



DESIGN AND DEVELOPMENT OF AUTOMATIC CABLE FAULT DISTANCE LOCATOR USING ARDUINO, GSM & GPS

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Abstract: Cable faults in underground power distribution networks can cause service interruptions, increased maintenance costs, and difficulties in identifying the exact fault location. Rapid and accurate fault detection is therefore essential for ensuring reliable power system operation. This paper presents the design and development of an Automatic Cable Fault Distance Locator using Arduino, GSM, and GPS technologies. The proposed system detects faults in underground cables by analyzing variations in electrical parameters and estimating the distance of the fault from the source based on resistance principles. An Arduino Uno microcontroller processes the acquired signals and displays fault information on a 16×2 LCD module. A GSM module is incorporated to transmit fault alerts through text messages to authorized personnel, enabling timely maintenance actions. The integration of a GPS module provides geographical coordinates of the fault location, improving accuracy during repair operations. The system minimizes manual inspection efforts, reduces fault detection time, and enhances maintenance efficiency. Experimental implementation demonstrates reliable fault identification and location estimation, making the system suitable for modern smart power distribution applications.

Index Terms – Underground Cable Fault Detection, Arduino Uno, GSM Module, GPS Tracking, Fault Distance Locator, Power Distribution System, Smart Monitoring, Fault Localization.

I. INTRODUCTION

Reliable electrical power distribution is an essential requirement for residential, commercial, and industrial sectors. As urbanization and industrial development continue to expand, the demand for uninterrupted electricity supply has increased significantly. To meet this demand, underground cable networks are widely employed in modern power systems because they offer improved safety, better protection from environmental conditions, reduced visual pollution, and enhanced operational reliability compared to overhead transmission lines. Despite these advantages, maintenance and fault management in underground cable systems remain challenging tasks due to the concealed nature of the cables. Cable faults are among the most common issues affecting underground power distribution systems. These faults may occur due to insulation degradation, moisture penetration, aging of cables, mechanical damage, short circuits, or accidental excavation activities. When a fault develops in an underground cable, locating the exact position becomes difficult because the cable is not directly visible. Conventional fault detection methods often require extensive manual inspection and excavation, resulting in increased repair time, higher maintenance costs, and prolonged power interruptions. Therefore, an efficient and automated solution is required to accurately identify fault locations and support rapid restoration of power services. The project titled “Design and Development of Automatic Cable Fault Distance Locator Using

Arduino, GSM & GPS” focuses on addressing these challenges through an intelligent monitoring and fault localization system. The proposed system utilizes the principle of resistance variation to estimate the distance of a fault from the source end of the cable. An Arduino Uno microcontroller serves as the central processing unit, continuously monitoring the electrical characteristics of the cable and calculating the fault distance. The detected information is displayed through an LCD module for immediate visualization. To enhance communication and monitoring capabilities, a GSM module is incorporated to transmit fault alerts directly to maintenance personnel through text messages. Additionally, a GPS module provides geographical location information, enabling technicians to reach the affected site quickly and accurately. The integration of these technologies improves operational efficiency and minimizes downtime in power distribution networks. The developed system offers a cost-effective, reliable, and user-friendly approach for underground cable fault detection. By reducing dependence on manual inspection and enabling accurate fault localization, the proposed solution contributes to improved maintenance practices and enhanced reliability of electrical distribution infrastructure. Such intelligent fault monitoring systems play a significant role in supporting modern smart grid applications and ensuring continuous delivery of electrical energy to consumers.

II. RELATED WORKS

Article[1] "IoT-based Cable Fault Detector with GSM and GPS Module using Arduino" by M. Thilagaraj and Arun Francis in 2023: This paper presents an intelligent underground cable fault detection system using Arduino, GSM, and GPS technologies. The proposed model identifies cable faults by monitoring electrical parameters and calculating fault distance. GSM communication is used to transmit fault information to maintenance personnel. GPS integration provides accurate fault coordinates for quick localization. The system reduces inspection time and improves operational efficiency. Experimental results demonstrated reliable fault identification under different fault conditions. The study highlighted the importance of real-time monitoring in modern power distribution networks.

Article[2] "Underground Cable Fault Detection Using Arduino GPS and GSM Module" by S. Pandiarajan and R. Karthikeyan in 2023: This research focuses on detecting underground cable faults through resistance measurement techniques. Arduino is utilized as the primary controller for processing sensor data. GPS technology is employed to identify the exact fault location. GSM communication sends instant alerts whenever a fault is detected. The proposed approach reduces maintenance costs and minimizes service interruptions. The system demonstrated satisfactory accuracy in fault localization. The study recommends further integration with IoT platforms for enhanced monitoring.

Article[3] "IoT-Based Smart Underground Cable Fault Detector" by Murugakummar Jayachandran and Khairul Najmy Abdul Rani in 2024: This paper introduces an IoT-enabled underground cable fault detection framework. The system continuously monitors cable conditions and identifies abnormalities in real time. Arduino and communication modules are integrated for data acquisition and transmission. Fault information is displayed through a user interface for quick analysis. The proposed solution supports remote monitoring and predictive maintenance. Experimental evaluation showed improved detection efficiency compared to conventional methods. The work contributes toward smart grid infrastructure development.

Article[4] "Underground Cable Fault Distance Locator using GSM and GPS Technology" by P. Venkata Kishore and K. Sree Latha in 2024: This study presents a cable fault distance locator capable of identifying fault positions accurately. GSM technology is utilized for fault notification and remote communication. GPS coordinates are generated to simplify maintenance activities. The system employs microcontroller-based processing for fault analysis. Results indicate a significant reduction in troubleshooting time. The proposed model enhances reliability and operational safety in underground cable networks. The research demonstrates practical implementation for utility applications.

Article[5] "Smart Underground Fault Monitoring and Detection Using IoT Technology" by R. Islam and S. Rahman in 2024: This paper proposes a smart monitoring system for underground power cables using IoT architecture. Sensors continuously collect electrical data and transmit it through wireless communication. Fault conditions are identified automatically through intelligent processing algorithms. The system enables real-time monitoring and remote diagnostics. Maintenance personnel receive instant

notifications regarding abnormal events. Experimental results verified improved response time and fault detection accuracy. The approach supports modern smart city power management systems.

Article[6] "Fault Location for Distribution Smart Grids" by J. De La Cruz and M. Vega in 2023: This research investigates fault localization techniques in modern distribution grids containing underground cables. Various fault scenarios were analyzed to improve location accuracy. Advanced monitoring technologies were incorporated for better system reliability. The study emphasized the importance of rapid fault detection in smart grids. Simulation results showed significant improvements in restoration time. The proposed methods support effective grid management and maintenance. The work provides valuable insights for future power distribution systems.

Article[7] "Underground Cable Fault Detection and Monitoring Using IoT" by P. Harish and K. Naveen in 2025: This paper presents an IoT-based monitoring platform for underground cable systems. The framework continuously observes cable parameters and identifies abnormalities. Cloud connectivity enables remote supervision and data storage. Fault locations are estimated accurately through intelligent processing techniques. The system reduces manual inspection requirements significantly. Performance analysis demonstrated reliable operation under multiple fault conditions. The study highlights the benefits of integrating IoT with power infrastructure.

Article[8] "IoT-enabled Automatic Underground Cable Fault Detection and Monitoring System" by R. Islam and M. Hasan in 2025: This research develops an automated underground cable monitoring system using GSM and GPS technologies. The proposed solution applies electrical analysis techniques to locate faults. Real-time notifications are delivered to authorized personnel. GPS coordinates assist maintenance teams in identifying exact fault positions. The system improves service continuity and reduces downtime. Experimental validation confirmed accurate fault distance estimation. The approach offers an efficient solution for modern utility networks.

Article[9] "Underground Cable Fault Detection Using NodeMCU in an IoT Framework" by M. Ahmed and A. Rahman in 2025: This study utilizes NodeMCU and IoT technologies for underground cable fault monitoring. Electrical parameters are continuously observed through distributed sensors. Fault data is transmitted to a centralized monitoring platform. Real-time alerts assist operators in responding quickly to failures. The system provides scalable deployment for large power networks. Results indicated enhanced fault detection performance and reliability. The research demonstrates the advantages of wireless monitoring technologies.

