iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 Issue: IV Month of publication: April 2025

DOI: https://doi.org/10.22214/ijraset.2025.68822

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue IV Apr 2025- Available at www.ijraset.com

Fault Detection in Transmission Line

Swati Jadhav[1], Sonali Bansode[2], Chanchal Thore[3], Prof.Pallavi Gajaphode[4], Prof.Dr.B.E.Shinde[5]
Department of Electronics and Telecommunication Engineering Dhole Patil College of Engineering, Pune Wagholi

Abstract: This project focuses on the design and implementation of an advanced fault detection system for overhead transmission lines, utilizing key components such as the ESP 8266 microcontroller, current sensors, a GPS module, and IoT integration. The system is capable of detecting and classifying four major fault types: single line to ground (L-G), line to line (L-L), double line to ground (L-L-G), and three-phase faults (L-L-LG). By placing current sensors at the transmission line's sending end, the system identifies faults and accurately determines their location through GPS coordinates. Simulations using protect us software were conducted to verify the system's performance prior to building a hardware prototype. Upon fault detection, the system provides alerts via an LCD display and a buzzer, while real-time fault data is transmitted to an Android app and web server through the arduino IoT cloud. Testing confirmed the system's precision in fault identification and location tracking, ensuring timely notifications for control room and remote device operators. This successful implementation highlights the system's potential for improving safety and efficiency in power transmission networks. the project lays the groundwork for further exploration into advanced fault detection and real-time monitoring solutions in electrical engineering.
Keywords : Fault Detection, Transmission Lines, ESP 8266, Current Sensor, GPS Module, IoT Cloud, Overhead Transmission Line, Power System Protection, Fault Localization, Proteus Simulation

I. INTRODUCTION

This project highlights the critical role of transmission lines in electrical power systems, which are essential for the generation, transmission, and distribution of energy. Transmission lines, typically made of conductive materials and using air as a dielectric medium, are prone to faults due to environmental factors like wind, rainfall, and lightning. These faults can disrupt electricity delivery and cause severe damage if not quickly detected and addressed. Traditional fault detection methods, such as impedance-based systems, have limitations, including slow response times and lower reliability. To address these challenges, this project proposes a smart monitoring and fault detection system using GPS and ESP8266. The system provides real-time monitoring by transmitting fault notifications to an IoT cloud server, allowing for remote fault detection and isolation. This approach enhances the reliability of the power grid, enabling users to monitor faults via mobile and desktop platforms seamlessly.Key objectives of the project include simulating the system with a programmable controller and current sensors, accurately detecting and identifying various fault types, and sending the fault location through GPS to the users. Although the system is designed for overhead transmission lines, it may face challenges due to environmental conditions or equipment limitations. Overall, the project aims to improve fault detection processes in transmission lines and enhance the efficiency of power systems.The main objective of this project is to design and implement a smart monitoring and fault detection system for overhead transmission lines, aimed at improving the reliability and efficiency of electrical power systems. Transmission lines are often vulnerable to faults caused by natural factors such as wind and rainfall, which can disrupt the power supply and cause significant damage. To address these issues and overcome the limitations of traditional fault detection methods, such as impedance-based systems with slowresponse times and reliability concerns, this project introduces a GPS-enabled IoT platform to ensure real-time fault detection and monitoring. By achieving these objectives, the project aims to significantly improve the response time and effectiveness of fault detection in power transmission systems, resulting in more reliable and efficient electrical power distribution.

The specific objectives of this project are:

1) Design and Implementation: Develop a smart monitoring system using Node MCU and current sensors to detect and classify various fault types in overhead transmission lines.
2) Real-Time Monitoring: Utilize GPS to pinpoint fault locations and transmit real-time fault data to an IoT cloud server.
3) IoT Platform: Enable remote monitoring via mobile and desktop platforms, providing easy access to fault information.
4) Fault Notifications: Implement a system that sends detailed fault notifications, including fault type and location, to users for rapid intervention.
5) Simulation: Simulate the system using a programmable controller to ensure its effectiveness in identifying and isolating faults before hardware deployment.

6) GPS Integration: Ensure accurate fault location detection and notification through GPS coordinates.
7) Reliability Improvement: Enhance the overall reliability of power systems by allowing timely responses to transmission line faults, reducing downtime and potential damage.

