



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 13, Issue 4, April 2024

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com

Smart Monitoring and Control of Distribution Transformer

Bharanitharan P, Nurudeen S, Dr. V. Kandasmy

U.G. Student, Department of Electrical & Electronics Engineering, Kumaraguru College of Technology, Coimbatore, Tamil Nadu, India

Associate Professor, Department of Electrical & Electronics Engineering, Kumaraguru College of Technology, Coimbatore, Tamil Nadu, India

ABSTRACT: The proposed project focuses on a novel system designed for the intelligent monitoring and control of distribution transformers by leveraging Internet of Things (IoT) technology. Current methods of transformer monitoring heavily rely on manual inspections, lacking real-time capabilities, thus leading to costly downtime and failures. To address this issue, our proposed system integrates advanced sensors to continuously monitor crucial parameters such as silica gel color, oil level, current, and temperature. These sensor readings are processed by an Arduino microcontroller, which oversees a relay mechanism to automatically disconnect the transformer in the event of abnormal conditions, thereby preventing potential damage. Furthermore, the collected sensor data is wirelessly transmitted to a cloud server, enabling remote monitoring via a user-friendly web application. The system offers real-time alerts for immediate action, facilitates historical data analysis for predictive maintenance, and grants remote control capabilities. By utilizing Arduino IDE for system implementation, we ensure efficient integration and operation of the monitoring and control functionalities.

KEYWORDS: Monitoring, Control, IoT, Sensors, Cloud storage.

I. INTRODUCTION

In the realm of power distribution, the integration of IoT technology has ushered in a new era of monitoring and controlling distribution transformers. Traditional methods, reliant on manual inspections, have proven inadequate, leading to costly downtime and failures. This paper presents a smart monitoring and control system designed to address these shortcomings. By incorporating advanced sensors and cloud connectivity, this system offers real-time insights and proactive maintenance capabilities. Through continuous monitoring of critical parameters such as silica gel color, oil level, current, and temperature, potential issues can be identified early on, mitigating risks and enhancing reliability. Moreover, automated responses to abnormal conditions ensure swift action, minimizing the potential for disruptions. With data transmitted wirelessly to a cloud server, remote monitoring and control become possible, enabling stakeholders to make informed decisions and optimize performance. In summary, this system represents a significant advancement in distribution transformer management, promising increased reliability, safety, and operational efficiency in power distribution networks.

II. RELATED WORK

HISTORY OF PROPOSED WORK:

1. Challenges in Distribution Transformer Monitoring:

Monitoring and controlling distribution transformers pose challenges due to the diverse range of factors affecting their performance, including load variations, environmental conditions, and aging components. Traditional monitoring methods often lack real-time capabilities, making it difficult to detect faults and optimize transformer operation efficiently.

2. Role of IoT and Cloud Technologies:

Leveraging Internet of Things (IoT) and cloud technologies, the smart monitoring and control system offers a solution to enhance distribution transformer management. By integrating advanced sensors, microcontrollers, and cloud connectivity, the system enables real-time data collection, analysis, and remote monitoring.

3. Benefits of Sensor Integration:

The integration of sensors for monitoring parameters such as temperature, oil level, and current allows for continuous assessment of transformer health. Real-time data acquisition enables proactive maintenance, reducing the risk of unexpected failures and optimizing operational efficiency.

4. Importance of Remote Monitoring:

Remote monitoring capabilities provided by the system enable stakeholders to access transformer data from anywhere, facilitating timely decision-making and rapid response to critical events. Alerts and notifications ensure that operators are promptly informed of any abnormalities, enabling them to take appropriate action.

5. Enhanced Operational Efficiency:

By harnessing the power of IoT and cloud technologies, the smart monitoring and control system enhances the operational efficiency of distribution transformers. Predictive maintenance capabilities enable proactive intervention, minimizing downtime and extending transformer lifespan, ultimately leading to improved reliability and cost savings.

Current Trends:

Incorporating AI and machine learning algorithms into distribution transformer monitoring systems enables predictive maintenance and fault prediction. By analyzing historical data and identifying patterns, AI algorithms can anticipate potential failures and recommend proactive interventions, reducing downtime and enhancing reliability.

