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Transmission Line Fault Monitoring System Using IoT

A Project Review Paper

[1]Abhinay Vijayrao Sahare, [2]Shreyas Sunil Patil, [3]Sejal Arun Shete, [4]Rutuja Sanjay Kandekar, [5]Prof. Minaj S. Shikalgar

[1,2,3,4] Final Year B.Tech Students, [5] Assistant Professor
[1,2,3,4] Department of Electronics & Telecommunication Engineering,
[1,2,3,4] Kolhapur Institute of Technology's Autonomous College of Engineering, Kolhapur, India.

Abstract : The transmission of electricity in India is becoming increasingly important than ever thought of. It depends on high-voltage lines which at times has to cross kilometers of forests or mountains to reach a certain area, and a preventive check has to be done since even a single fault can stop power supply. Maintaining uninterrupted power supply is crucial, and any faults in the system must be detected promptly. In order to check for faults, shocks or corrosive element in the wire, the power supply has to be first cut down and interruption of energy flow is not always admissible.

To monitor each and every endpoint/transmission point for a specific area is too difficult which ultimately results in delay to repair the problem occurred. To address these challenges, this project aims to reduce power consumption delays for both delay-sensitive and delay-insensitive traffic. Proposed method offers the uninterrupted power supply and less maintenance time for problem occurred with in advance alerts to the power-stations. In this method, an Arduino nano is used as a primary device to which various types of sensors are attached like voltage sensor, wind speed sensor, load cell sensor, temperature sensor, current sensor. These sensors measure the specific values of the transmission line and send it wirelessly to the power-stations so that they can get to know all the data related to power failure, reasons for power failure & the location point.

With the integration of IOT in this method, we can directly automate various things which can be the future scope of this model. The data can be directly viewed by anyone using web browser and a simple & efficient web-app. Overall, this project demonstrates the potential of IoT technology to enhance power failure maintenance efficiency and monitoring in long-distance power transmission systems.

***Keywords* - Arduino, Voltage sensor, Load cell, Temperature sensor, IOT, Thingspeak.**

INTRODUCTION

The modern electrical system has been experiencing an exponential growth rate. A critical component of this system is the electrical power transmission line that links power generation plants with the end-users. However, due to the long length of the transmission line, faults may occur, which can disrupt the supply of power to consumers. Compared to other parts of the power system, transmission and distribution networks experience high losses. The vulnerability of the electric power infrastructure to various physical events, both natural and malicious, poses a significant threat to the stability and overall performance of the grid. If not detected and cleared quickly, faults in the transmission network can lead to transformer damage, destruction of human life, and even fire outbreaks.

Unfortunately, in India, there is currently no real-time system that notifies of faults as they occur on multiple parameters. This increases the risk of damage to connected devices and poses a threat to human life. To prevent such incidents, transmission lines require frequent maintenance, which demands increased manpower. However, frequent line checks may not prevent faults caused by unpredictable events such as tree topples and rainfall. Therefore, there is a need for a fast fault identification and clearance system.

In response to the challenges described, the proposed solution is an Internet of Things (IoT) based transmission line with various fault detection and an indication system to notify the respective power stations of any detected faults. Here, the proposed system uses an Arduino nano, Various parameter sensors & Esp32 sensor to detect the fault in the transmission line and then send the data accordingly to the power stations. As soon as the pre-configured threshold limit for the particular sensor is exceeded, the Arduino instantly detects it and creates an alert, and sends the information data related to it to respective power stations. This real-time system lets power station crews respond to faults more quickly & easily, reducing the response time needed to solve the problem. As a result, this helps to avoid severe transformer damage and any other disasters that could arise from the delay.

The system transmits the fault information to the control room using IoT technology. With this system in place, it will be possible to detect and clear faults in transmission lines quickly, preventing transformer damage and other disasters.

PROBLEM STATEMENT

The growing demand for power across various sectors such as industry, agriculture, banking, education, and more has led to a significant increase in the requirement of electric power transmission. However, with the modern electric system growing exponentially, transmission line issues have become increasingly complex, making it difficult to accurately determine the reasons, location, and other relevant parameters of a fault. This problem often leads to significant losses during fault location, which is detrimental to the transmission line.

The time required to clear these faults is also significant, which can lead to a reduction in the lifespan of the transmission line and may ultimately pose a direct threat to human safety. In today's fast-paced world, where time is of the essence, the loss of power due to transmission faults can cause major disruption, leading to economic and societal losses.