II. LITERATURE SURVEY

Accurate and timely fault detection in transmission lines is essential for maintaining the stability and reliability of power systems. Over the years, various techniques and approaches have been explored by researchers and engineers to address the challenges in fault classification, location, and system protection.

Kincic and Papic [1] explored the effects of series compensation on the voltage profile of transmission lines. Their study highlighted how series compensation improves power transfer capabilities but also alters fault current behavior, which can complicate traditional fault detection. Understanding these dynamics is critical when designing fault detection systems for compensated networks.

Shaaban and Hiyama [2] proposed a wavelet transform-based fault classification method for transmission lines. Their research demonstrated the capability of wavelet transforms to accurately classify fault types, leveraging the time-frequency domain for enhanced fault feature extraction. This methodology inspired the adoption of advanced signal processing in modern fault detection frameworks.

Bendre et al. [3] analysed the root causes of equipment failures in industrial systems, focusing on disturbances in power quality. Their work emphasized that power quality anomalies—often arising from undetected faults—could cause severe damage to sensitive equipment. This finding underscores the need for systems that provide both real-time fault detection and proactive protection.

Brumsickle et al. [4] discussed the relationship between power quality and system reliability, highlighting how unaddressed faults directly degrade both. Their study validated the importance of automated detection mechanisms that allow quick responses to prevent cascading failures in power transmission networks.

Basho and Bakshi [5] offered comprehensive insights into the principles of protection and switchgear, covering key protection schemes for transmission lines, including relay coordination, circuit breakers, and isolation techniques. Their textbook serves as the foundation for designing practical fault isolation systems using hardware components like relays, which were implemented in this project.

Lauglo [6], in his master's thesis, examined ground fault protection mechanisms in transmission lines. The research provided strategies for accurate ground fault identification and protection, reinforcing the importance of precise fault type classification — especially for ground faults, which are the most common in overhead systems.

III. PROBLEM STATEMENT

The increasing complexity and demand for reliability in electrical power systems emphasize the need for effective fault detection in transmission lines. Traditional methods, like impedance measurement, often fall short due to slow response times and inadequate fault localization, leading to prolonged outages and high operational costs. Historically, electricity suppliers underestimated the importance of precise fault detection, treating faults as temporary issues. Coupled with environmental factors like wind and rainfall that exacerbate faults, there is a pressing need for a robust, efficient fault detection system utilizing modern technologies, such as GPS and IoT integration, to enhance real-time monitoring and overall system reliability.

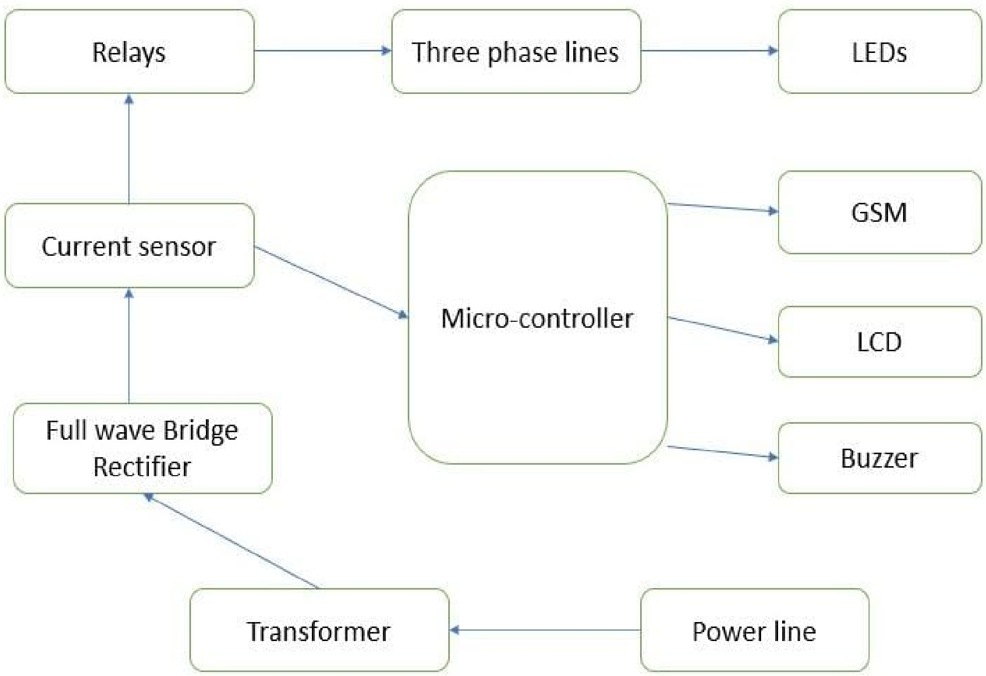
IV. METHODOLOGY

The block diagram showcases the interconnection of various components essential for the fault detection system in overhead transmission lines:

