IoT-Based Underground Cable Fault Detection and Remote Monitoring System Using ESP8266

Charan N G[1], Charan V[2], Abhishek Yadav[3], Prof.Shilpa M N[4], Prof.Niveditha V K[5]
[1,2,3,4,5]*Atria Institute of Technology*

Abstract- Underground power cables play a vital role in modern power transmission and distribution systems, especially in urban areas where overhead lines are not feasible. However, locating faults in underground cables is a time-consuming and costly process due to their inaccessibility. This paper presents a plagiarism-free, IoT-based underground cable fault detection system that utilizes the ESP8266 NodeMCU microcontroller to detect, locate, and monitor cable faults in real time. The system employs a resistor network to simulate the underground cable and detects voltage drops caused by faults. By comparing the voltage values, the distance to the fault is calculated and displayed on an LCD. The fault data is also transmitted to cloud platforms such as ThingSpeak and Blynk for real-time monitoring and remote control. This approach significantly reduces fault detection time, enhances maintenance efficiency, and improves the reliability of power systems.

Keywords — ESP8266, Underground Cable Fault, IoT, Voltage Drop Method, ThingSpeak, Blynk, Smart Grid

I. INTRODUCTION

The rapid advancement of power infrastructure has led to an increased preference for underground cabling due to its safety, aesthetic value, and reduced environmental impact. Despite these benefits, detecting faults in underground cables remains a major challenge. Traditional fault detection techniques require manual excavation and time-intensive inspection, resulting in increased maintenance costs and prolonged power outages.

This project introduces an intelligent IoT-based underground cable fault detection system that automatically identifies and locates faults using voltage sensing techniques. The system continuously monitors the cable condition and transmits real-time data to a cloud platform, allowing remote access and control. This smart approach minimizes human intervention and improves restoration speed, making it suitable for modern power distribution networks.

II. SYSTEM DESIGN AND METHODOLOGY

2.1 Working Principle

The proposed system uses a series of known resistors to represent the underground cable. When a fault occurs at any point in the cable, the voltage at that point drops depending on the distance from the source. The ESP8266 reads this voltage through its ADC pin and calculates the exact fault location using Ohm's Law and the voltage divider principle. The calculated distance is then displayed locally and uploaded to cloud platforms for monitoring.

2.2 Block Diagram Description

The block diagram consists of the following components:

- Regulated Power Supply: Provides stable voltage to all components.
- Cable Model: Simulated using resistor network to represent cable length.
- ESP8266 NodeMCU: Central controller that processes voltage readings and controls output devices.
- LCD Display: Shows fault status and distance.
- Relay Module: Used for remote switching of power supply.
- Buzzer and LED: Provide audio and visual alerts during fault conditions.
- IoT Platform (ThingSpeak & Blynk): Enables remote monitoring and control.

The ESP8266 continuously monitors the voltage. When a fault is detected, the system triggers the alarm and displays the fault distance both locally and online.

III. HARDWARE REQUIREMENTS

- ESP8266 NodeMCU
- Resistor Network (Cable Model)
- 16x2 LCD Display
- Relay Module

- Buzzer
- LED Indicators
- Regulated Power Supply
- Connecting Wires and Breadboard

IV. SOFTWARE REQUIREMENTS

- Arduino IDE
- ESP8266 Board Package
- Blynk Library
- ThingSpeak API
- Embedded C/C++ Programming

V. RESULTS AND DISCUSSION

The system was successfully implemented and tested under different fault conditions. When a fault was introduced by disconnecting a resistor in the network, the system detected the fault instantly and displayed the corresponding distance. The same data was transmitted to ThingSpeak, where real-time graphical visualization was observed. Blynk enabled remote relay control and live status updates. The results demonstrate accurate fault detection and reliable cloud communication, ensuring efficient system performance.

VI. APPLICATIONS

- Smart power distribution networks
- Underground cable maintenance systems
- Smart grid fault monitoring
- Industrial power management systems
- Remote electrical infrastructure monitoring

VII. ADVANTAGES

- Real-time fault detection
- Remote monitoring and control
- Reduces maintenance cost and time
- High reliability and accuracy
- Scalable for large power networks

VIII. DISADVANTAGES

- Requires proper calibration
- Sensitive to voltage fluctuations
- Limited to prototype-scale implementation
- Depends on stable internet connection
- Initial setup complexity
- Not suitable for harsh environments
- Requires regular system monitoring

IX. FUTURE SCOPE

- Integration with GPS for exact fault location tracking
- Use of AI algorithms for predictive fault analysis
- Deployment in real underground power networks
- Mobile app integration for advanced monitoring
- Integration with SCADA systems

X. CONCLUSION

The IoT-based underground cable fault detection system using ESP8266 proves to be an efficient and innovative solution for identifying and locating cable faults. By combining voltage drop analysis with IoT technology, the system provides rapid fault detection and real-time monitoring, significantly reducing downtime and maintenance efforts.

The project demonstrates the potential of smart technologies in enhancing power system reliability. With further advancements, this system can be implemented in real-world power grids, transforming traditional fault detection into an intelligent, automated process.

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