To address this issue, modern technology has introduced innovative solutions, including the use of an IoT-based system to improve transmission line performance.

LITERATURE SURVEY

Various research studies have explored the use of IoT-based systems for fault monitoring and detection in power transmission lines.

For instance, a study conducted by Kumar et al. (2020) [1] proposed an IoT-based fault detection and identification system for overhead transmission lines. The proposed system uses vibration sensors to detect mechanical vibrations caused by faults and sends notifications to the control center for further analysis. The authors reported that the proposed system achieved high accuracy in detecting and identifying faults, with a detection rate of up to 99%.

Another study by Muyeen et al. (2019) [2] proposed an IoT-based fault detection and diagnosis system for underground power cables. The system uses a combination of acoustic sensors, temperature sensors, and current sensors to detect and diagnose faults in real-time. The authors reported that the proposed system achieved a high accuracy rate in fault detection and diagnosis, with a sensitivity of up to 95%.

One such system is the use of distributed temperature sensors for fault detection in power cables. The system monitors the temperature profile of power cables and detects anomalies that could indicate faults. This technique is non-intrusive and can detect faults even when the cable is buried underground, making it an effective solution for fault detection in underground cables. Several studies have explored the use of distributed temperature sensors for fault detection in power cables, such as the study by Liu et al. (2016) [3] , which proposed a new algorithm for fault detection in underground cables based on distributed temperature sensors. The authors reported a high accuracy rate in fault detection, with a sensitivity of up to 99%.

Another technique for fault detection in power transmission and distribution networks is the use of power quality monitoring. Power quality monitoring involves the measurement of various parameters, such as voltage, current, frequency, and waveform, to detect anomalies that could indicate faults. This technique is effective in detecting faults caused by voltage sags, swells, harmonics, and transients. Several studies have explored the use of power quality monitoring for fault detection, such as the study by Lashkarara et al. (2017) [4], which proposed a fault detection method for distribution networks based on power quality monitoring. The authors reported that the proposed method achieved high accuracy in fault detection, with a sensitivity of up to 98%.

Moreover, machine learning algorithms have been increasingly used for fault detection and diagnosis in power transmission and distribution networks. Machine learning algorithms use historical data to learn the normal behavior of the system and can detect deviations from the normal behavior that could indicate faults. Several studies have explored the use of machine learning algorithms for fault detection and diagnosis, such as the study by Chen et al. (2021) [5], which proposed a fault diagnosis method for transmission lines based on convolutional neural networks. The authors reported that the proposed method achieved high accuracy in fault diagnosis, with a sensitivity of up to 99%.

Overall, the use of IoT technology and advanced fault monitoring and detection systems has the potential to significantly improve the reliability, safety, and efficiency of power transmission and distribution networks. These systems offer real-time monitoring, predictive maintenance, and early warning capabilities, enabling system operators to take preventive measures and reduce losses caused by fault.

PROPOSED SOLUTION

To address this pressing issue, modern technology has introduced innovative solutions, including the use of an Internet of Things (IoT)-based system to improve transmission line performance. This system uses multiple sensors to accurately detect faults and notify the necessary power stations in real-time. By promptly identifying the location of faults and enabling rapid response times, power station crews can more effectively rectify faults, reducing the lifespan of the transmission line and minimizing the risk of transformer damage and other potential disasters.

Overall, the implementation of an IoT-based system for transmission lines will play a critical role in improving the efficiency, reliability, and safety of the power supply system. By reducing the impact of faults on transmission lines and enabling faster recovery, this technology can significantly reduce losses and enhance the overall performance of the electric power transmission system.

The implementation of an IoT-based system for transmission lines is a significant step towards building a robust, smart transmission infrastructure that can handle the ever-increasing demand for electricity. This technology can significantly reduce losses, improve the overall efficiency of the transmission system, and ensure a reliable and safe power supply to support the sustainable growth of the economy.

PROPOSED METHODOLOGY

5.1 Solution Strategy

The project report aims to develop a monitoring system for high transmission lines on multiple towers. To achieve this goal, various parameters such as temperature, wind speed, sag, current, and voltage are tested. Sensors are used to measure these parameters, and the physical information obtained is sent to an Arduino. The Arduino then sends the data to a web page via a Wi-Fi module. The system allows users to set limits for each parameter, and if any parameter exceeds its limit, a warning message is sent to the authority mobile.

