needed for repair.
2) Reduced Downtime: By quickly detecting faults and pinpointing their location, the system significantly reduces power outages and the time required to restore normal operations.
3) Cost-Effective: The system helps lower repair costs by eliminating the need for extensive cable excavation and manual inspections along the entire length of the cable.
4) Minimizes Damage: Detecting faults early and precisely helps prevents further damage to the cable and surrounding infrastructure, reducing the need for major repairs.

IV. SCOPE OF PROJECT

The scope of the underground cable fault detection project covers a broad range of applications aimed at improving the reliability and efficiency of power distribution systems. This system is particularly suited for urban, industrial, and rural environments, addressing the growing need for precise fault detection in underground cables, which are increasingly used for aesthetic and environmental reasons. It is capable of detecting various types of faults, including short circuits, open circuits, and insulation breakdowns, making it suitable for use across a range of voltage levels, from low to high.

In addition, the project offers the potential for integration with advanced communication technologies such as GPS, GSM, and IoT, allowing for real-time monitoring and remote fault detection. This integration helps reduce response times and provides utility companies with valuable data to support proactive maintenance efforts. The system's scalability ensures that it can be adapted to larger power grids, making it a strong solution for managing the increasing complexities of underground cable networks.

Ultimately, the project is designed not only to enhance operational efficiency but also to improve service reliability, reducing outages and contributing to a more resilient power infrastructure for the future.

V. CONCLUSION

In conclusion, the underground cable fault detection project presents a significant advancement in the maintenance and management of power distribution networks. Through the development of an efficient and accurate fault detection system, we have addressed critical challenges associated with underground cables, including timely fault identification and location. By leveraging modern techniques such as Time Domain Reflectometry (TDR), impedance measurement, and the integration of communication technologies like GPS and GSM, the system not only improves the reliability of electricity supply but also enhances operational efficiency for utility providers. The ability to detect various types of faults—ranging from short circuits to insulation failures—demonstrates the system's versatility and applicability across different voltage levels and settings. Furthermore, the implementation of real-time monitoring capabilities allows for proactive maintenance, minimizing downtime and repair costs while ensuring a continuous power supply. As the demand for reliable and efficient power infrastructure continues to grow, this project lays the groundwork for future innovations in fault detection technologies. By promoting the adoption of such systems, we contribute to the development of a more resilient and responsive electrical grid, ultimately benefiting consumers and power companies alike. This project not only highlights the importance of advancing cable fault detection methods but also emphasizes our commitment to enhancing the sustainability and reliability of modern power distribution systems.

REFERENCES

[1] M. R. H. Hossain, A. A. M. Rahman, and M. T. I. Khan, "Real-Time Monitoring and Fault Detection of Underground Cables Using IoT," in Proceedings of the 2019 IEEE International Conference on Power Electronics, Drives, and Energy Systems (PEDES), pp. 1-5, 2019.

[2] J. K. Smith, "An Overview of Modern Techniques for Underground Cable Fault Detection," in 2017 IEEE Power and Energy Society General Meeting, pp. 1-6, 2017.

[3] “Detection and localization of cable faults by time and frequency domain measurements”, Qinghai Shi, Troeltzsch U, Kanoun O. Conf. Systems and Signals and Devices, 7th International conference, Amman.2010; 1-6

