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Design and Implementation IoT-Driven Distribution Transformer health monitoring system for smart power grid

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INTRODUCTION & AIM

A distribution transformer is an electrical equipment used in power systems to reduce voltage in distribution lines to the voltage customers use. It is responsible for the final voltage change and includes an electromagnetic circuit. To make transformers more reliable, it is necessary to select specific auxiliaries and design a precise magnetic circuit, structure, and insulation system [1].Concerns like overloaded conditions and insufficient thermal management lead to transformer decline, necessitating data collection for efficient monitoring and control of the entire apparatus [2].Transformer health and safety are crucial in electrical distribution due to potential faults. Monitoring and diagnosing defects can reduce equipment damage and impact network reliability [3], [4].The use of this method allows for regular monitoring and maintenance of a transformer, ensuring its optimal state and potential issues are addressed .Wireless IoT-based monitoring systems are widely used in the business sector to monitor critical performance from remote locations .The increased lifespan of a transformer will facilitate easier service provision and provide crucial information about its health .The report can be accessed through mobile applications by storing the processed output data in a database .An online measuring device is used to collect and analyze various sensor data types over time to maintain accuracy . This project aims to build an improved health monitoring system for distribution transformers to optimize operating efficiency and ensure system dependability. The device incorporates an automatic tripping mechanism, facilitating real-time surveillance of essential transformer characteristics like voltage, temperature, and current/load. The main goal is to proactively detect probable problems and anomalies in transformer performance prior to their escalation into catastrophic failures. This method improves transformer longevity, decreases downtime, and reduces maintenance expenses through early issue diagnosis. The project seeks to enhance a resilient and economical energy distribution infrastructure, guaranteeing reliable service and promoting sustainable grid operations.

METHOD

The "Design and Implementation IoT-Driven Distribution Transformer health monitoring system for smart power grid" is a comprehensive design methodology that aims to create a robust and efficient system for monitoring critical parameters of distribution transformers. The methodology includes a conceptualization phase, where the project team analyzes monitoring needs, such as voltage measurement, current sensing, and temperature monitoring. The design phase integrates sensors, relay systems, and a 2A fuse for fault detection and protection. The connectivity and visualization phase uses the Blynk platform for real-time data access and decision-making. The validation phase ensures the system aligns with objectives and robust fault detection mechanisms. The implementation phase brings the designed system to life, integrating sensors, relay systems, and Blynk connectivity for optimal performance and health. The system includes protective measures like Fuse and Phase Failure Circuit for safety and reliability.

System Overview:

Real-Time Monitoring: It Continuously measures the critical parameters to assess transformer health and operational state.

Distributed Intelligence: Manipulates the decentralized intelligence for an efficient monitoring without overloading the central systems.

Remote Connectivity: Real-time data sent to Blynk server for easy stakeholder access.

Protective Measures: Safety features like fuses and phase failure circuits ensure transformer protection.

Enhanced Resilience: It means Continuous monitoring and the protection to improve infrastructure resilience and longevity.

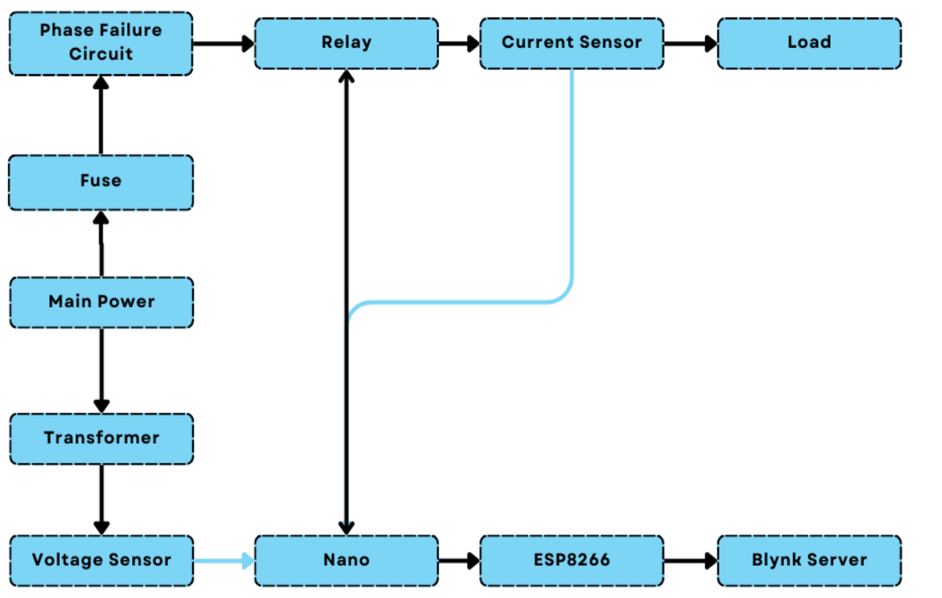

Figure 1: *Block diagram of the project*

Data Collection and Measurement: Gathers critical data from sensors to monitor transformer health.

Error-Checking and Validation: Uses while loops and validation mechanisms to ensure data integrity.

Fault Detection and Protection: Assesses overvoltage, undervoltage, and earth faults, triggering protective actions.

Data Transmission for Remote Monitoring: Packages and transmits information for real-time visualization and tracking of transformer health.

Continuous Monitoring and Feedback: Ensures reliable and safe operation of the transformer through continuous monitoring and adjustments.

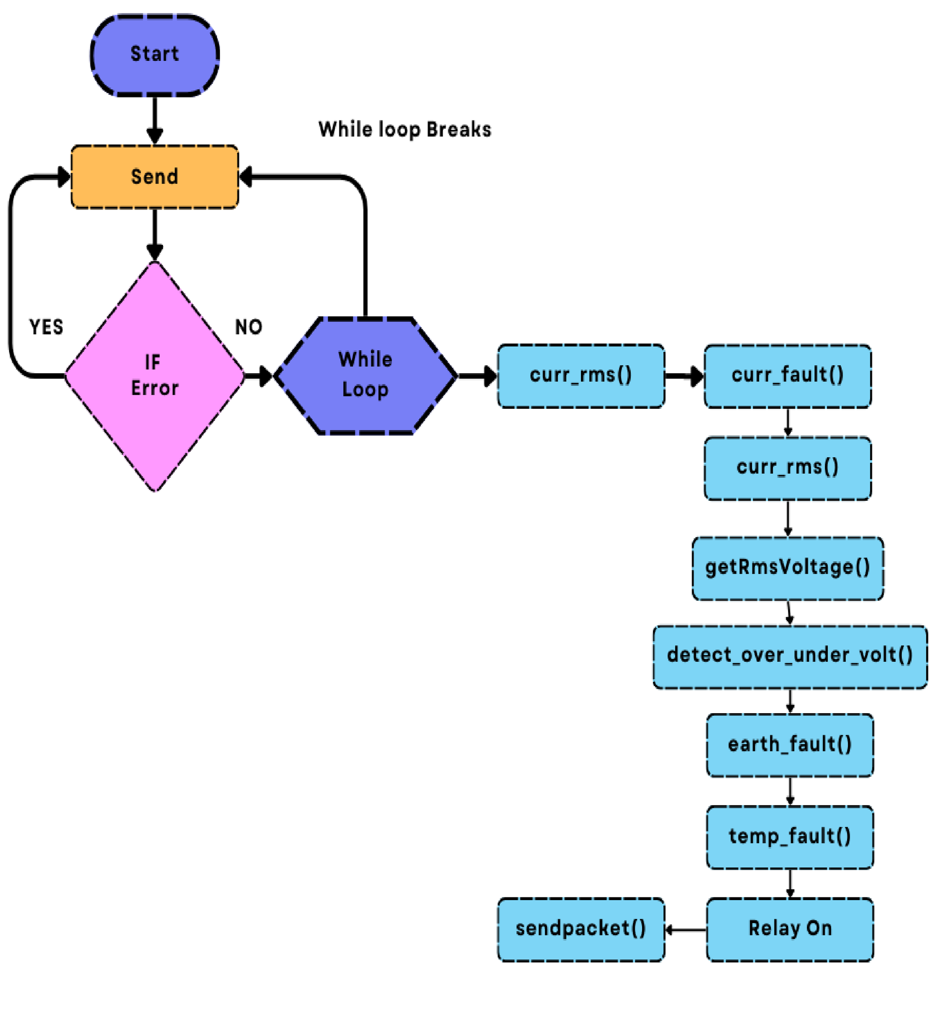

Figure 2: *Flowchart of the project*

RESULTS & DISCUSSION

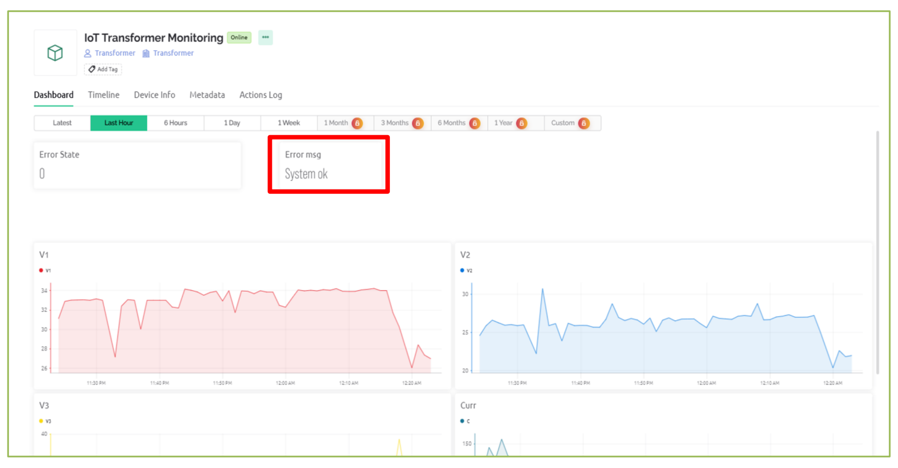

Fig 3.1: When the system is in perfect condition

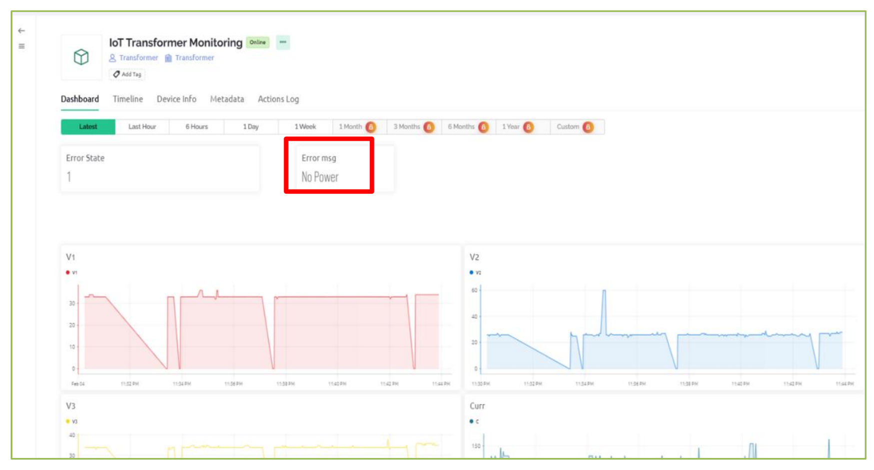

Fig 3.2: Output Error Message for when the failure occurs in the system

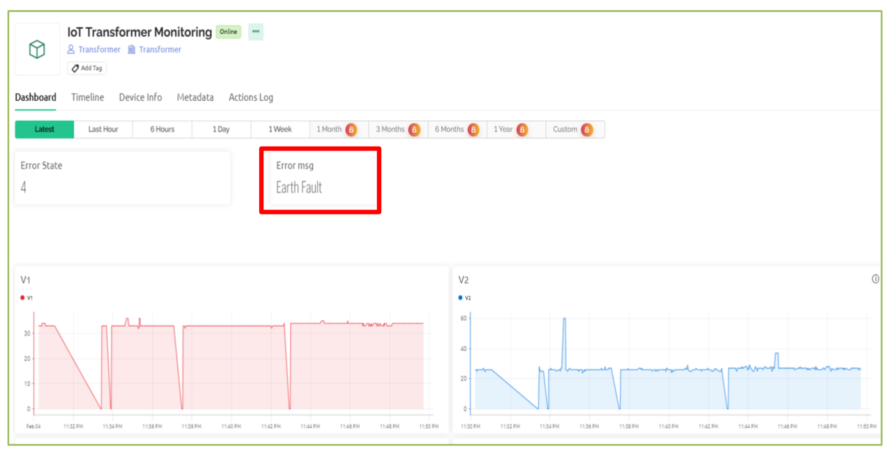

Fig 3.3: Output Error Message for when the earth fault occurs in the system

Fig 3.4: Output Error Message for when Transformer oil temperature in the system is high temperature

