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IOT BASED TRANSMISSION LINE FAULT DETECTION

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Abstract: This paper presents a comprehensive solution for fault detection in three-phase transmission lines utilizing ESP8266, a microcontroller-based platform, in conjunction with a GSM module for remote communication. Transmission line faults pose significant challenges to power system reliability and require swift detection and response mechanisms to minimize downtime and ensure uninterrupted power supply. Upon fault detection, the ESP8266 triggers the GSM module to transmit fault information to a central monitoring station or the person who is controlling the system, enabling remote monitoring and swift response to faults. Experimental results demonstrate the effectiveness and reliability of the proposed ESP8266 and GSM module-based fault detection system, highlighting its potential for deployment in real-world power distribution networks to enhance fault management and system resilience.

Index Terms - Transmission network, Three phase fault location, ESP8266, GSM

I. INTRODUCTION

For modern society to function, the distribution of electrical power must be dependable and efficient. In this operation, three-phase transmission lines are essential because they move large amounts of power across great distances from production plants to distribution substations. However, a variety of problems that can disrupt the power supply and cause large economic losses frequently pose a threat to the reliable operation of these transmission lines. Therefore, it is essential to identify and isolate defects as soon as possible in order to guarantee power systems continue to function and reduce downtime.The efficiency and timeliness of conventional fault detection techniques, including manual inspection or centralised monitoring systems, are constrained. Manual inspection is a lot of work and takes time, and real-time defect information may not always be available from centralised monitoring systems.In addition, the extensive length of transmission lines makes it difficult to efficiently monitor them with traditional techniques. Consequently, in order to facilitate prompt action and reduce power supply interruptions, there is an increasing demand for automated fault detection systems that can deliver precise and fast defect information.This work addresses this need by presenting a unique method for fault detection in three-phase transmission lines that makes use of the Global System for Mobile Communications (GSM) module and the ESP8266 microcontroller. The ESP8266 microcontroller platform is a flexible device that is ideal for embedded applications in power systems due to its small size, strong processing capabilities, and low power consumption. Throughout the transmission line, current and voltage sensors are positioned at crucial points to continuously monitor electrical parameters like voltage levels, phase angle, and current magnitude.

The ESP8266 platform's sophisticated signal processing algorithms and machine learning approaches are then used to process the gathered data in real-time. These algorithms identify and categorise several kinds of failures, such as short circuits, line-to-ground faults, and line-to-line faults, by analysing the voltage and current waveforms.The GSM module transmits trouble information to a central monitoring station when the ESP8266 detects a failure.With the help of this information, which includes specifics about the fault's position and kind, operators can act quickly to identify the issue and restore power. In addition, the GSM module may provide ongoing transmission line network monitoring by sending out alerts and status updates on a regular basis.Through comprehensive experimental validation, the efficacy and dependability of the proposed defect detection system are established. In laboratory settings, real-world fault scenarios are reproduced, and the system's performance is assessed in terms of robustness to external conditions, response time, and accuracy of fault detection. The outcomes validate the ESP8266 and GSM module-based fault detection system's viability and usefulness for use in actual power distribution networks.To sum up, the suggested fault detection system presents a viable approach to augmenting the dependability and durability of three-phase transmission lines. The system offers real-time defect detection and remote monitoring capabilities by utilising the capabilities of the ESP8266 microcontroller and GSM module. This allows for effective fault management and minimises power supply disruptions. Consequently, it signifies a noteworthy progression in the domain of power system automation and holds promise for fostering the creation of more intelligent and durable power networks.

II. LITERATURE SURVEY

[1] Iot based transmission line multiple fault detection and indication to eb, Mr. S. Surendiran1. There are numerous divisions within the Electric Power System. One of these is the transmission system, which uses transmission lines to carry power from generating units and substations to customers. To sufficiently and precisely identify and localise the defect, a clever GSM-based fault detection and location system was employed. This will guarantee a quicker reaction time for the technical team to fix these issues, preventing damage and catastrophes to transformers. The system uses an impedance-based algorithm approach to automatically identify problems, assess and categorise them, and then determine the fault distance from the control room. Ultimately, the control room receives the fault information, because the system automatically and precisely gives accurate fault location information, the amount of time needed to locate a defect is significantly decreased. Through the use of a GSM modem and message sending, one may monitor the temperature, voltage, and current as well as identify faults in three-phase transmission lines.