Edge computing is gaining prominence in distribution transformer monitoring, allowing data processing and analysis to be performed closer to the source of data. By processing data locally at the edge of the network, edge computing reduces latency, conserves bandwidth, and enhances real-time decision-making capabilities.

Wireless sensor networks are increasingly being utilized in distribution transformer monitoring for their flexibility and scalability. WSNs enable seamless integration of sensors across a wide geographical area, providing comprehensive coverage and real-time data collection without the need for extensive cabling infrastructure.

Need for project work:

1. Improved Dependability: Ensuring a stable power supply is vital in today's highly reliant world. The proposed system promises to significantly decrease the likelihood of transformer malfunctions, thereby ensuring a more dependable power provision for end-users.

2. Safety Enhancement: Through automation and reduced manual intervention during fault resolution, the system mitigates potential hazards and minimizes risks to field workers, prioritizing their safety in operational settings.

3. Operational Streamlining: Integrating automation and real-time monitoring optimizes the management of distribution transformers. By implementing predictive maintenance measures, costly downtimes are curtailed, leading to streamlined operations and potential cost reductions.

III. LITERATURE REVIEW

In "Status and trends in transformer monitoring," the discussion revolves around the commercial aspects associated with monitoring transformers, particularly emphasizing the importance of reliability and cost-effectiveness in online monitoring methods. The authors conduct a comprehensive survey of various techniques utilized for both online monitoring and offline diagnostics. They specifically focus on assessing the lifespan of transformers, with an emphasis on distinguishing between the end-of-life stages of the insulating material and the transformer unit as a whole. Through this exploration, insights are provided into the evolving landscape of transformer monitoring strategies, aiming to enhance reliability and cost efficiency in the process.

"Monitoring of power transformers using the transfer function method" delves into the application of the transfer function concept for assessing the impulse test of power transformers, applicable both in laboratory settings and during

active service. The paper delineates between offline and online monitoring methodologies, with a primary focus on capturing transient signals to facilitate the calculation of transfer functions. This approach enables a deeper understanding of the transformer's behavior by analyzing its response to external stimuli, offering insights into its performance and condition. By leveraging transfer function analysis, practitioners can effectively monitor power transformers in real-time, enabling proactive maintenance and ensuring optimal operation of these critical assets.

"Transformer Health Monitoring System Using Internet of Things" presents a system for acquiring real-time data on distribution transformer conditions using IoT technology, including temperature, voltage, and current measurements. This implementation allows for remote monitoring and proactive maintenance to prevent power supply disruptions.

A microprocessor-based "Transformer Monitoring System" provides continuous online monitoring and analysis of power transformer operating parameters, allowing for early detection of potential problems and preventive maintenance measures.

"Digital Twin of Distribution Power Transformer" proposes using low-voltage measurements to calculate real-time waveforms of medium-voltage sides of transformers, allowing for accurate monitoring without the need for expensive instrumentation.

These studies collectively demonstrate the importance of transformer monitoring for ensuring reliable power distribution and the diverse methods and technologies available for achieving this goal.

IV. METHODOLOGY

The methodology for the smart monitoring and control system for distribution transformers involves several key steps. Initially, the system architecture is designed to define the roles and functionalities of components such as sensors, microcontrollers, and cloud infrastructure, considering factors like scalability and interoperability. Suitable components are then selected based on system requirements, including sensors for critical parameter monitoring and microcontrollers for data processing. Hardware implementation follows, with sensors installed on transformers and microcontrollers programmed to handle data acquisition and processing tasks. Software development encompasses programming microcontrollers, developing cloud server software, and creating a user interface for the web-based monitoring platform. Integration and testing validate system functionality and performance, ensuring data accuracy and reliability. Once tested, the system is deployed in real-world environments, with ongoing monitoring and maintenance to ensure reliable operation and potential updates based on user feedback and performance metrics. This methodology ensures the effective design, implementation, and operation of the monitoring and control system for distribution transformers.