1) Node MCU(ESP8266): Acts as the central microcontroller, responsible for processing data and facilitating communication between different components and the IOT platform.
2) ACS712 Current Sensor: Measures the current flowing through the transmission line. It provides analog output corresponding to the current level, enabling the detection of abnormal conditions that may indicate a fault.
3) GPS Module: Used for determining the exact geographical location of the fault. It provides real-time coordinates that can be transmitted to the control centre for quick response.
4) LCD Display: Displays crucial real-time data, including current measurements and fault status, providing immediate feedback to users or operators on-site.

5) Buzzer: Functions as an alert mechanism, notifying users of detected faults through audible signals, prompting immediate investigation.
6) IOT Cloud Server: Enables remote monitoring and data transmission, allowing users to access fault information via mobile and desktop applications.
7) Current Measurement Circuit: Ensures accurate detection of current levels, integrating with the ACS712 to provide precise data for fault analysis.
8) Power Supply: Provides necessary power to the entire system, ensuring stable operation of all components.

V. BLOCK DIAGRAM



Fault Detection in Transmission Line

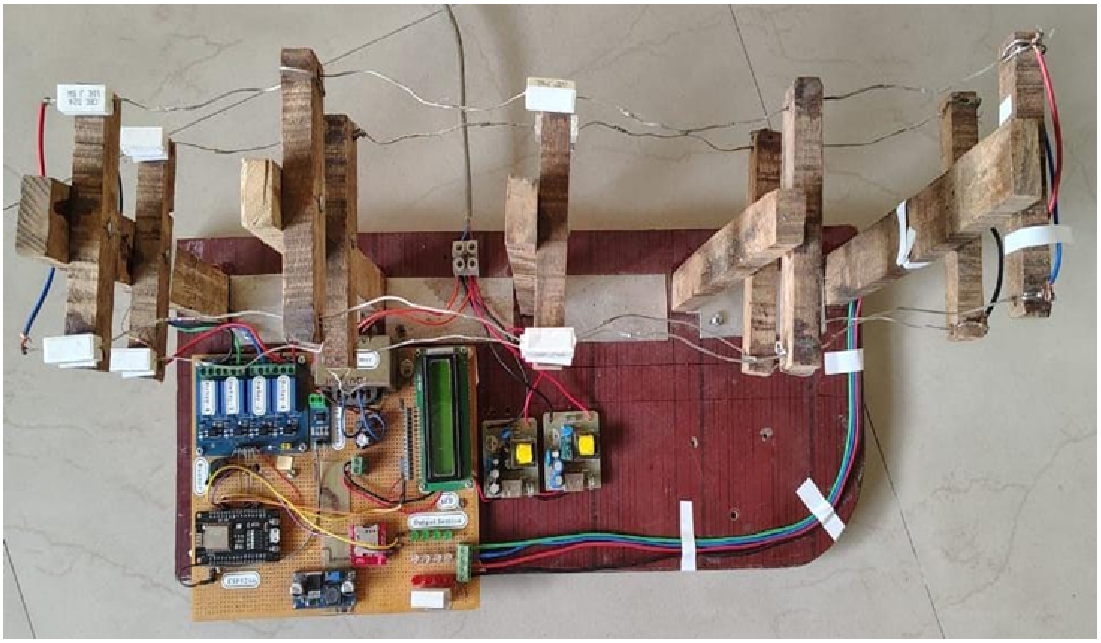
VI. FUTURE SCOPE

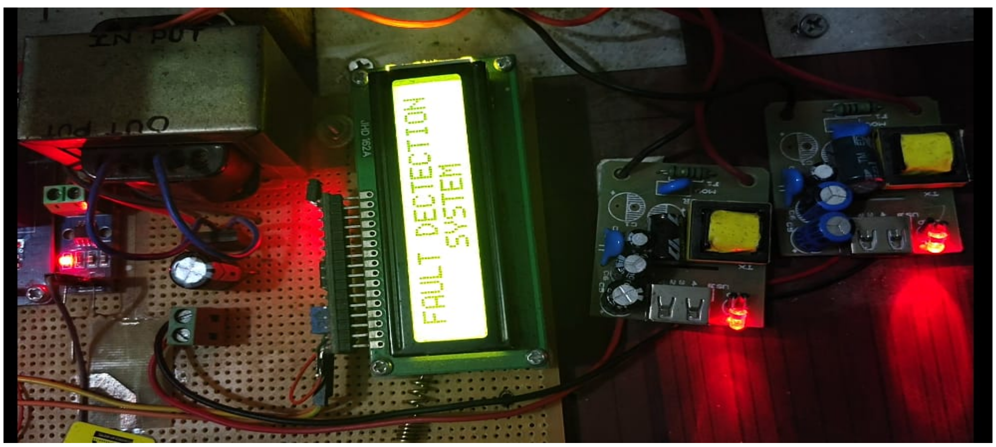
1) Integration with Advanced Analytics: Future iterations of the system could incorporate machine learning algorithms to analyse historical fault data, improving prediction models and enhancing fault localization accuracy.