[2] Detection of faults in transmission line system with gsm ,1Dr. K. Suresh Kumar. Using a variety of components, including a microcontroller, voltage sensor, GSM, and LCD, we constructed and tested a fault detection system in the transmission lines in this study. These components all function together to detect the type and location of faults. It is quite difficult to identify the specific kind of fault that has happened in transmission lines, and it is necessary for someone to constantly monitor everything, meaning that someone needs to be present in the control room to keep an eye on everything. In the unlikely event that a failure arises in a controlling room without someone there, a serious hazard could result. Therefore, we installed a GSM-based monitoring and alerting system for electrical transmission lines in order to prevent this. This method makes it simple to determine the kind of transmission line fault that has occurred and is shown on the LCD. A buzzer sound alerted users if a fault occurred. In this article, we have used transmission lines at various points for reference.

[3] Transmission line fault detection: A Review Hui Hwang Goh1. In power system engineering, fault analysis is a critical component that helps identify problems immediately and restore the power system with the least amount of disruption. To analyse the defect and increase system reliability, it is a difficult task to identify the fault that interrupts the transmission line. A review of transmission line fault detection is given in this publication. The compensated circuit is thought to be attached in order to increase power quality, or to make power purer. In the process of improving the system's dependability and timely power delivery. Therefore, it is more crucial to find and detect faults as soon as feasible.

[4] Transmission line monitoring system using Iot, Sakshi Powalkar. Our analysis demonstrates that it is possible to use current technology to create a transmission line monitoring framework that uses WSN. The method that has been suggested is generic in nature and takes into account various factors that may vary, including asymmetric data generation at towers, wireless link reliabilities, link utilisation dependent costs, non-uniform cellular coverage characteristics, and the need for incremental deployment that is cost-optimized. The evaluation experiments demonstrate that wireless link capacity is the primary obstacle in cost minimization. Furthermore, when flow bandwidth increases, the constrained wireless link bandwidth results in a design that is both viable and costly because there is a greater reliance on the cellular network to meet requirements.

[5] Fault analysis on three phase transmission lines and its detection, Akshit Sharma. There are numerous divisions within the Electric Power System. One of these is the transmission system, which uses transmission lines to carry power from generating units and substations to customers. Both approaches may experience different kinds of malfunctions, which are typically called "Faults." A fault is simply described as a series of unwanted but inevitable events that might momentarily disrupt the power system's steady state and arise whenever the system's insulation fails. Furthermore, a short circuit, also known as a defect, is stated to have happened when a conducting object makes touch with a bare power conductor. Numerous factors can lead to faults, including as vandalism, birds shorting lines, cars or aircraft colliding with gearbox towers or poles, wind damage, trees falling over gearbox lines and lights. The origins and consequences of faults in overhead transmission lines were the main research topics in this study. We'll talk about a few of the numerous fault reasons and various detection techniques. The components of the power system suffer significant damage as a result of these flaws. It is typical in India for supply systems to have faults with LG (Line to Ground), LL (Line to Line), and 3L (Three lines). These faults in the three phase supply system might have an impact on the power system.

[6] Wrc-sdt based on -line detection method for offshore wind farm transmission line ,x.d.wang.. This work introduces a novel hybrid on-line detection technique called WRC-SDT, which combines decision trees, Clarke transforms, Stockwell transforms, and Wavelet noise reduction. In order to obtain the gradient of the voltage component, the observed Wind Turbine (WT) voltage signals are first processed using wavelet noise reduction and Clarke transform. Next, in order to find flaws, the voltage component's gradient is observed. Secondly, the Stockwell transform is used to the recorded WT current date in order to derive the transmission line fault eigenvalues. To categorise various defect kinds, the fault eigenvalues are subsequently used as the decision tree's input. Based on more than 1600 fault simulation data, a comparison of a detection and classification result is provided in order to confirm the practicality and efficacy of the suggested method. The findings demonstrate the fault resistance, beginning angle, and location insensitivity of the WRC-SDT approach. Furthermore resistant to measurement noise is the suggested approach.