Block Diagram:

Fig. 1. depicts the block diagram of the proposed system, providing a brief overview of its workflow.

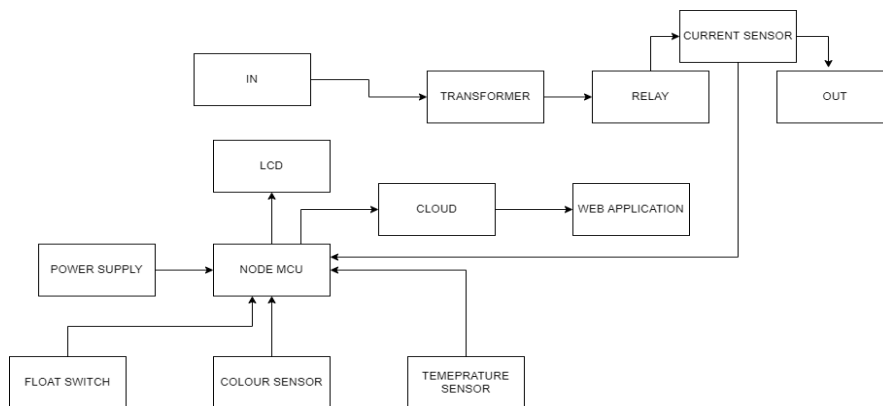


Fig. 1. Block Diagram of the proposed system

The hardware setup of the proposed system comprises several essential components seamlessly integrated to facilitate smart monitoring and control of distribution transformers. At its core lies the NodeMCU ESP8266 development board, serving as the central processing unit for data acquisition and transmission. Connected to the NodeMCU board are various sensors, including a float switch for oil level monitoring, a temperature sensor for environmental conditions, a current sensor for measuring electrical parameters, a voltage sensor for voltage level monitoring, and a color sensor for monitoring the color of silica gel. Additionally, an LCD 16*2 display is employed to provide real-time visual feedback on the system's status and parameters. The relay mechanism enables automated control actions in response to detected faults or abnormal conditions. All these hardware elements work synergistically to ensure seamless operation and effective management of distribution transformers, enhancing their reliability and performance.

Algorithm of Proposed Work:

1. Data Acquisition: Sensors continuously monitor crucial parameters such as temperature, oil level, current, and voltage of the distribution transformer.
2. Data Processing: The collected sensor data is processed by a microcontroller, such as an Arduino, which analyzes the data in real-time.
3. Fault Detection: The system employs algorithms to detect abnormalities or potential faults based on predefined thresholds or patterns in the sensor data.
4. Decision Making: Upon detecting a fault or anomaly, the system determines the appropriate response, which may include activating protective measures or sending alerts to operators.
5. Remote Control: The system allows for remote control capabilities, enabling operators to intervene and manage transformer operations remotely if necessary.
6. Data Transmission: Processed data, including fault notifications and status updates, is transmitted wirelessly to a cloud server for storage and further analysis.
7. Cloud-based Analysis: The cloud server hosts advanced analytics tools that analyze the collected data to derive insights, such as predictive maintenance recommendations or performance trends.
8. User Interface: A user-friendly web application provides operators with real-time monitoring dashboards, alert notifications, and control functionalities, accessible from any internet-enabled device.

Flowchart:

The proposed flowchart, depicted in Fig. 4, outlines the steps in the smart monitoring system for distribution transformers. It starts with sensor data acquisition, followed by real-time processing by a microcontroller.

