

Underground Cable Fault Distance Identifier Over IOT

Vinay S. (3BR21EE104), Aishwarya (3BR21EE401), K. Shivaprakash (3BR21EE412)

Department of Electrical and Electronics Engineering

Ballari Institute of Technology and Management (BITM), Ballari, Karnataka, India

ABSTRACT

Underground cables are increasingly used in modern power distribution systems because they provide improved safety, reduced electromagnetic interference, protection from environmental conditions, and better aesthetic integration compared with overhead lines. However, locating faults in underground cables is difficult because the fault point is not physically visible and conventional fault-finding methods can require considerable manual effort and downtime. This paper presents an IoT-enabled underground cable fault distance identification system using an Arduino UNO microcontroller, fault sensing circuit, ESP8266 Wi-Fi module, LCD display, and relay-based phase isolation. The proposed system applies a low DC voltage to the cable and detects changes in electrical parameters associated with a fault. The Arduino processes the sensed signal using the relationship between voltage, current, and resistance to estimate the fault distance from the feeder end. The detected fault information is displayed locally on an LCD and transmitted through the ESP8266 to a mobile application for remote monitoring. Relays are employed to isolate the affected R, Y, or B phase, thereby improving operational safety. Fault switches positioned at known intervals provide a controlled method for testing and verification. The proposed system offers a modular, low-cost, and scalable approach for real-time underground cable fault monitoring and can be adapted for power distribution and other underground cable networks.

Keywords— Underground cable, fault detection, fault localization, Internet of Things, Arduino UNO, ESP8266, relay, real-time monitoring.

INTRODUCTION

Underground cables have become an important part of modern electrical infrastructure, particularly in urban and industrial environments. They provide several advantages over overhead transmission and distribution lines, including reduced exposure to environmental hazards, lower electromagnetic interference, and improved aesthetic appearance. However, underground installation also creates difficulties during fault detection and maintenance because the fault cannot be visually identified. Faults may occur because of insulation failure, physical damage, environmental conditions, or cable aging, and they can result in power interruptions, safety hazards, reduced efficiency, and increased maintenance costs.

Conventional techniques such as sectionalizing and Time Domain Reflectometry (TDR) can involve manual intervention, specialized equipment, and considerable downtime. Therefore, an automated system capable of detecting and locating cable faults is desirable. The project described in the source report addresses this requirement by combining an embedded controller with IoT communication. The system uses an Arduino UNO to process the sensing information and an ESP8266 Wi-Fi module to transmit fault information to a mobile application.

The proposed system detects changes in the electrical characteristics of the cable by applying a low DC voltage and monitoring the resulting current and voltage variations. The sensing information is processed using the principles of Ohm's law, allowing the system to estimate the distance of the fault from the feeder end. The calculated fault information is presented on an LCD for local monitoring and transmitted through the ESP8266 for remote access.

An additional safety feature is provided through relay-based phase isolation. When a fault is identified, the corresponding relay can isolate the affected phase among R, Y, and B. This arrangement helps prevent further damage

and allows unaffected phases to remain operational. Fault switches positioned at predetermined locations are also incorporated to simulate faults and verify the operation of the system.

LITERATURE SURVEY

Several researchers have investigated underground cable fault detection using embedded systems and Internet of Things (IoT) technologies. Namassivaya *et al.* [1] proposed an IoT-based underground cable fault detection system for real-time fault identification and monitoring. The approach demonstrated the potential of integrating microcontrollers with IoT communication for remote fault notification. Hari Krishna *et al.* [2] developed an underground cable fault detection system using IoT, in which fault information could be monitored remotely. Prabha *et al.* [3] also investigated an IoT-based underground cable fault detection system, emphasizing automated fault identification and improved monitoring compared with conventional manual techniques. These studies demonstrate that IoT connectivity can reduce the time required for fault identification and provide remote access to cable condition information.

Further studies have explored individual components and supporting technologies relevant to the proposed system. Bai *et al.* [4] investigated IoT-based monitoring for industrial applications, highlighting the importance of continuous remote monitoring. Patil *et al.* [5] studied applications of the ACS712 current sensor in smart battery systems, demonstrating the usefulness of current sensing for embedded monitoring applications. Sinha and Bose [6] examined relay-based load optimization in IoT networks, supporting the use of relay interfaces for automated electrical control. Nguyen and Kim [7] discussed challenges associated with conventional monitoring systems. Based on these developments, the proposed work integrates an Arduino UNO, sensing circuit, relay-based phase isolation, LCD indication, and ESP8266 Wi-Fi communication to provide fault detection, distance identification, and remote monitoring within a single system.

PROBLEM STATEMENT

The project aims to develop an efficient and automated system for detecting and locating faults in underground power cables. Traditional fault-identification methods may require considerable manual intervention and can result in increased maintenance time and downtime. The proposed solution uses embedded-system and IoT technologies to provide real-time fault detection and localization with reduced manual intervention, thereby improving the reliability and safety of underground power networks.