The proposed system has the potential to integrate with IoT systems, enhancing its feasibility and practicality. The sensor data transmitted via the Wi-Fi module is stored in a database, which could be utilized by power companies to improve the safety of transmission lines or serve as a reference in power dispatch centers. The recorded sag, wind, and temperature data of overhead transmission lines are collected at frequent intervals, providing a detailed overview of the line's behavior.

By implementing this monitoring system, the safety and reliability of high transmission lines can be improved, ensuring uninterrupted power supply to consumers. Furthermore, the system's real-time monitoring capabilities and early warning mechanisms enable maintenance personnel to take preventive measures before faults occur, reducing system downtime and losses. Overall, the proposed system offers an efficient and cost-effective solution for monitoring high transmission lines, contributing to the continuous improvement of power transmission and distribution networks.

5.2 Basic Block Diagram

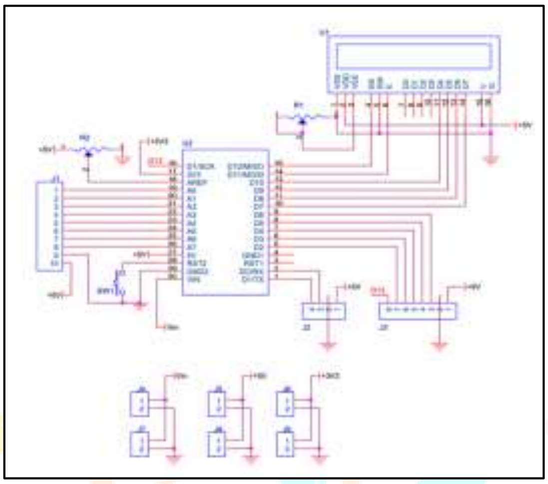

Fig. 1. Block Diagram of proposed solution

5.3 Component List

1. Arduino Nano 2. LCD display 3. ESP8266 Wi-Fi Module 4. Temperature Sensor LM35 5. Load Cell with Signal Conditioning Circuit 6. Current Sensor / Current Transformer 7. Voltage Sensor / Step Down Transformer 8. DC Motor / Wind Speed Sensor 9. Relay Module 10. Piezo-electric Buzzer 11. Resisters 12. Adapter (Input Source)

