IOT Based Underground Cable Fault Detection

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Abstract — Underground power cables are widely used in modern electrical distribution systems due to improved safety, reliability, and aesthetic advantages. However, locating faults in underground cables remains a difficult and time-consuming task. This paper presents a detailed IoT-based underground cable fault detection system integrated with a web-based monitoring platform. The proposed system continuously monitors voltage and current parameters using sensors, processes real-time data through a microcontroller, and identifies faults such as open circuit, short circuit, and earth faults. Fault information including type and approximate location is transmitted through an IoT communication module to a web interface for remote monitoring. The system significantly reduces downtime, minimizes excavation efforts, lowers maintenance cost, and enhances reliability of power distribution networks. The design is scalable and suitable for integration into smart grid infrastructure.

Keywords: Underground Cable, Fault Detection, IoT, Web Monitoring, Microcontroller, Smart Grid

I. INTRODUCTION

Underground cabling systems are increasingly adopted in urban and industrial areas due to their reduced exposure to environmental conditions such as storms, pollution, and mechanical damage. Despite their advantages, detecting and locating faults in underground cables is complex because the cables are not visible and require excavation for inspection. Traditional fault detection methods rely heavily on manual measurements and skilled labor, resulting in increased operational cost and prolonged service interruption.

The rapid development of embedded systems and Internet of Things technologies has enabled real-time monitoring and automated fault detection systems. This project proposes an integrated solution that combines sensors, a microcontroller, and a web-based interface to provide continuous monitoring and remote accessibility. The system calculates fault distance based on resistance and voltage drop principles and displays the results on a web page, enabling faster response and improved efficiency.

II. LITERATURE SURVEY

Various techniques have been developed for underground cable fault detection. Traditional approaches such as Time Domain Reflectometry (TDR), Murray Bridge, and Varley Bridge methods estimate fault location by analyzing signal reflections or resistance changes. Although accurate, these methods require expensive equipment and manual operation. Microcontroller-based systems improved automation by continuously monitoring electrical parameters and displaying fault information locally. Recent advancements emphasize IoT-based monitoring systems where fault data is transmitted to cloud servers or web platforms for remote access. However, challenges such as sensor noise, internet dependency, and cost constraints still exist. The proposed system addresses these limitations by providing a cost-effective and scalable web-integrated monitoring solution suitable for practical deployment.

III. AIM OF PROJECT

The aim of this project is to design and develop an IoT-based system for detecting and locating faults in underground electrical cables in real-time. The system will monitor electrical parameters such as current and voltage using appropriate sensors. When a fault occurs—such as an open circuit, short circuit, or insulation failure—the system will automatically identify the fault and determine its approximate location using signal analysis techniques. The fault information will then be transmitted wirelessly through an IoT communication module (such as GSM or Wi-Fi) to a remote monitoring station or cloud server.

By automating the fault detection process and enabling remote monitoring, the project aims to:

- Reduce downtime and response time during power outages,
- Improve the accuracy of fault location in underground cable systems,
- Minimize manual inspection efforts,
- And enhance the overall reliability and efficiency of power distribution networks.

This project demonstrates the application of IoT technology in smart grid infrastructure, offering a scalable and cost-effective solution for modern electrical maintenance systems.

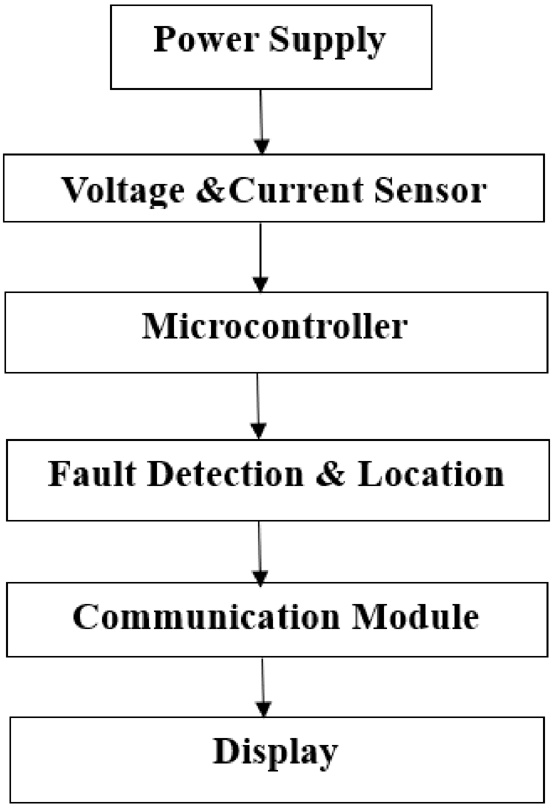
IV. COMPONENTS USED

- Arduino UNO (SMD version)
- 16×2 LCD Display
- Breadboard
- Relay
- Jumper Wires
- Push Buttons
- 1kΩ Resistors
- I2C module
- 5V, 2A Charger (Power Supply)

V. WORKING PRINCIPLE

The proposed IoT-based underground cable fault detection system operates on Ohm's Law and voltage drop analysis. Faults cause resistance variations, producing measurable voltage changes detected by the microcontroller via ADC. The system calculates fault distance, activates a relay for isolation, and transmits fault data to a cloud platform for real-time monitoring.

