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# Underground Cable Fault Detection using Micro Controller

Prof. Nikhita A. Kolhe<sup>1</sup>, Prasad P. Patil<sup>2</sup>, Vikas V. Kor<sup>3</sup>, Prathamesh M. Verma<sup>4</sup>,  
Sarvesh B. Vyapari<sup>5</sup>

Department of Electrical Engineering, Indala College of Engineering, Kalyan, India.<sup>1</sup>

Department of Electrical Engineering, Indala College of Engineering, Kalyan, India.<sup>2,3,4,5</sup>

**ABSTRACT:** Underground electrical power distribution networks are becoming increasingly important due to their improved safety, reduced pollution, and enhanced system reliability. Despite these advantages, locating faults in underground cables remains a major challenge because the faults are not visible and usually require excavation or manual inspection, leading to high maintenance cost and extended outages. This paper presents a microcontroller-based underground cable fault detection and location system integrated with IoT technology to offer a low-cost, accurate, and efficient solution capable of identifying fault type and estimating the fault distance in real time. The proposed system operates on the principle of voltage variation across a potential divider network. When a fault occurs, the resulting change in voltage is sensed through an analog-to-digital converter, enabling the microcontroller to calculate the exact location of the fault from the monitoring point. The prototype includes sensing circuits for short-circuit, open-circuit, overvoltage, and undervoltage conditions, and displays results on an LCD while simultaneously transmitting real-time information through an IoT platform. A hardware model consisting of resistor-based cable simulation, sensors, buffering circuits, relay drivers, and a microcontroller was developed to validate the methodology. Experimental outcomes confirm that the system offers accurate fault estimation, quick response, and remote monitoring capability, significantly reducing the need for unnecessary excavation and minimizing downtime. The system's simplicity, reliability, and IoT-based communication make it highly suitable for real-world low-voltage and medium-voltage distribution environments, including urban networks, industrial installations, and smart city infrastructure. Future improvements may include GPS-based mapping, impedance-based AC fault analysis, and predictive diagnostics using machine learning.

**KEYWORDS:** Underground Cable Fault Detection; Microcontroller; IoT Monitoring; Fault Location.

## I. INTRODUCTION

Underground power distribution is widely adopted in modern urban networks due to its superior safety, reliability, and resistance to harsh weather conditions. Unlike overhead lines, underground cables are protected from environmental disturbances such as storms, lightning, falling branches, and pollution, making them preferred in densely populated regions, industrial areas, airports, and metro rail systems. However, when faults occur in underground cables due to moisture ingress, insulation breakdown, rodent attacks, ageing, mechanical stress, or accidental excavation, locating the exact point of failure is extremely difficult. Traditional methods rely on physical inspection, trial-and-error digging, or complex equipment, all of which lead to increased repair time and operational cost. These challenges highlight the need for a low-cost and efficient system capable of detecting and locating underground cable faults quickly and accurately. The present study proposes a microcontroller-based solution integrated with IoT communication to enable real-time monitoring of underground power cables and thereby improve the overall reliability of distribution networks.

## II. LITERATURE REVIEW

Several research efforts have focused on improving underground cable fault detection techniques. Early approaches often relied on bridge circuits, pulse reflection methods, and high-voltage testing equipment, which were effective but expensive and required technical expertise. Later studies introduced microcontroller-based solutions that utilized voltage-drop measurements to estimate fault distance. These solutions implemented the principle of Ohm's law and potential divider networks to measure voltage variations caused by faults. More advanced methodologies explored the

use of embedded controllers, wireless communication modules, and low-cost sensors for enhanced monitoring and automation. Research also expanded into expert systems, artificial intelligence, and impedance based techniques for high-voltage systems. The significant trend observed in the literature is the shift toward integrating fault detection with real-time communication technologies, enabling intelligent monitoring and faster maintenance response. The present work aligns with this trend by combining a microcontroller-controlled detection mechanism with IoT-based alert systems to create an efficient diagnostic tool for underground electrical networks.

### III. METHODOLOGY

The proposed system functions by applying a low DC voltage across the underground cable model. Under normal operating conditions, the voltage distribution along the cable remains stable. When a fault occurs, such as a short circuit, open circuit, or abnormal voltage level, the voltage drop changes, and this variation is sensed by the microcontroller through an analog-to-digital converter. Using pre calibrated values, the microcontroller interprets the voltage difference to compute the approximate distance of the fault from the monitoring point. This computation is then displayed on an LCD module for immediate on-site observation. To extend the system's functionality, an IoT module is integrated to transmit the detected fault information to remote users through the internet. This allows personnel to receive notifications instantly without being physically present near the underground system. The methodology ensures efficient detection, simplified operation, and real-time reporting, which collectively enhance the reliability of underground cable monitoring.

### IV. SYSTEM DESIGN AND HARDWARE IMPLEMENTATION

The hardware setup includes a regulated power supply that converts AC mains into stable DC voltages required for the microcontroller and sensors. A resistor network is used to simulate the length of the cable, with switches representing different fault points for experimental testing. Sensors for overvoltage, undervoltage, and short-circuit conditions feed their outputs through buffering circuits and monostable multivibrators to ensure stable signal conditioning before reaching the microcontroller. Relay drivers are employed to isolate and control switching operations. The core of the system is the microcontroller, which performs periodic voltage sampling and fault computation. An IoT or GSM module enables the transmission of detected fault details to a remote device. The LCD provides a user-friendly interface for displaying live cable status, including the fault location and affected phase. The system is designed to be compact, low-cost, and suitable for integration into practical distribution networks.

### V. RESULTS AND DISCUSSION

The hardware prototype was tested by simulating faults at known distances along the resistor-based cable model. The microcontroller accurately calculated the fault distance and identified the fault type in each case. The voltage sensing mechanism performed reliably under different simulated fault conditions, confirming the effectiveness of the potential divider method. The system responded quickly to voltage changes and successfully transmitted fault notifications through the IoT platform, demonstrating its suitability for remote monitoring. Overall, the results indicate that the system significantly reduces the complexity of locating underground cable faults while improving the speed of maintenance activities. Compared to traditional methods, the solution offers a practical, low-cost, and technologically advanced alternative for cable monitoring in modern electrical networks.

### VI. ADVANTAGES

The proposed system provides an affordable and accurate method for detecting underground cable faults without requiring advanced testing equipment. Its IoT-based reporting enables immediate awareness of cable faults and supports timely decision-making. The compact hardware design ensures easy implementation, while the microcontroller-based processing offers efficient fault estimation. The system reduces downtime, minimizes manual labour, and eliminates unnecessary excavation. It also supports enhanced safety and reliability within power distribution networks and aligns with ongoing developments in smart grid technology.

## VII. LIMITATIONS

The system is primarily designed for DC-based testing and may require modification for AC cable fault detection in real-world installations. Variations in soil resistivity and cable path complexity can affect measurement accuracy. Additionally, long-distance or multi-branch cable networks may require advanced signal processing techniques to maintain precise fault localization.

## VIII. APPLICATIONS

This system can be applied to underground electrical distribution networks in residential and industrial areas. It is useful in metro stations, airports, commercial complexes, and smart city infrastructure, where underground cabling is extensively used. It can also be applied to underground control cables, communication networks, and instrumentation systems. Its low cost and simple operation make it suitable for deployment in both developing and advanced power distribution environments.

## IX. CONCLUSION AND FUTURE SCOPE

The microcontroller-based underground cable fault locator presented in this study provides a reliable and cost-effective solution for identifying and locating faults in underground cable systems. By integrating IoT-based communication, the system ensures real-time monitoring and rapid response, which are essential for reducing downtime and improving overall network reliability. The prototype successfully demonstrates accurate fault detection and distance estimation, making it a promising option for widespread practical use. Future developments may focus on incorporating GPS-based mapping for visual fault representation, extending the system to AC cable networks through impedance analysis, and integrating machine learning algorithms to support predictive maintenance. These enhancements can further strengthen the role of such systems in modern smart grid applications.

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