2) Expansion to Underground Cables: The technology could be adapted for monitoring underground transmission lines, expanding its applicability and providing similar fault detection capabilities in different environments.
3) Enhanced Communication Protocols: Development of more robust communication protocols, such as 5G integration, could improve data transmission speed and reliability, especially in remote areas.
4) Development of Self-Healing Networks: Future advancements may focus on creating self-healing networks that can automatically isolate faults and reroute power to minimize outages without human intervention.
5) Integration with Renewable Energy Sources: As renewable energy sources become more prevalent, integrating the fault detection system with solar and wind power infrastructure can enhance overall system reliability and efficiency.
6) Real-Time Visualization Dashboards: Creating user-friendly dashboards for real-time monitoring and analysis could improve user experience, providing utilities with valuable insights and facilitating better decision-making.
7) Research on Environmental Impact: Future research could focus on the environmental impacts of transmission line operations, leveraging the data collected to develop eco-friendly practices and designs for transmission infrastructure.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue IV Apr 2025- Available at www.ijraset.com

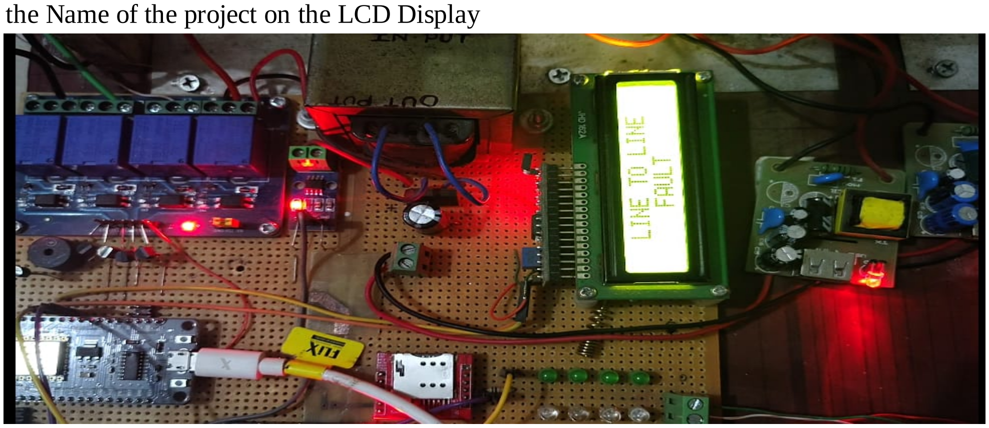
VII.RESULT

Various fault conditions—single line-to-ground (L-G), line-to-line (L-L), double line-to-ground (L-L-G), and three-phase (L-L-LG)—were simulated by inducing abnormal current levels across different lines. The system accurately detected each fault type based on current variations measured.

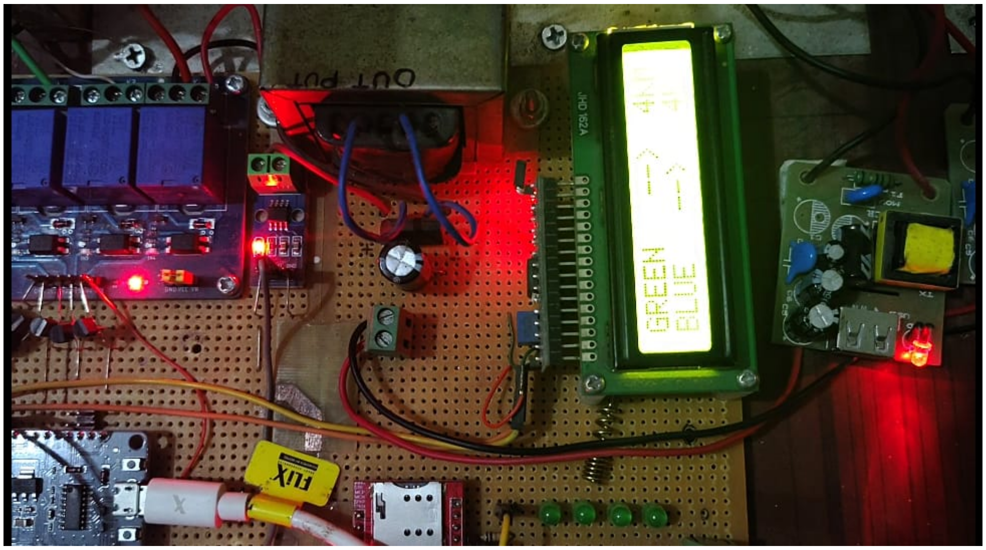




Above Image shows the Name of the project on the LCD Display



Above image shows the status of the transmission line. Fault detected in the system.



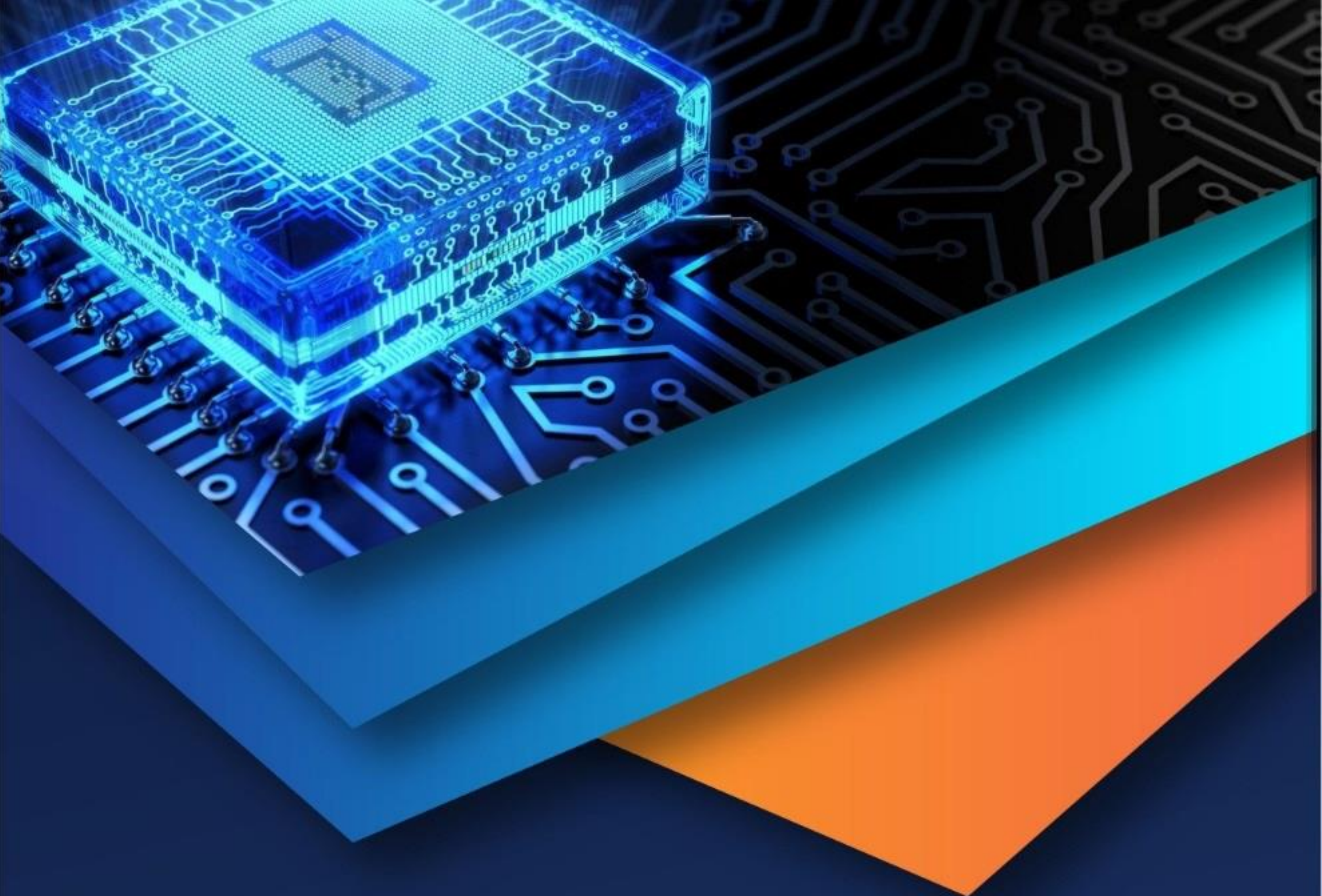
Above Image shows the fault detected in the transmission line and distance from the Substation.