Article[10] "Artificial Intelligence in Cable Fault Detection and Localization" by Q. Shao and Y. Wang in 2025: This paper reviews the application of artificial intelligence techniques in cable fault detection. Machine learning algorithms are used to improve fault identification accuracy. Various fault localization approaches are analyzed and compared. The study discusses challenges associated with modern power systems. AI-based methods demonstrated superior performance compared to traditional techniques. The paper highlights future opportunities for intelligent monitoring solutions. The findings support the adoption of smart fault diagnosis systems.

Article[11] "Connecting the Dots: A Comprehensive Literature Review on Low and Medium-Voltage Cables, Fault Types, and Digital Signal Processing Techniques for Fault Location" by Shankar Ramharack and Sanjay Bahadoorsingh in 2023: This review paper examines different underground cable fault types and localization methods. Digital signal processing techniques are evaluated for fault detection applications. The study discusses insulation degradation and conductor failures in detail. Various diagnostic approaches are compared systematically. The review identifies limitations of existing fault location methods. Recommendations are provided for improving detection accuracy. The paper serves as a valuable reference for future research.

Article[12] "Autonomous Smart Grid Fault Detection" by Qiyue Li and Yuxing Deng in 2022: This paper explores autonomous fault detection techniques for smart grid environments. Advanced monitoring technologies are integrated with intelligent decision-making algorithms. The study addresses challenges related to fault diagnosis and system reliability. Automated approaches reduce dependency on manual intervention. Simulation results demonstrate effective fault identification performance. The research

discusses future directions for autonomous power system monitoring. The proposed concepts support next-generation smart electrical networks.

III. PROBLEM STATEMENT

Underground power cables are extensively used in modern electrical distribution systems because of their safety, reliability, and protection from environmental disturbances. However, when a fault occurs within an underground cable, identifying the exact fault location becomes a major challenge due to the concealed installation of the cable network. Conventional fault detection methods are often time-consuming, labor-intensive, and require extensive excavation, leading to increased maintenance costs and prolonged power interruptions. The absence of accurate fault localization delays repair activities and affects the continuity of power supply. Additionally, limited real-time communication regarding fault occurrence makes monitoring and maintenance more difficult. Therefore, an efficient system is required to detect cable faults accurately, determine their distance from the source, and provide timely fault information for rapid corrective action.

IV. OBJECTIVES

The primary objective of this study is to design and develop an automatic cable fault distance locator capable of detecting faults in underground power cables accurately and efficiently. The study aims to determine the distance of the fault from the source using electrical parameter analysis and resistance-based measurement techniques. Another objective is to reduce the time and effort required for manual fault identification and maintenance operations. The system is intended to provide real-time fault notifications through GSM communication and precise location details using GPS technology. Additionally, the study focuses on improving the reliability of power distribution networks, minimizing service interruptions, reducing maintenance costs, and supporting the implementation of intelligent monitoring solutions in modern electrical infrastructure.

V. METHODOLOGY

1) Power Supply Unit: The methodology begins with the power supply section, which provides the required operating voltage to all system components. A step-down transformer converts the AC mains voltage into a lower voltage level. A bridge rectifier converts AC into DC, while a voltage regulator ensures a stable power supply. This regulated voltage is distributed to the Arduino, GSM module, GPS module, and display unit for reliable operation.

2) Cable Modeling and Fault Simulation: Underground cables are represented using a series of resistors connected sequentially to simulate actual cable lengths. Each resistor corresponds to a specific distance of the cable, enabling fault location estimation. Push-button switches are placed at predefined locations to create fault conditions. This arrangement helps in testing and validating the performance of the fault detection system under different scenarios.

3) Fault Detection Mechanism: The fault detection mechanism operates by monitoring changes in voltage and resistance values within the cable network. Whenever a fault occurs, the electrical characteristics of the circuit change significantly. These variations are continuously sensed and analyzed by the system. The detected changes provide the necessary information required for identifying the occurrence of a fault.