PROPOSED HARDWARE CIRCUIT DIAGRAM

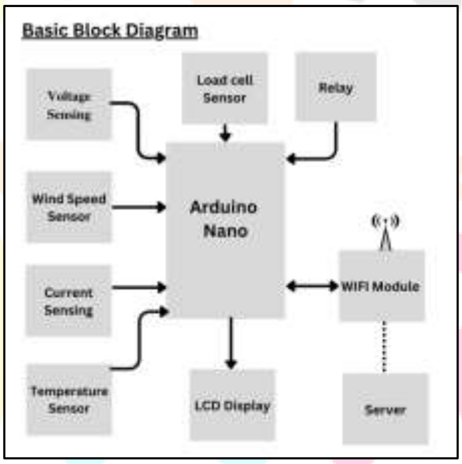

Fig. 2. Circuit Diagram of Proposed Solution

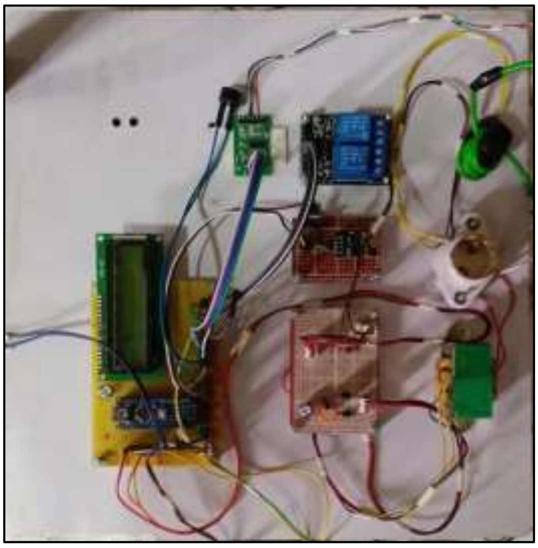

Fig. 3. Hardware Connection of Proposed Solution

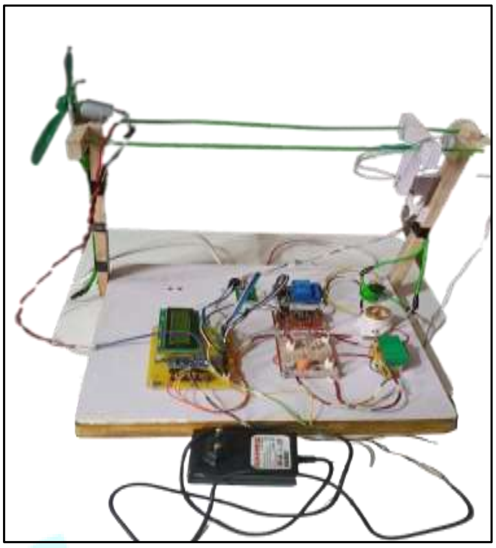

Fig. 4. Final Hardware Model of Proposed Solution

Fig.2. Represents the Simulation of Circuit Diagram using proteus simulation software to test the overall functioning of model beforehand.

Fig.3. Represents the Image of Hardware Connection done for proposed model solution which is mounted on a wooden board to present it in sophisticate way.

Fig.4. Represents the Final Image of our proposed model solution.

OBSERVATION

1. All the five sensors will take readings and then it sends to thingspeak sever with the help of ESP8266 Module.
2. Whenever any reading for any parameter exceeds above limit, it will create an alert and also shows it on server screen.

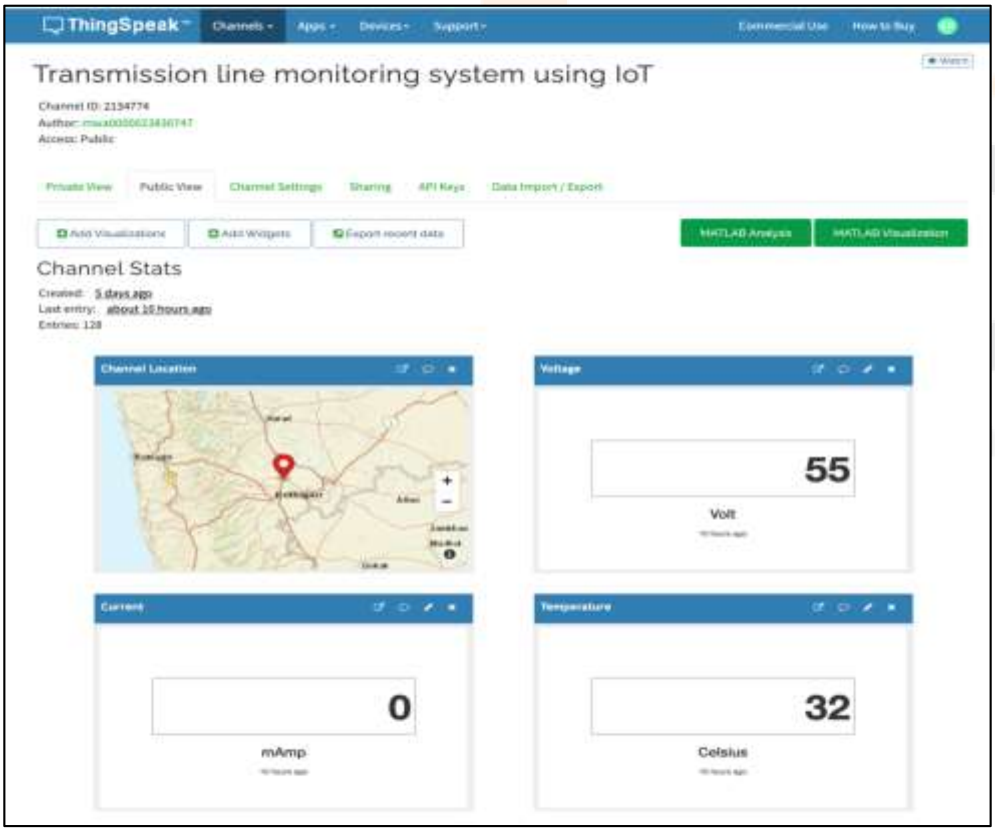

Fig.5. Thingspeak IoT interface.