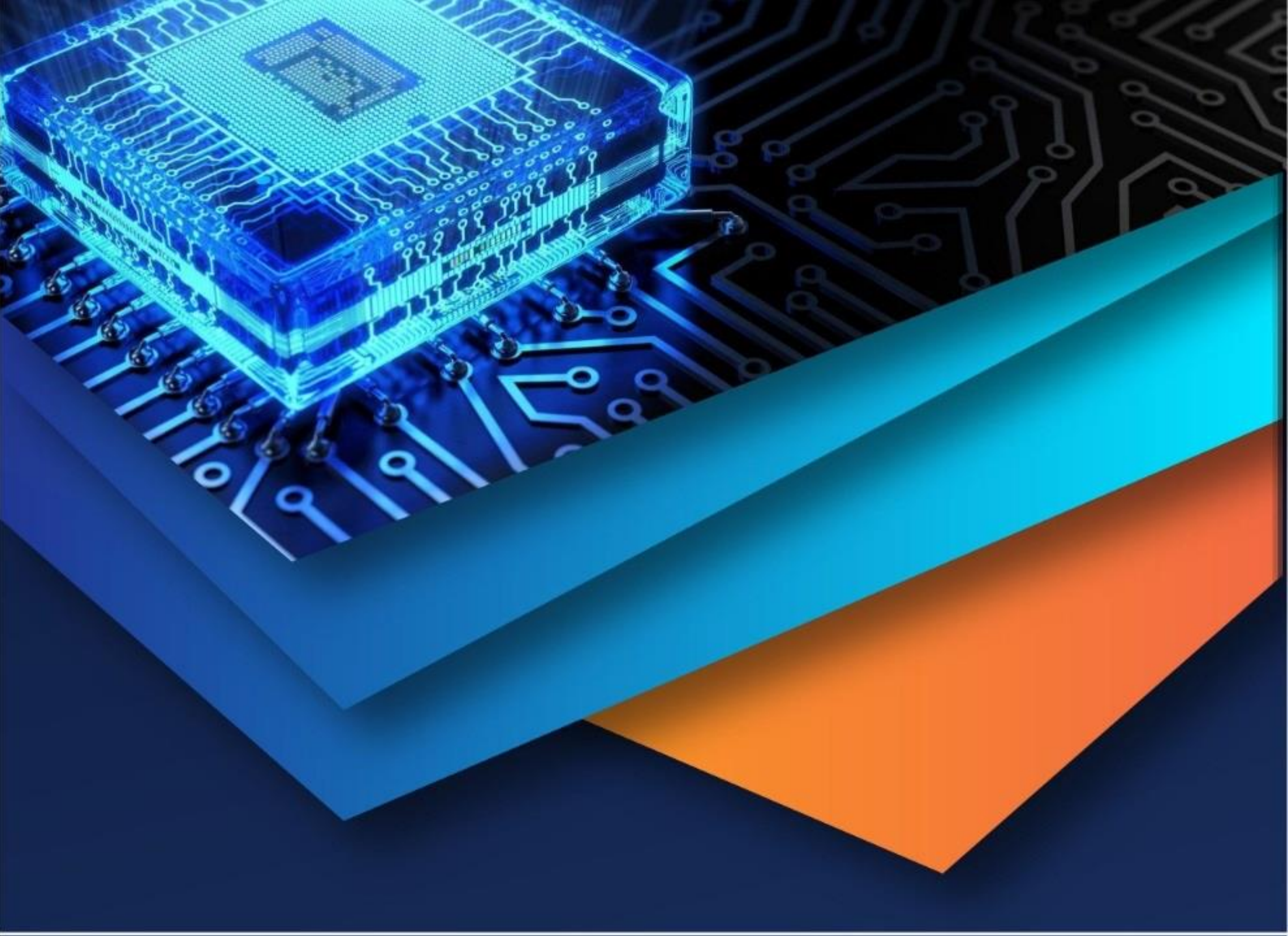
[4] “Underground Cable Fault Location” ,B. Clegg. New York: McGraw- Hill, 1993. “A line to ground fault location algorithm for underground cable system”, M-S Choi, D-S Lee, Jun. 2005.

[5] “Computerized underground cable fault location Expertise”, E. C, Bascom in Proc. IEEE Power Eng. Soc. General Meeting, Apr. 10-15, 1994, pp.376-382 J.

[6] “Detection of incipient faults in distribution underground cables”, IEEE transactions on power delivery, Tarlochan S. Sidhu, ZhihanXu, Vol. 25, No. 3, JULY 2010.

[7] “Locating underground cable faults: A review and guidelines for new development”, Md. Fakhrul Islam, Amanullah M T Oo, Salahuddin. A. Azad1, 2013 IEEE.

[8] IOT based underground cable fault detection www.nevonprojects.com.



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY