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LORA ENABLED TRANSFORMER FAULT DETECTION AND MONITORING USING IoT

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ABSTRACT- The LoRa-enabled smart fault detection and monitoring platform using IoT technology is a novel strategy for improving the dependability and efficiency of power distribution networks. This attempts to identify many types of faults in real time, including line-to-ground, short-circuit, and line-to-line problems. Critical operational data is continuously collected and wirelessly transferred to a centralized monitoring system via the deployment of sensors and LoRa modules. By taking a proactive stance, utility firms and operators can minimize downtime and maximize network performance by taking preventive measures like timely repair or power rerouting. The platform gives stakeholders the capacity to make well-informed decisions, hence increasing shedding, planning and service reliability, by offering real-time data on transformer health and performance. Moreover, the platform's long-range, low-power communication capabilities provide affordable monitoring options, especially in isolated or difficult-to-reach areas. The platform lowers the possibility of catastrophic failures like rain, thunderstorm, etc., improving safety and reducing environmental impact, by quickly recognizing and fixing defects. Furthermore, the platform supports the shift to more ecologically friendly and efficient power grids by enabling data-driven optimization of energy distribution. To sum up, the smart fault detection and monitoring platform with LoRa support provides a complete solution to improve the sustainability, dependability, and efficiency of power distribution systems. The platform enables stakeholders to maximize network performance while guaranteeing a resilient and sustainable energy future through proactive fault identification and real-time monitoring.

Keywords: LoRa, three-phase distribution transformers, real-time monitoring, line-to-ground, short circuit, and line-to-line faults.

I.INTRODUCTION

A distribution transformer is used in the distribution side to end consumers to transmit electricity. This paper focuses on the continuous monitoring of the distribution transformer using Visual Basic software. This improves the efficiency and reduces the downtime of the distribution transformer. This platform is used to detect real-time transformer faults like phase to phase fault, and phase to ground fault and also view the unbalanced current and voltage. This platform detects faults of the three-phase distribution transformer using PT, CT module, temperature sensor, full wave precision rectifier, embedded controller board, LoRa RF transmitter, LoRa RF receiver, and step-down transformer. The three-phase step-down transformer is about 48 Volts. This is an isolation transformer because for each phase separate transformer is used. The potential transformer is about 250V and the current transformer is about 5 Amps as per Indian electrical standard.

The PT and CT module is used to detect the voltage and current of the three-phase distribution transformer. The temperature sensor is used to detect the temperature of the transformer. A dual general-purpose operational amplifier is used to convert i/p voltage to o/p voltage and i/p current to o/p voltage. The transceiver communicates information between a microcontroller and the PC. A series of encoders is used in the LoRa RF transmitter. A series of decoders is used in the LoRa RF receiver. The characteristics of the current and voltage of the transformer can be monitored and the fault that occurs in the transformer is also monitored from the transmitter side. This is a continuous monitoring system where if a fault occurs it will display the fault that has occurred. On the receiver side annunciator-type software is used to display the fault that occurs in the transformer. This platform helps to identify the faults that occur in street distribution transformers easily.

II. LITERATURE REVIEW

[1] An overview of current transformer health monitoring systems is given in this study, with a focus on the need for cutting-edge technologies to improve problem detection and predictive maintenance.

[2] This paper presents the design and execution of an Arduino-based low-cost transformer health monitoring system, emphasizing the practicality and affordability of Arduino-based solutions.

[3] To establish the foundation for incorporating wireless communication, such as LoRa, into transformer health monitoring, this investigation examines various communication network designs in power systems.

[4] In addition to reviewing fault-tolerant and fault-diagnosis methods for power transformers, the study offers insights into the use of artificial intelligence in transformer failure detection.

[5] The application of long-range communication technologies, such as LoRa, in the Internet of Things scenarios is covered in this study, offering important insights into LoRa's potential for transformer monitoring in large-scale industrial settings.