OBJECTIVES

The principal objectives of the proposed system are:

1. To detect faults in underground cables accurately using a sensing circuit based on electrical parameter variations and Ohm's law.
2. To determine and communicate the fault location in real time using the Arduino UNO, LCD interface, ESP8266 Wi-Fi module, and IoT-based mobile monitoring.

PROPOSED SYSTEM

The proposed Underground Cable Fault Distance Identifier consists of a regulated power supply, fault sensing circuit, Arduino UNO microcontroller, relay driver and relays, LCD display, ESP8266 Wi-Fi module, LED indicators, and manually operated fault switches. The Arduino UNO acts as the central processing unit. It receives the analog signal from the fault sensing circuit, processes the signal using its ADC, determines the fault condition and distance, and controls the display, relay system, and IoT communication.

The fault sensing circuit represents the cable resistance through resistor sections and provides a controlled method for simulating faults at known locations. When a fault is introduced, the electrical characteristics of the corresponding

section change. The resulting voltage or current variation is sensed and supplied to the Arduino. The controller processes this information and determines the corresponding fault condition and location.

The ESP8266 provides the communication interface between the embedded controller and the remote monitoring platform. Fault information processed by the Arduino is transmitted through Wi-Fi to a mobile application or cloud-based platform. Simultaneously, the LCD provides local information for technicians. The relay system provides phase isolation when a fault is detected.

BLOCK DIAGRAM

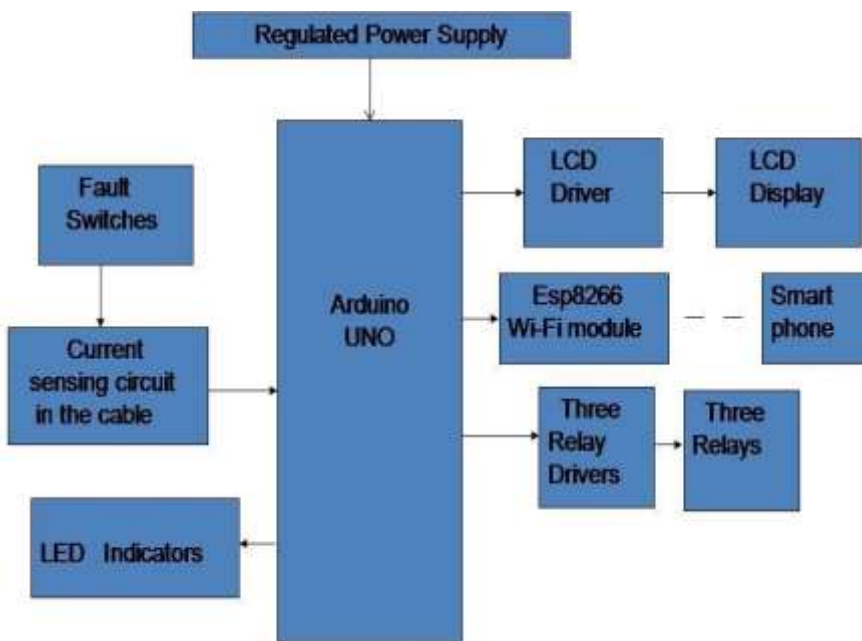


Fig 1 block diagram

CIRCUIT DIAGRAM

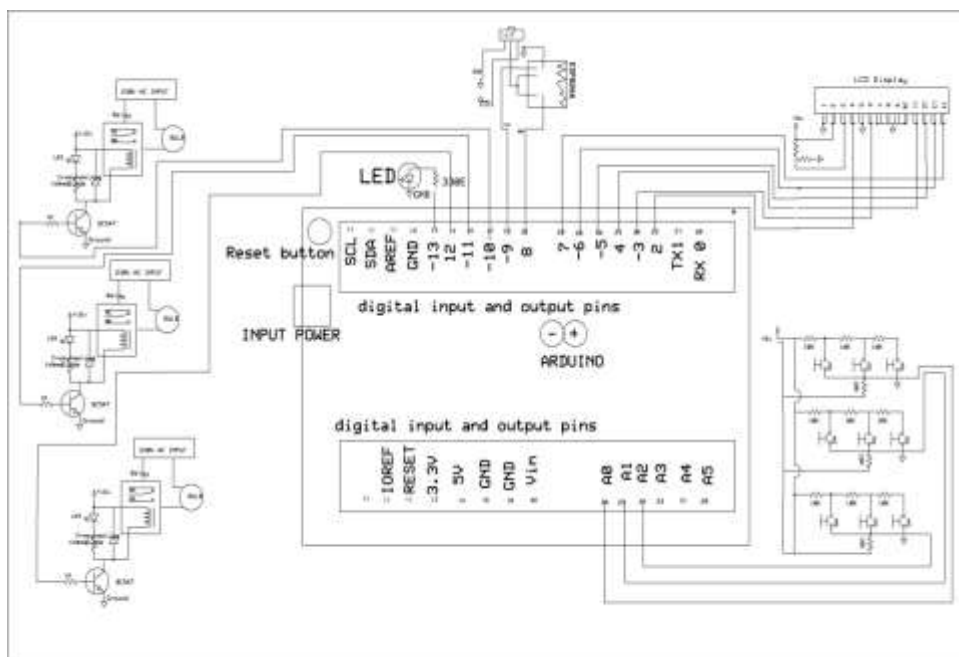


Fig 2 circuit diagram

METHODOLOGY

The methodology begins with supplying the system using a regulated DC source. The report describes a 12–24 V DC input arrangement for the overall system, with regulated voltage levels provided to the different components. Stable power is important because variations in supply voltage can influence the sensing circuit and Arduino ADC readings.