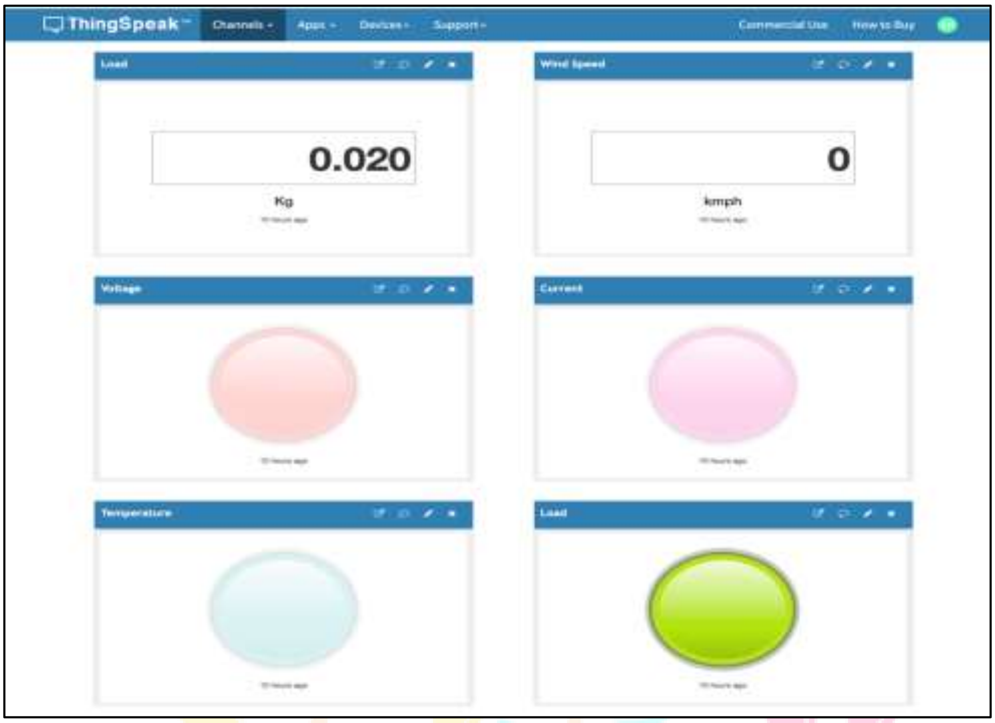

Fig.6. Thingspeak IoT interface.

3. Also, With the help of Thingspeak server one can easily view a complied graph of ranges of parameters within a time and can easily export it and send it to do required work.

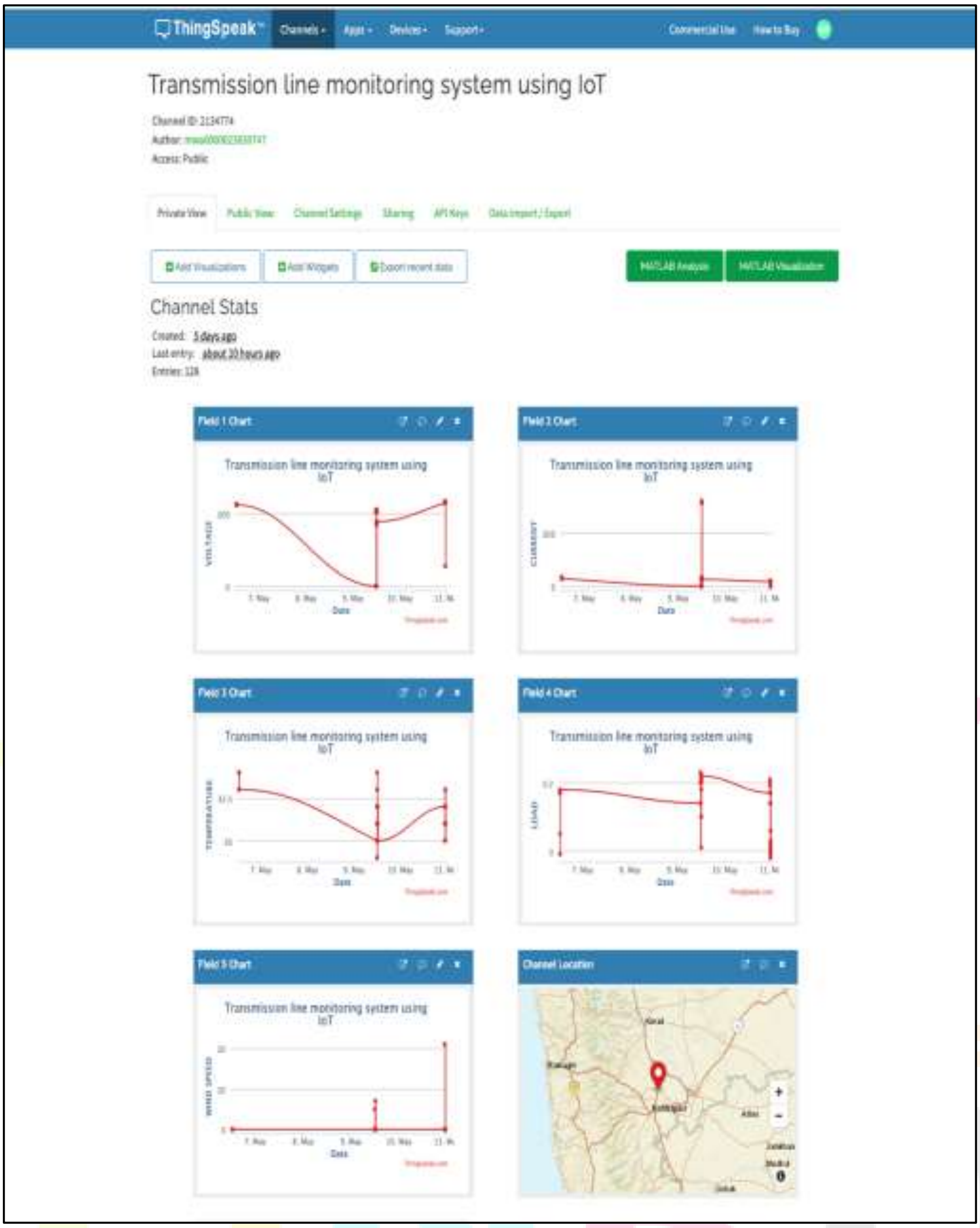

Fig.7. Thingspeak IoT interface.

4. It also shows the location of particular transmission line which will help to locate the fault happened at a location.
5. We can integrate various API's as well if we want to use more functionalities.

SUMMARY

This project addresses the challenges in modern electrical power transmission lines through an IoT-based monitoring system. It utilizes Arduino, sensors, and an ESP32 sensor to detect faults in transmission lines and promptly notify the respective power stations. By leveraging IoT technology, the system enables quicker response times for fault clearance, preventing transformer damage and ensuring a reliable power supply. The monitoring system measures parameters such as temperature, wind speed, sag, current, and voltage, sending the collected data to a web page for visualization. Users can set limits for each parameter, receiving warning messages if any threshold is exceeded. The system's real-time monitoring capabilities and early warning mechanisms improve the safety and reliability of high transmission lines, reducing downtime and losses. Overall, this IoT-based solution enhances the performance of transmission lines and contributes to the advancement of power transmission networks.

CONCLUSION

In conclusion, the proposed project introduces an Internet of Things (IoT)-based monitoring system for modern electrical power transmission lines. By leveraging Arduino, sensors, and an ESP32 sensor, the system enables the prompt detection of faults in transmission lines and real-time notification to the respective power stations. It offers the flexibility for users to set customized thresholds for parameters such as temperature, wind speed, sag, current, and voltage, and receive immediate warning messages if any threshold is exceeded. This advanced monitoring system significantly reduces response times for fault clearance, mitigating the risk of transformer damage and ensuring a reliable power supply to end-users. The integration of IoT technology enhances the efficiency, reliability, and safety of power transmission, addressing the challenges posed by faults and disruptions in the electrical grid. Through the continuous monitoring and early detection of faults, the system contributes to the optimization of transmission line performance and the overall improvement of power transmission networks.

FUTURE SCOPES

The proposed IoT-based monitoring system for transmission lines lays the foundation for several potential future advancements and enhancements. Here are some future scopes that can be considered:

1. A mobile application can be developed to complement the monitoring system. The app can provide real-time updates and notifications to power station authorities and maintenance personnel, enabling them to monitor and manage transmission lines from anywhere.
2. Implementing AI algorithms can further enhance the fault detection and prediction capabilities of the system. AI models can analyze the collected sensor data, identify patterns, and detect potential faults before they occur.
3. Building upon the IoT architecture, remote control and automation features can be incorporated into the system. This would allow operators to remotely control transmission line operations, switch operations, and maintenance activities, reducing the need for manual intervention and enhancing overall operational efficiency.
4. Collaborating with power grid authorities and utility companies can facilitate the integration of the monitoring system into existing power infrastructure. This collaboration would enable the deployment of the system on a larger scale, covering a broader network of transmission lines and optimizing the overall grid performance.

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