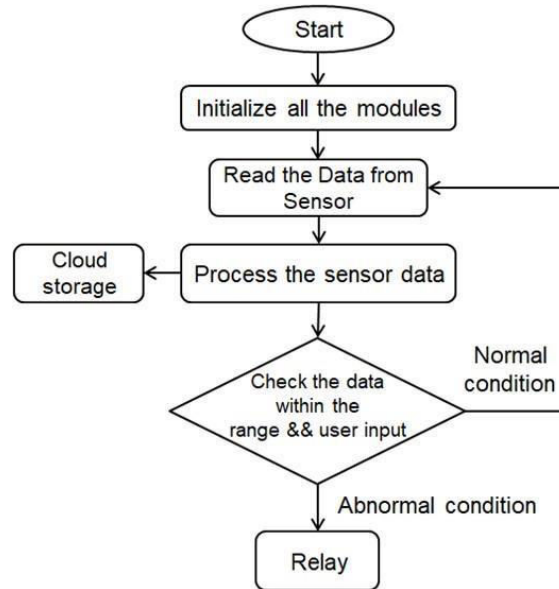


Fig. 4.: Flowchart of proposed work

If faults are detected, remote control capabilities are activated. Simultaneously, data is sent to a cloud server for storage and analysis. Users interact via a web app, accessing real-time dashboards and receiving alerts. This cycle ensures continuous monitoring and control.

It illustrates the process from data collection to prediction using various symbols and connectors. This flowchart serves as a comprehensive guide for understanding the functioning of the system and its key components.

V. EXPERIMENTAL RESULTS

Simulation results of proposed work

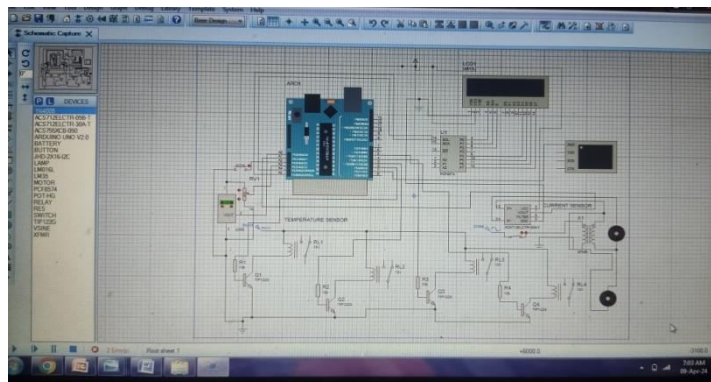


Fig 5: Simulation results of proposed work

In this the simulation results obtained using Proteus software for the proposed smart monitoring and control system for distribution transformers. The simulations were conducted to validate the functionality and performance of the system under various operating conditions and fault scenarios. We discuss the system's response to simulated faults, the accuracy of fault detection algorithms, and the effectiveness of remote control features. These simulation results provide valuable insights into the system's behavior and its capability to enhance the reliability and efficiency of distribution transformer management.

Hardware Result:



Fig 6: Hardware Result

In the hardware setup, the LCD 16*2 display serves as a crucial interface for presenting real-time data and system feedback directly from the hardware components of the smart monitoring and control system for distribution transformers. Through this display, operators gain instant access to essential information such as sensor readings, system status messages, fault alerts, and other relevant data obtained from the hardware components. This direct feedback mechanism enables operators to quickly assess the system's performance, identify any anomalies or issues, and take appropriate actions as needed to ensure the smooth operation of the distribution transformers.