A current-sensing arrangement, such as a Hall-effect sensor, monitors the electrical current associated with the underground cable. The sensor produces a proportional voltage signal that is connected to an analog input of the Arduino. The controller continuously samples this signal and compares it with predefined operating thresholds. A significant reduction in current may indicate an open circuit or cable break, while an abnormal increase can indicate a short circuit or other fault condition.

For distance identification, the system uses the relationship between voltage, current, and resistance. The cable or its representative resistor sections are arranged so that electrical variations correspond to different positions along the cable. The Arduino processes the sensed voltage/current information and determines the fault distance from the feeder end. This information is then presented on the LCD.

When a fault is detected, the Arduino activates the corresponding relay through the relay driver. The relay isolates the affected phase, thereby limiting the impact of the fault on the remaining phases. Relay drivers provide the necessary current amplification and protective interface between the Arduino GPIO outputs and relay coils.

The final stage is IoT communication. The Arduino transfers fault information to the ESP8266 through the serial interface. The ESP8266 then communicates the fault condition and available localization information through Wi-Fi to a mobile application or cloud platform. This provides remote monitoring and allows operators to respond without being physically present at the cable location.

RESULTS AND DISCUSSION

The implemented prototype includes the Arduino UNO, fault sensing section, ESP8266 Wi-Fi module, relay system, LCD display, power supply, and fault simulation switches. The hardware setup and corresponding output results are documented in the project report.

The testing approach uses fault switches positioned at known locations along the representative cable sections. These switches provide controlled fault conditions for verifying the ability of the system to detect abnormal electrical conditions and identify their corresponding locations. The report identifies testing and verification through known-distance fault switches as an important part of the proposed system.

The system demonstrates the integration of four important functions: fault detection, fault-distance identification, faulty-phase isolation, and remote notification. The LCD provides local access to fault information, while the ESP8266 extends the monitoring capability to a remote user. Relay operation provides an additional safety function by isolating the affected phase. These features collectively reduce dependence on manual fault tracing and support faster maintenance response.

The report does not provide a detailed numerical error table, percentage accuracy, response-time measurements, or a complete set of experimental distance readings. Therefore, specific numerical accuracy or performance claims are not included in this paper.



fig 3 hardware setup

CONCLUSION

This paper presented an IoT-based underground cable fault distance identification system using an Arduino UNO, fault sensing circuit, ESP8266 Wi-Fi module, LCD display, and relay-based phase isolation. The proposed system detects changes in electrical parameters associated with cable faults, processes the sensing information, estimates the fault location, displays the information locally, and communicates it remotely through IoT. The relay mechanism provides additional protection by isolating the affected phase.

The developed concept provides a cost-effective and modular approach for improving underground cable monitoring. By combining embedded processing, fault localization, remote communication, and phase isolation, the system can reduce manual troubleshooting effort and support faster maintenance decisions. The project report concludes that the integration of IoT and embedded systems can provide an effective and adaptable approach for modern underground cable fault monitoring.

REFERENCES

- [1] N. Namassivaya, S. Kotamarthi, H. Akunuri, and G. Sanjana, "Underground Cable Fault Detection System Using IoT," *JETIR Research Journal*, 2023.
- [2] V. Hari Krishna, G. Neelima, P. Poojitha, M. Madhu, D. V. N. Surya, and C. Satwika, "Underground Cable Fault Detection Using IoT," *IJNRD*, 2024.
- [3] R. Prabha, S. Y. Kousika Shree, R. Kavin Kumar, C. K. S. Lalitha Shri, and Guru Manickam, "Underground Cable Fault Detection System Using IoT," *JETIR Research Journal*, 2023.
- [4] Y. Bai, L. Wang, and J. Zhang, "IoT-Based Battery Monitoring for Industrial Applications," *Sensors Journal*, 2020.
- [5] K. Patil et al., "Applications of ACS712 in Smart Battery Systems," *International Conference on Embedded Systems*, 2021.
- [6] R. Sinha and T. Bose, "Relay-Based Load Optimization in IoT Networks," *Transactions on IoT Systems*, 2019.
- [7] T. Nguyen and Y. Kim, "Challenges in Legacy Battery Monitoring Systems," *Journal of Power Sources*, 2020.