4) Arduino-Based Processing: Arduino Uno serves as the central controller responsible for processing all acquired data. The analog voltage signals received from the cable model are converted into digital values using the built-in Analog-to-Digital Converter. The controller performs the necessary calculations to determine fault distance. Based on the processed information, the system generates accurate fault status details.

5) Fault Distance Calculation: Fault distance is calculated using the principles of resistance variation and voltage division. The location of the fault influences the voltage drop across the cable model. By analyzing these voltage changes, the Arduino estimates the distance of the fault from the source end. This method enables efficient and accurate localization of underground cable faults.

6) GSM and GPS Communication: After detecting a fault, the GSM module is activated to transmit fault information to authorized personnel through text messages. This allows immediate awareness of the fault condition without requiring physical inspection. The GPS module simultaneously provides the geographical coordinates of the fault location. These features significantly improve maintenance efficiency and response time.

7) Display and Monitoring System: The processed fault information is displayed on a 16×2 LCD display for real-time monitoring. The display shows the affected phase and the estimated distance of the fault. Under normal operating conditions, the display indicates that no fault is present. This monitoring facility enables operators to observe system status continuously and take prompt corrective actions whenever necessary.

VI. SYSTEM ARCHITECTURE

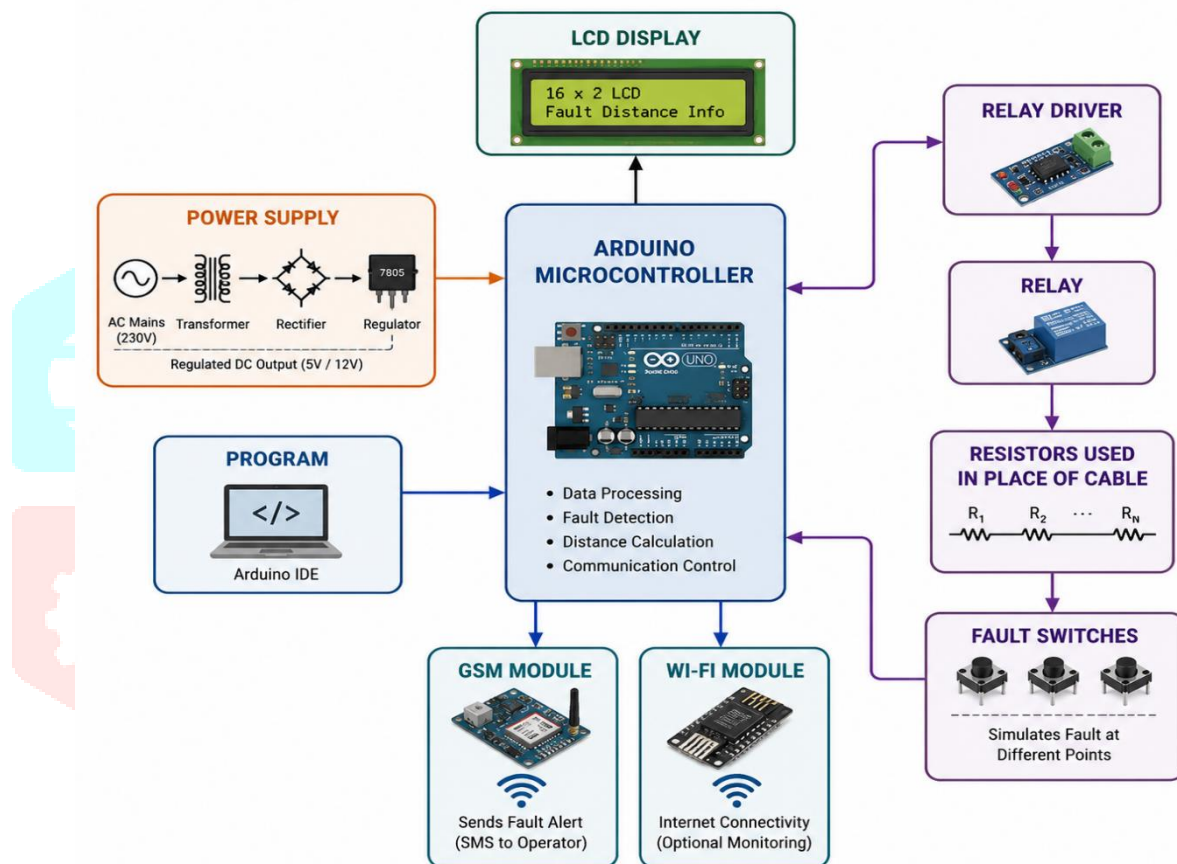


Fig 1: System Architecture of Automatic Cable Fault Distance Locator Using Arduino, GSM and Wi-Fi Module