Result display in Web Application

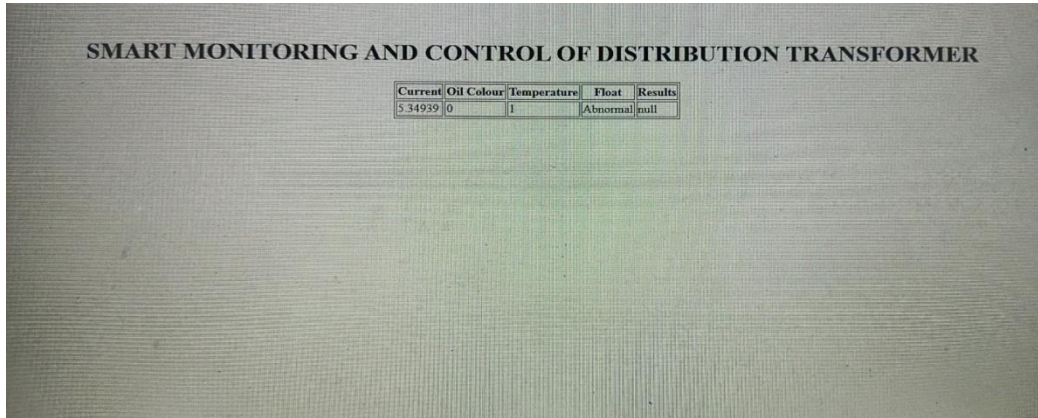


Fig 7: Result display in Web Application

The web application interface provides a comprehensive display of various parameters crucial for monitoring and controlling distribution transformers. Users can visualize real-time temperature readings, monitor the color changes of silica gel, track voltage and current sensing data, and observe the oil level within the transformer. These parameters are presented through intuitive graphical representations such as charts, graphs, and numerical values, allowing users to quickly assess the transformer's health and performance. Additionally, the application can generate alerts and notifications based on predefined thresholds, enabling users to promptly address any abnormalities or faults detected in the system. Overall, the web application offers a user-friendly interface for efficient monitoring and control of distribution transformers, enhancing operational reliability and safety.

VI. CONCLUSION

In conclusion, the smart monitoring and control system for distribution transformers marks a pivotal stride in the modernization of electrical infrastructure management. By harnessing the power of IoT technology, alongside sophisticated sensors and seamless cloud connectivity, this system heralds a new era of real-time monitoring, predictive

maintenance, and remote control capabilities. Through the continuous surveillance of critical parameters like temperature, voltage, current, oil level, and silica gel color, potential faults and anomalies are swiftly detected, thus minimizing operational downtime and bolstering overall reliability. The amalgamation of automation and instantaneous data analysis not only streamlines operational efficiency but also ensures a safer working environment for field personnel. Moreover, the system's scalability and interoperability render it adaptable for seamless integration into existing distribution networks, promising enhanced reliability and efficiency for the broader electrical infrastructure. In summary, the proposed system not only offers an innovative solution to the age-old challenges of distribution transformer management but also signifies a paradigm shift towards a more resilient and sustainable electrical ecosystem. With its robust capabilities and future-ready design, it stands poised to revolutionize the way distribution transformers are monitored and controlled, ultimately driving towards a more efficient, reliable, and sustainable energy future.

REFERENCES

1. C. Bengtsson, "Status and trends in transformer monitoring", IEEE Transactions on Power Delivery
2. T. Leibfried, K. Feser, "Monitoring of power transformers using the transfer function method", IEEE Transactions on Power Delivery.
3. Divyank Srivastava, M. M. Tripathi, "Transformer Health Monitoring System Using Internet of Things", 2018 2nd IEEE International Conference on Power Electronics Intelligent Control and Energy Systems (ICPEICES).
4. T. D. Poyser, D. A. Yannucci, J. B. Templeton, B. N. Lenderking, "IEEE Transactions on Power Apparatus and Systems.
5. C. Bengtsson, "Status and trends in transformer monitoring", IEEE Transactions on Power Delivery.
6. Panayiotis Moutis, Omid Alizadeh-Mousavi, "Digital Twin of Distribution Power Transformer for Real-Time Monitoring of Medium Voltage From Low Voltage Measurements", IEEE Transactions on Power Delivery.
7. Sanjay S Tippannavar, Vijay Mishra, Yashwanth S D, Rishitha R Gowda, Sathvik H R, Ajay M, "Smart Transformer - An Analysis of Recent Technologies for Monitoring Transformer", 2023 International Conference on Recent Trends in Electronics and Communication (ICRTEC).
8. C. Bengtsson, "Status and trends in transformer monitoring", IEEE Transactions on Power Delivery.
9. "Lifetime estimation and monitoring of power transformer considering annual load factors", IEEE Transactions on Dielectrics and Electrical Insulation.
10. "Data Driven Transformer Thermal Model for Condition Monitoring", IEEE Transactions on Power Delivery.
11. K. Hazarika, Gauri Katiyar, Noorul Islam, "IOT Based Transformer Health Monitoring System: A Survey", 2021 International Conference on Advance Computing and Innovative Technologies in Engineering (ICACITE).



INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details