[6] This survey offers a thorough review of predictive maintenance methods and integrated systems with a focus on data mining-based condition monitoring for power transformers.

[7] This study examines LoRa's potential as an IoT long-range communication substrate. It lays the groundwork for comprehending how it integrates with Arduino in the suggested fault detection and maintenance system.

The literature review combines the value of IoT, LoRa, and Embedded system technologies in transformer health monitoring systems, highlighting the possible enhancements to fault detection, predictive maintenance, and smart grid communication effectiveness. The listed references aid in the comprehension of the various parts and technologies that make up the suggested system.

III. PROPOSED SYSTEM

This paper gives ideas and efficient ways to detect faults in three-phase distribution transformers and to continuously monitor the faults, voltage, temperature, and current of the transformer. Here 3 phase transformer is used to detect the faults in the transformer. Three separate transformers are used for monitoring the three-phase transformer. Every transformer's one end is connected to a separate line and the other is connected to the ground. Isolated phase like three separate phases and ground-like connection is given. The 48-volt low-voltage bus is designed. 48-volt AC is given to the small transmission line. This transmission line is an annealed metal wire, which is more flexible. Each phase delivers about 48 volts. 48-volt AC is given to CT and PT modules. The PT, CT module is about 250 V PT and 5 Amp CT as per the Indian electrical standard. So these voltages are first calibrated with 230 V of 200 Watts. This is first calibrated with the real lamp loads. Once the calibration is over 230 V is removed and connected to 48 V. After this voltage is given to 3 PT and 3 CT as this is focused on 3 3-phase distribution transformers. Generally, the transmission line are 3-phase 3-wire system. But to find out the fault 3 phase 4 wire system is used. Because earth fault could be the major reason this requires 3 phase 4 wire system. The PT, and CT output is connected to the full wave precision rectifier. This precision rectifier reproduces the AC input from the PT, CT module as a DC. Full wave precision rectifier even converts 1m V AC to 1m V DC. It is also known as an absolute rectifier. It even finds a fast conversion. A low-pass filter reduces noise. Integrating filters are used. The blue color potentiometer is used for calibration purposes. When 250 V occurs we give about 5 V and 5 Amp occurs it will give about 5 V in the precision rectifier. The precision rectifier output is connected to the embedded controller. In the embedded controller PIC16F877A is used. So the output of the precision rectifier is given to the embedded controller system which converts the analog into digital, digital into serial, and serial into RS232 and programs to the computer. If there are any abnormalities in the transformer relay is used for tripping purposes. As soon as the relay switch is on the wireless data is delivered. Here the whole information is given to the computer where graphical user interface language is used. All the data collected are returned to the software. LoRa transmitter's carrier frequency is about 432 Hz and modulation frequency is about 36,37,38,39 KHz. On the receiver side similar embedded system is used which receives the data. By using annunciator software we can be able to find the fault. The transmitter and receiver-side monitoring has one major difference is that on the receiver side, the fault is locked whereas on the transmitter side, it is not locked it is a continuous monitoring. As this is continuous monitoring once the fault occurs it will show the fault and once the fault has gone it will stop

showing the fault. Once the fault occurs it will lock in the receiver side even if the fault has occurred for a second. LED indicator is also used on the receiver side for giving an alert to the fault that has occurred.

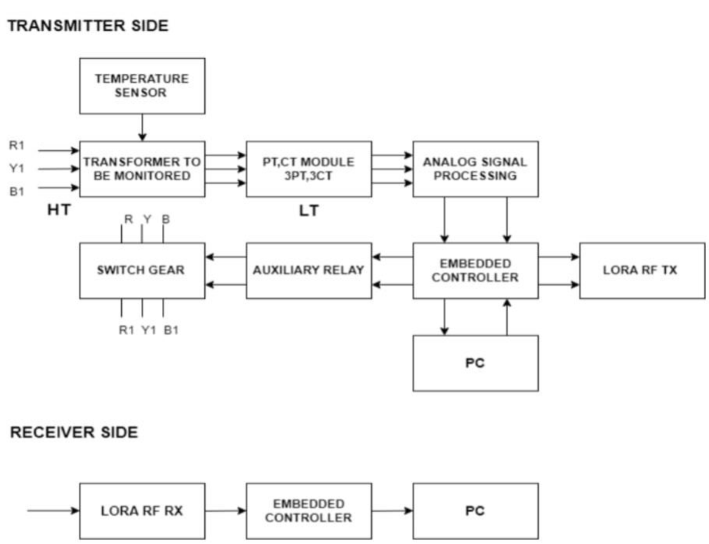

Fig 1. Proposed block diagram

IV. RESULT AND DISCUSSION

The efficiency of the three-phase distribution transformer is focused on this project as it continuously monitors the current, voltage, and temperature of the transformer. This also shows the current and voltage characteristics of the three-phase distribution transformer. By using these parameters we can be able to detect the condition of the transformer. The working condition of the transformer is continuously monitored by using Visual Basic software on both the transmitter side and the receiver side. On the receiver side, we have created annunciator software based on the Indian electrical standard. Fig 2(a) shows the three-phase step-down distribution transformer used which is a scale-down model of 48 Volts. Fig 2(b) shows the full wave precision rectifier, LoRa RF module, and the PT, CT module used. Fig 2(c) shows the transmission line. Fig 3 shows the receiver kit. Fig 4,5,6,7 shows the faults identified on the transmitter side which is a continuous monitoring system. Fig 8 shows the fault detected on the receiver side.