VIII. CONCLUSION

In this research, a comprehensive system for fault detection in overhead transmission lines has been successfully developed and tested. By integrating various hardware components, including the Arduino Mega microcontroller, ACS712 current sensors, a 16x2 LCD, and a GPS module, the system effectively identifies and locates four distinct types of faults: single line to ground (L-G), line to line (L-L), double line to ground (L-L-G), and three-phase faults (L-L-LG).The methodology employed involved extensive simulation using Proteus software, ensuring the system's design was validated before physical implementation. The results demonstrated that the system could accurately monitor transmission line conditions, alerting operators through visual and auditory signals upon fault detection The integration of the Arduino IoT Cloud further enhanced the system's capabilities, enabling real-time data transmission to an Android app and a web server, facilitating efficient monitoring and response.The successful execution of simulations and hardware tests confirmed the system's reliability and effectiveness in detecting faults and their precise locations along transmission lines. This innovative approach not only improves the safety and reliability of electrical transmission systems but also presents a scalable model that can be adapted for various applications in power system monitoring.In conclusion, the findings from this project underscore the importance of advanced fault detection mechanisms in maintaining the integrity of transmission lines and highlight the potential for further research and development in the field of electrical engineering.

REFERENCES

[1] Kincic S, Papic, M. Impact of Series Compensation on the voltage profile of transmission lines. Power and Energy Society General Meeting PES. 2013; 1-5.
[2] Shaaban SA, Hiyama, T. Transmission Line Faults Classification Using Wavelet Transform. 14th International Middle East Power Systems Conference (MEPCON'10). Cairo University, Egypt. 2010; 532-537.
[3] Bendre A, Divan D, Kranz W, Brumsickle W. Equipment failures caused by power quality disturbances. In Industry Applications Conference. 39th IAS Annual Meeting. Conference Record of the 2004 IEEE. 2004; 1.
[4] Brumsickle WE, Divan DM, Luckjiff GA, Freeborg JW, Hayes RL. Power quality and reliability. IEEE Industry Applications Magazine. 2005; 11(1): 48-53.
[5] Basho UA, Bakshi MV. Protection And Switchgear. Technical Publications; 2009.
[6] Lauglo M. Ground Fault Protection of Transmission Lines (Master's thesis, NTNU).
[7] Jena P, Pradhan AK. A Positive- Sequence Directional Relaying Algorithm for Series Compensated Line. IEEE Transactions on Power Delivery. 2010; 25(4): 2288- 2298.
[8] Nayak PK, Pradhan AK, Bajpai P. A fault detection technique for the series-compensated line during power swing. IEEE transactions on power delivery. 2013; 28(2): 714-22.
[9] Izykowski, J., Rosolowski, E., Balcerek, P., Fulczyk, M. and Saha, M.M. Fault Location on Double Circuit Series-Compensated Lines Using Two-End Unsynchronized Measurements. IEEE Transactions Power Delivery. 2011; 26(4): 2072-2080.
[10] Pierz, P., Balcerek P. and Saha, M. M. A Method for Internal and External Fault Discrimination for Protection of Series Compensated Double-Circuit Line. IEEE Grenoble Power Tech. 2013; 1-6.



10.22214/IJRASET

INDEX COPERNICUS 45.98

ISRA JIF IMPACT FACTOR: 7.129

SJIFactor TOGETHER WE REACH THE GOAL IMPACT FACTOR: 7.429

ISI

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY