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IOT BASED TRANSFORMER PARAMETERS MONITORING SYSTEM

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Abstract: Transformers play a major role in electrical power transmission and distribution systems. Continuous monitoring of transformer parameters is essential to ensure reliable operation and prevent unexpected failures. Traditional transformer monitoring methods mainly depend on manual inspection and periodic maintenance, which are time- consuming and less efficient. To overcome these limitations, an IoT Based Transformer Parameters Monitoring System is proposed.

The proposed system continuously monitors important transformer parameters such as temperature and oil level using suitable sensors. The sensor data is processed using the NodeMCU microcontroller and transmitted to the cloud platform through Wi-Fi communication. The system also includes a fault detection mechanism that identifies abnormal conditions such as overheating and low oil level. Whenever the monitored parameters exceed predefined threshold values, alerts are generated automatically.

The monitored data can be accessed remotely through the IoT platform, enabling real-time transformer monitoring from any location. The proposed system is simple, reliable, cost-effective, and easy to implement. It reduces manual maintenance effort, improves transformer safety, and enhances operational efficiency.

Keywords: IoT, Transformer Monitoring, NodeMCU, Temperature Sensor, Oil Level Monitoring, Fault Detection.

I. INTRODUCTION

Transformers are one of the most important components in electrical power systems. They are widely used in generation, transmission, and distribution sectors for voltage transformation and power transfer. Since transformers operate continuously under varying load conditions, their health condition must be monitored regularly to ensure reliable performance and uninterrupted power supply.

Conventional transformer monitoring systems mainly rely on periodic manual inspection. This method is inefficient and may fail to detect faults at an early stage. Parameters such as overheating, oil leakage, and abnormal operating conditions can reduce transformer efficiency and may lead to severe damage if not detected properly.

With the advancement of Internet of Things (IoT) technology, real-time monitoring systems can be developed for continuous transformer parameter monitoring. IoT enables remote data collection, monitoring, and fault detection through internet connectivity. In the proposed system, sensors are used to measure transformer parameters such as temperature and oil level. The collected data is processed using the NodeMCU microcontroller.

The processed data is transmitted to the cloud platform through Wi-Fi communication, allowing users to monitor transformer conditions remotely. The system also provides alerts during abnormal conditions, thereby improving safety, reliability, and maintenance efficiency.

The proposed IoT Based Transformer Parameters Monitoring System helps in early fault identification and minimizes transformer failure risks. The system is suitable for smart monitoring applications in modern electrical power systems.

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II. LITERATURE SURVEY

Afkar and Vahedi (2014) proposed a method for identifying winding faults in distribution transformers. Their work focused on transformer fault localization techniques for improving protection systems.

Behjat and Vahedi (2011) presented numerical modelling of transformer interturn faults under different operating conditions. The study emphasized the importance of early fault detection to improve transformer reliability.

Basak et al. (2006) reviewed various fault diagnosis and condition monitoring techniques used in electrical machines. The authors discussed several monitoring approaches and their advantages.

Ehsan Tarkesh Esfahani et al. (2014) developed a multisensor wireless monitoring system for fault detection in induction motors. Their work demonstrated the effectiveness of wireless sensor-based monitoring systems.

Gaeid et al. (2011) proposed fault diagnosis techniques using Motor Current Signature Analysis (MCSA) and Fast Fourier Transform (FFT). Their work improved fault detection accuracy in electrical systems.

Bellini et al. (2008) discussed advances in diagnostic techniques for induction machines. The study explained different fault monitoring approaches used in industrial applications.

From the literature survey, it is observed that IoT and wireless communication technologies provide efficient solutions for real-time transformer monitoring and fault detection.

III. EXISTING SYSTEM

In traditional transformer monitoring systems, transformer parameters are checked manually at regular intervals. This method requires continuous human supervision and periodic inspection. The monitoring process becomes difficult in remote locations and large-scale power distribution systems.

The existing systems mainly focus on manual fault identification, which increases maintenance time and operational cost. In many cases, faults are identified only after severe damage occurs. Parameters such as temperature rise and oil level reduction may remain unnoticed during operation.

The lack of continuous monitoring reduces transformer reliability and increases the possibility of unexpected failures. Manual monitoring methods are also less accurate and may result in delayed maintenance actions.