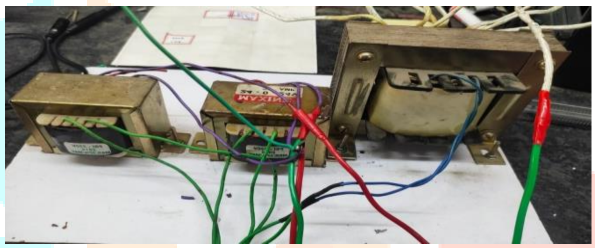

Fig 2(a). TRANSMITTER SIDE

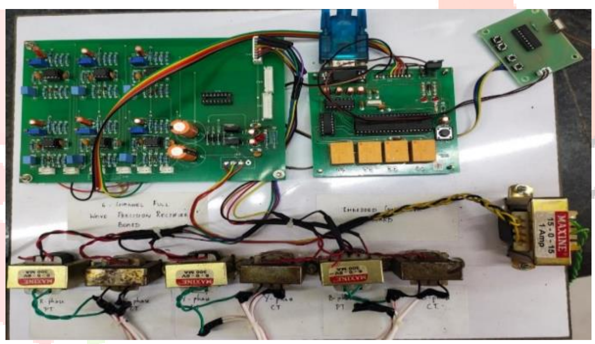

Fig 2(b). TRANSMITTER SIDE

Fig 2(c). THREE PHASES ARE CONNECTED TO THE LINE

Fig 3. RECEIVER SIDE

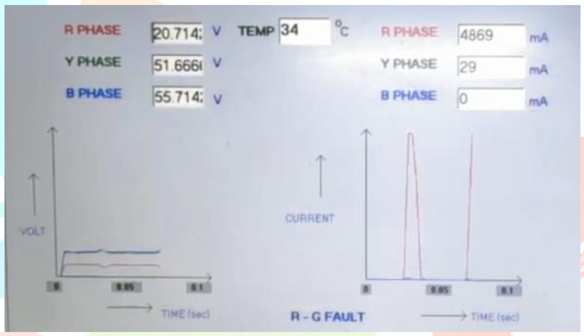

Fig 4. R-G FAULT DETECTED

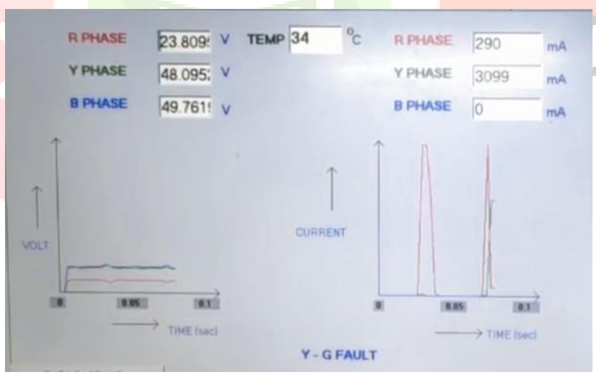

Fig 5. Y-G FAULT DETECTED

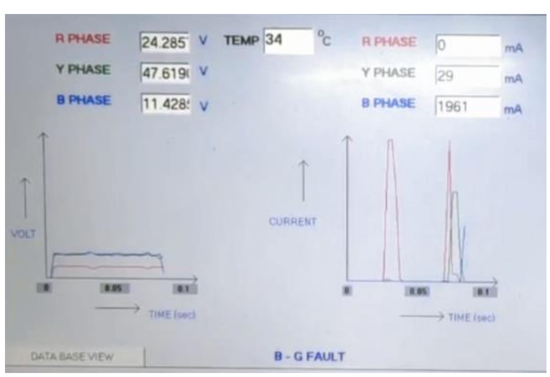

Fig 6. B-G FAULT DETECTED

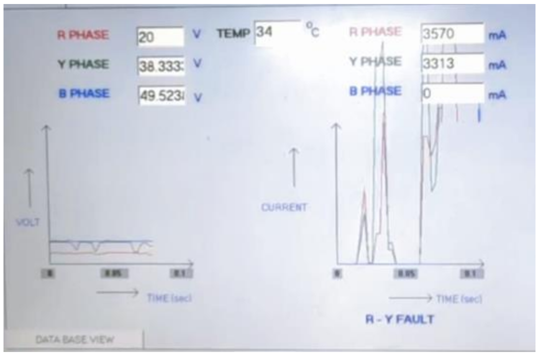

Fig 7. PHASE-PHASE FAULT DETECTED

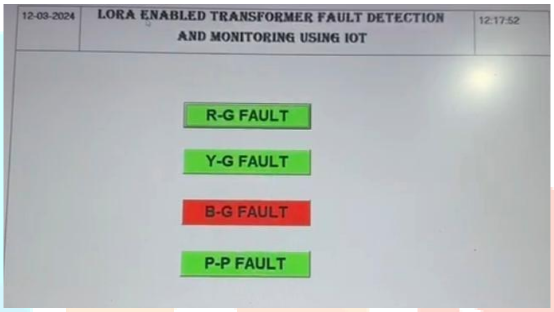

Fig 8. FAULT DETECTED - RECEIVER SIDE

V. CONCLUSION

LoRa-Enabled Transformer Fault Detection and Monitoring Using IoT" is a paper that represents a significant advancement in electrical grid maintenance and management. To reliably and energy-efficiently monitor the transformer and detect faults, we have developed a system that makes use of LoRa technology and IoT devices. This platform addresses problems with energy consumption in transformers, data transmission, and delays in the detection of transmission faults. In addition to increasing dependability, this monitoring system optimizes maintenance expenses. A transformer has been used to test the suggested system in real-time, and all associated variables and all of the parameters are displayed on the computer screen. The implementation of the LoRa-enabled fault detection and monitoring platform makes use of Internet of Things technology and has led to an improvement dependability of power distribution networks. An overall solution that handles the difficulties of sustaining a steady supply of energy has been developed as a result of the project's testing and study. This platform uses customized transformers to collect data and focuses on three-phase distribution transformers. This makes it easier to monitor vital operational data in real-time. We reduce the risk of major failures and boost network performance by addressing any issues and adding relays and switches as needed. This system establishes the groundwork for an intelligent and sustainable energy system using the most latest technological developments.

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