The system architecture of the Automatic Cable Fault Distance Locator is designed to detect underground cable faults, estimate fault distance, and communicate fault information efficiently. The power supply unit provides regulated DC power to all system components, ensuring stable operation of the Arduino microcontroller and peripheral modules. The Arduino microcontroller acts as the central processing unit, receiving input signals from the cable fault simulation network and performing fault analysis. A relay driver and relay module are used to sequentially monitor different cable phases and control the fault detection process. Resistors connected in series represent underground cable lengths, while fault switches are used to simulate faults at predefined locations along the cable route. Based on voltage variations and resistance changes, the Arduino calculates the distance of the fault from the source end. The processed information is displayed on the LCD display for real-time monitoring. The GSM module enables transmission of fault alerts to maintenance personnel through text messages, while the Wi-Fi module supports remote monitoring and data communication. This integrated architecture improves fault

localization accuracy, reduces maintenance time, and enhances the reliability of power distribution systems.

VII. EXPERIMENTAL SETUP

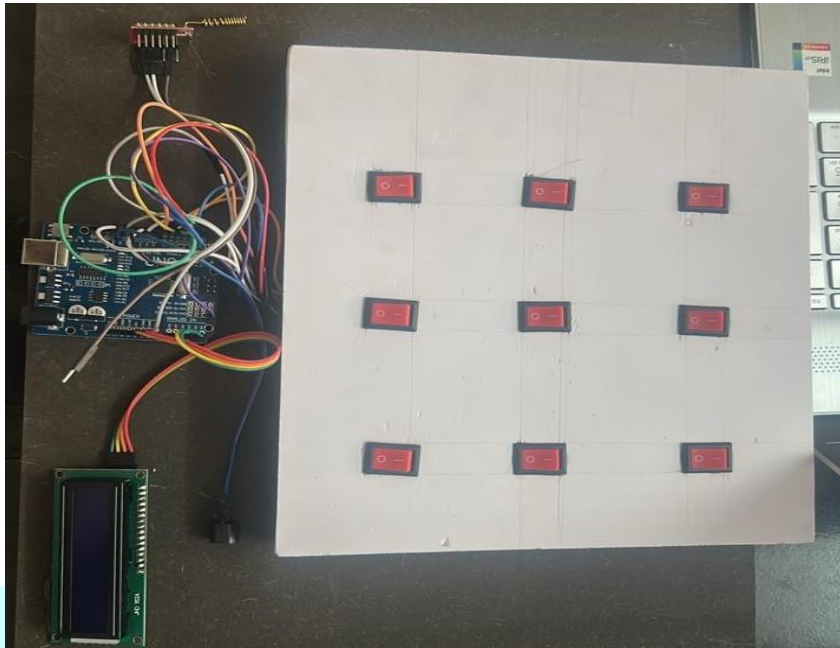


Fig. 2: Hardware Prototype of Automatic Cable Fault Distance Locator Using Arduino, GSM and GPS

The developed hardware prototype consists of an Arduino Uno controller, LCD display, communication modules, and multiple fault switches used to simulate underground cable faults at different locations.

VIII. CONCLUSION AND FUTURE WORKS

In this research, an Automatic Cable Fault Distance Locator using Arduino, GSM, and GPS technologies was developed to improve the detection and localization of underground cable faults. The system successfully identifies fault occurrence, estimates fault distance, and provides timely notifications to maintenance personnel. The integration of communication and location-tracking technologies enhances operational efficiency and reduces fault repair time. Future work can focus on increasing detection accuracy for different fault types, integrating IoT and cloud-based monitoring platforms, supporting real-time data analytics, and implementing advanced predictive maintenance techniques. These enhancements can further improve reliability, scalability, and smart grid compatibility.

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