Limitations of Existing System

- Requires continuous manual inspection.
- Difficult to monitor transformers in remote locations.
- Delayed fault detection.
- Increased maintenance cost.
- Reduced operational efficiency.
- No real-time monitoring facility.
- Possibility of major transformer failures

IV. PROPOSED SYSTEM

The proposed IoT Based Transformer Parameters Monitoring System is designed to continuously monitor transformer parameters and provide real-time data transmission through IoT technology.

The system uses sensors to measure important parameters such as temperature and oil level. The sensor outputs are connected to the NodeMCU microcontroller, which acts as the main processing unit.

The NodeMCU processes the sensor data and compares the values with predefined threshold limits. If the monitored values remain within the safe range, the transformer operates normally. If any parameter exceeds the threshold value, the system identifies it as a fault condition.

The monitored data is transmitted to the cloud platform using Wi-Fi communication. Users can access the real-time

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parameter values remotely through the IoT platform.

The system also activates output devices such as buzzer and cooling fan during abnormal conditions. This improves transformer protection and reduces the risk of transformer failure.

Advantages of Proposed System

- Real-time monitoring of transformer parameters.
- Early fault detection.
- Remote monitoring through IoT.
- Reduced maintenance effort.
- Improved transformer safety.
- Cost-effective implementation.
- Easy installation and operation.

V. SYSTEM ARCHITECTURE

The proposed system architecture consists of sensors, NodeMCU microcontroller, cloud platform, LCD display, buzzer, and cooling fan.

The temperature sensor continuously measures transformer temperature, while the ultrasonic sensor monitors the transformer oil level. These sensor outputs are connected to the NodeMCU.

The NodeMCU acts as the central processing unit of the system. It receives sensor data, processes the values, and compares them with predefined threshold limits.

The processed data is transmitted to the cloud platform through Wi-Fi communication. The cloud platform stores the received data and enables remote monitoring.

The LCD display shows real-time transformer parameter values. During abnormal operating conditions such as overheating or low oil level, the system activates the buzzer and cooling fan automatically.

The system architecture provides continuous monitoring, fault detection, and real-time IoT communication.

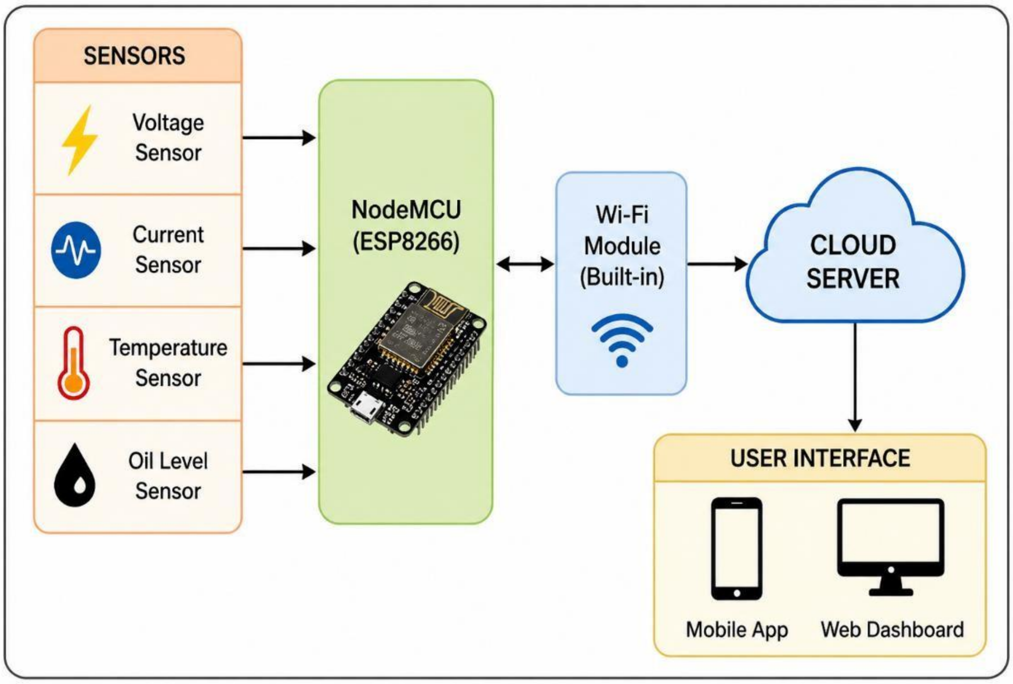

Fig. 1 System Architecture of IoT Based Transformer Parameters Monitoring System

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Data Flow Architecture

The data flow architecture describes how information moves through different components of the proposed system.
Initially, sensors continuously measure transformer parameters such as temperature and oil level. These values are converted into electrical signals and sent to the NodeMCU microcontroller.
The NodeMCU processes the sensor data and compares the values with predefined threshold levels. After processing, the data is transmitted to the cloud platform through Wi-Fi communication.
The user can monitor transformer conditions remotely through the IoT dashboard. If any abnormal condition is detected, alert notifications are generated immediately.