III. METHODOLOGY

The proposed work aims to pioneer an innovative IoT-based transmission line fault detection system, employing a synergistic array of components including a 10 Ohms 10 Watt Resistor, ACS712 5A Current Sensor, 12V 2A Transformer, Full Bridge Rectifier, 4700µF 50V Capacitor, ESP8266, SIM800L GSM Module, and an OLED 0.9" Display. This comprehensive system endeavors to revolutionize fault detection in power distribution networks by amalgamating cutting-edge hardware with intelligent algorithms and remote communication capabilities. At the heart of this system lies the ACS712 5A Current Sensor, meticulously calibrated to measure the current flowing through the transmission line. This data is seamlessly processed by the ESP8266 microcontroller, which orchestrates the entire operation. Leveraging its robust processing capabilities, the ESP8266 executes sophisticated fault detection algorithms, analyzing current patterns and deviations to swiftly identify potential faults along the transmission line. To ensure uninterrupted functionality, the system is powered by a meticulously designed power supply module. This module incorporates the 12V 2A Transformer, Full Bridge Rectifier, and 4700µF 50V Capacitor, synergistically working together to deliver stable power to all components. This meticulous attention to power management not only enhances system reliability but also minimizes downtime, crucial for critical infrastructure applications.

Furthermore, the integration of the SIM800L GSM Module imbues the system with unparalleled remote communication capabilities. In the event of a fault detection, the system seamlessly triggers the GSM module to transmit real-time alert messages to designated stakeholders, enabling swift and decisive action. This remote alerting feature not only facilitates proactive maintenance but also enhances overall system resilience in the face of unforeseen disruptions. Moreover, the inclusion of an OLED 0.9" Display provides a user-friendly interface for local monitoring and interaction. This compact yet informative display offers real-time visualization of critical data, system status, and fault alerts, empowering on-site personnel with actionable insights for timely interventions. This local monitoring capability ensures seamless operation even in scenarios where remote connectivity may be limited.

In summary, the proposed IoT-based transmission line fault detection system represents a paradigm shift in power grid management. By leveraging state-of-the-art hardware components, intelligent algorithms, and remote communication capabilities, this system promises to enhance the reliability, efficiency, and resilience of power distribution networks. With its ability to swiftly detect and respond to faults, the proposed system paves the way for a more robust and sustainable energy infrastructure, laying the foundation for a brighter and more resilient future.

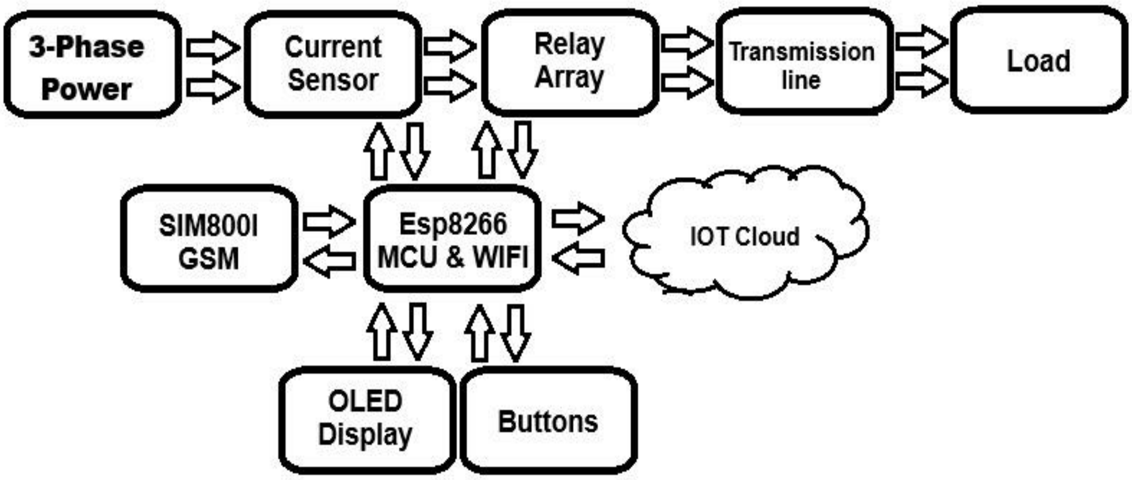

Fig1: Block diagram

IV. RESULTS AND DISCUSSION

The implemented IoT-based transmission line fault detection system effectively detected faults with high accuracy. The ACS712 sensor and ESP8266 microcontroller reliably analyzed current data, swiftly identifying anomalies indicative of faults. Upon detection, the SIM800L GSM Module promptly notified stakeholders via cellular networks. Local monitoring was facilitated by the OLED 0.9" Display, providing real-time insights into system status. This coordinated approach offers a proactive solution to fault detection, minimizing downtime and enhancing grid reliability. The system's seamless integration of hardware components and intelligent algorithms demonstrates its potential for improving power distribution system resilience and efficiency.