Fig 3.5: Output Error Message for when Transformer body temperature in the system in high temperature

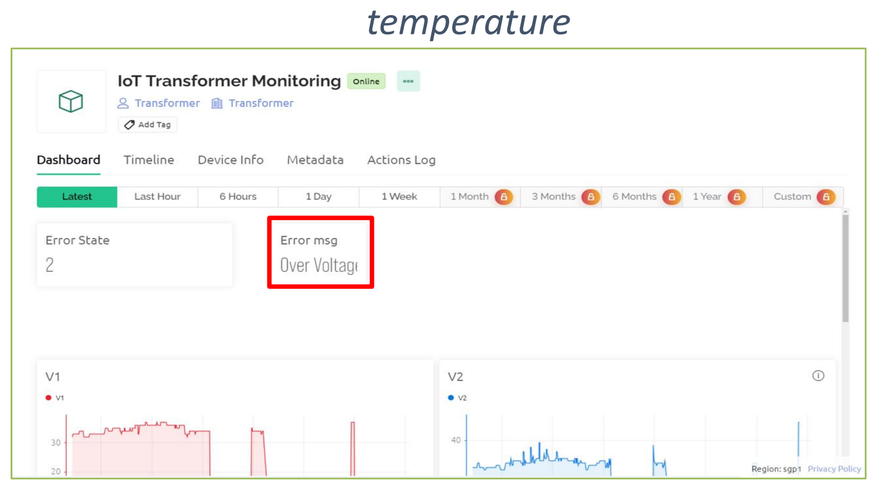

Fig 3.6: Output Error Message for when the overvoltage occurs in the system.

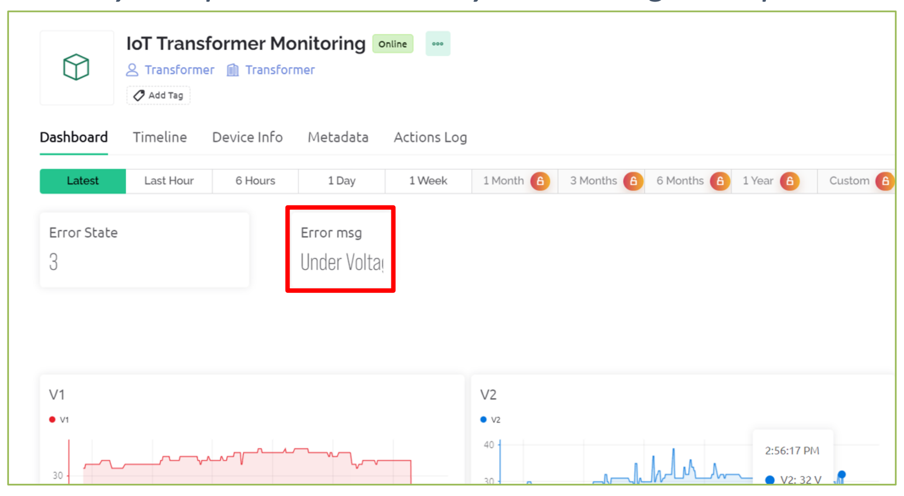

Fig 3.7: Output Error Message for when the Under Voltage occurs in the system

Fig 3.8: Total Overview of the system

The system performance assists in assuring the continued life, safety and good operation of distribution transformers in power distribution systems. This means it offers real-time tracking of things like voltages, current flow, and temperature. This system also helps in identifying the issues like over voltage, over current, phase failure and earth failure and the time and effective solution of the same can be done. By adopting this forward-looking monitoring strategy, transformer reliability is significantly improved, and the potential for catastrophic failures is reduced, leading to enhanced maintenance processes and improved customer service

CONCLUSION

The "Design and Implementation IoT-Driven Distribution Transformer health monitoring system for smart power grid" is a crucial step in ensuring the reliability, efficiency, and safety of distribution transformers. It uses sensors and communication modules to monitor parameters, allowing proactive maintenance and minimizing failure risks. The system's real-time insights and remote accessibility make it a valuable asset in smart power distribution networks.

FUTURE WORK / REFERENCES

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Conflicts of Interest: The authors declare no conflict of interest.