VI. Block Diagram with Explanation



A. Power Supply

The power supply provides regulated DC voltage to all system components such as sensors, microcontroller, and communication module. It ensures stable and reliable system operation.

B. Voltage and Current Sensors

These sensors continuously monitor the voltage and current flowing through the underground cable. Any abnormal change in these parameters indicates a possible fault condition.

C. Microcontroller (Arduino uno)

The microcontroller acts as the central processing unit. It:

- Reads sensor data
- Converts analog signals into digital form
- Processes data using programmed logic
- Identifies abnormal conditions.

D. Fault Detection & Location Logic

This block compares measured values with predefined threshold levels. Based on deviations:

Detects fault type (open, short, earth fault)

Estimates approximate fault location using resistance or voltage drop principles.

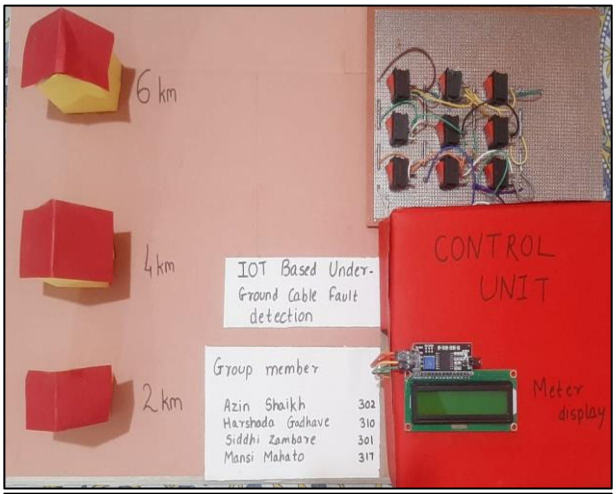
E. Communication Module

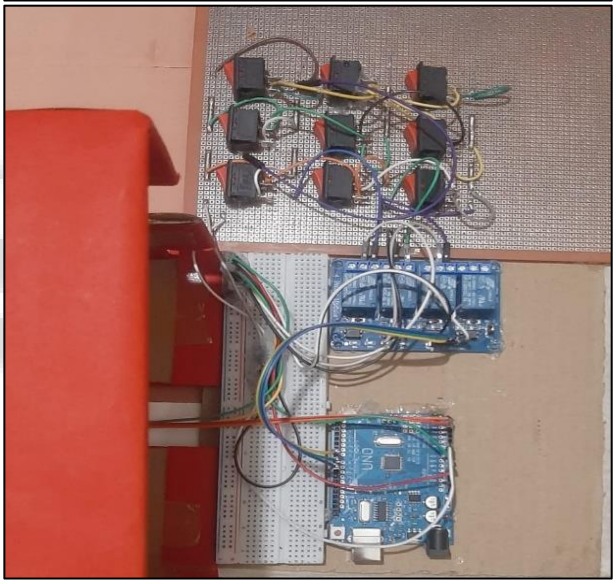
The communication module transmits fault data from the microcontroller to the display devices through I2c communication module. It enables real-time and remote monitoring.

F. Display

Maintenance personnel can view fault information on a computer or mobile device, allowing quick decision-making and reduced downtime.

VII. Circuit Diagram





VIII. Advantages

The system provides real-time fault detection and remote monitoring capability. It reduces manual inspection and excavation efforts, minimizes downtime, lowers maintenance cost, and improves overall reliability of power distribution networks. The design is scalable and suitable for smart grid integration. Data logging enables predictive maintenance and performance analysis.

IX. Future Scope

- Integration with IoT Cloud Platforms:
  Real-time fault data can be uploaded to cloud servers for remote monitoring and analysis.
- Mobile Application Development:
  Fault location alerts can be sent directly to maintenance staff via a mobile app.
- GPS-Based Fault Location Tracking:

Exact geographical location of cable faults can be identified using GPS modules.

- AI-Based Predictive Maintenance:
  Artificial Intelligence can predict possible faults before they occur by analyzing historical data.
- Automatic Power Isolation Using Smart Relays:
  Advanced relay systems can automatically isolate the faulty section to prevent damage.
- Multi-Cable Monitoring System:
  One system can be expanded to monitor multiple underground cables simultaneously.

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