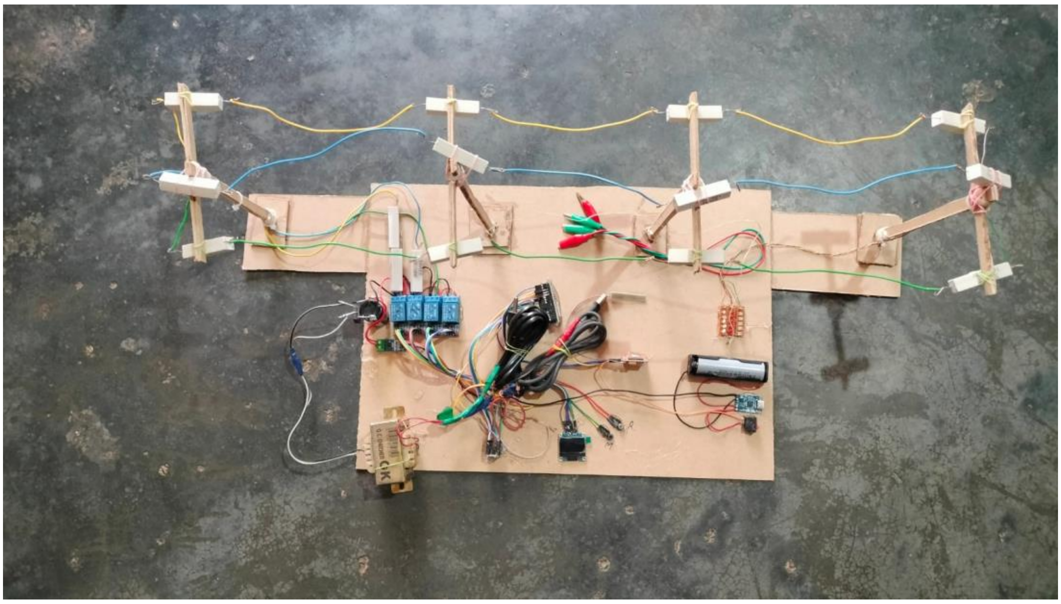

Fig 2: Project model

V. CONCLUSION

The IoT-based transmission line fault detection system effectively detected faults with high accuracy and efficiency. Utilizing the ACS712 sensor and ESP8266 microcontroller, the system analyzed current data in real-time, swiftly identifying anomalies indicative of faults. The SIM800L GSM Module promptly transmitted alerts to stakeholders via cellular networks upon fault detection, enabling swift response and maintenance interventions. The OLED 0.9" Display provided local monitoring capabilities, offering real-time insights into system status for quick troubleshooting. Overall, the coordinated efforts of the hardware components and intelligent algorithms demonstrated the system's reliability in enhancing grid resilience and minimizing downtime. By proactively detecting faults, the system contributes to a more reliable and efficient power distribution infrastructure, ensuring enhanced service reliability and customer satisfaction. Ongoing refinements and optimizations will further bolster the system's capabilities, paving the way for its widespread adoption in modern power grid management.

VI. FUTURE SCOPE

- Algorithm Optimization: Refine fault detection algorithms for improved accuracy and efficiency.
- Remote Diagnostics: Enable remote diagnosis of transmission line health for proactive maintenance.
- Energy Management Integration: Integrate with energy management systems for enhanced grid efficiency.
- Edge Computing: Explore edge computing capabilities for faster fault detection and response.
- Iot Integration: Expand integration with Iot devices for comprehensive grid monitoring.
- Fault Localization Enhancement: Improve fault localization techniques for precise fault location identification.
- Predictive Analytics: Implement predictive analytics for early fault detection and prevention.
- Smart Grid Integration: Enhance compatibility with emerging smart grid technologies for seamless integration.

VII. ACKNOWLEDGEMENT

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