VI. HARDWARE COMPONENTS

A. NodeMCU

NodeMCU is a Wi-Fi-enabled microcontroller based on the ESP8266 module. It is used for sensor interfacing, data processing, and IoT communication.
Features:

- Built-in Wi-Fi module.
- Low power consumption.
- Easy programming using Arduino IDE.
- Supports IoT applications.

B. Temperature Sensor

The temperature sensor is used to measure transformer temperature continuously. It helps in identifying overheating conditions during operation.

C. Ultrasonic Sensor

The ultrasonic sensor is used to monitor transformer oil level. It measures the distance between the sensor and oil surface.

D. LCD Display

The LCD display shows real-time parameter values such as temperature and oil level.

E. Buzzer

The buzzer generates alerts during abnormal operating conditions.

F. Cooling Fan

The cooling fan helps in reducing transformer temperature during overheating conditions.

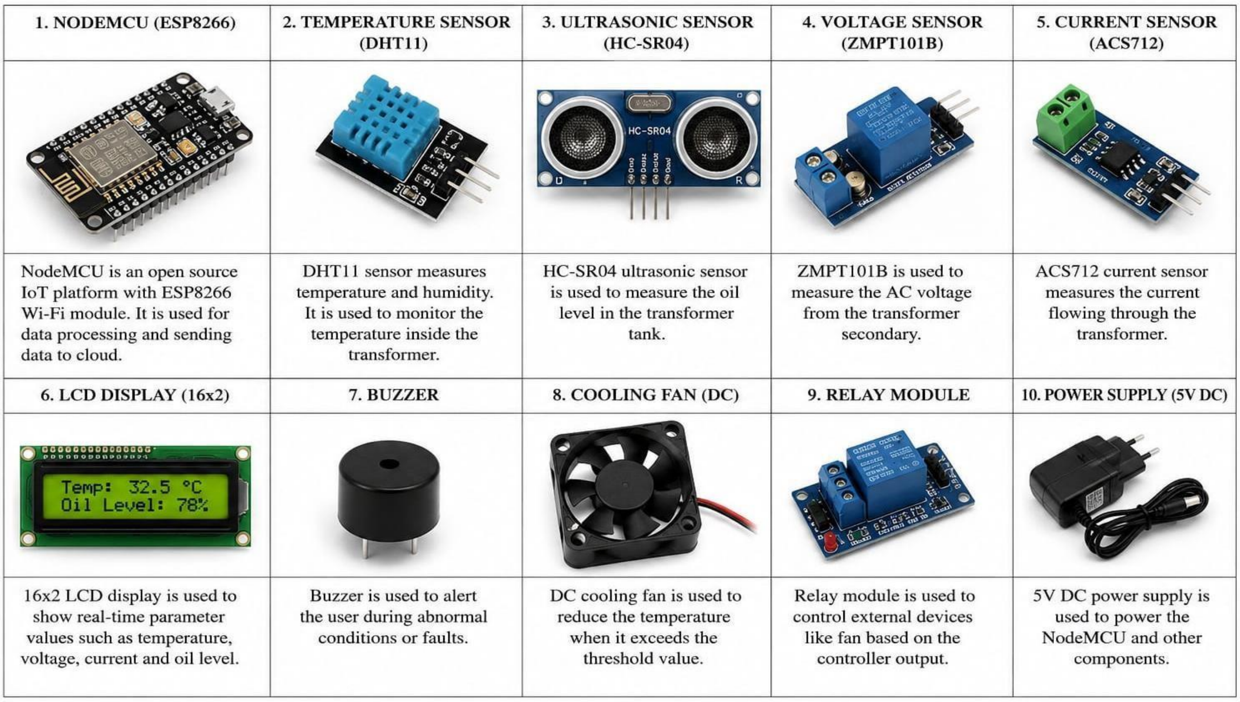

Fig. 2 Hardware Components Used in the Proposed System

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VII. CIRCUIT DIAGRAM

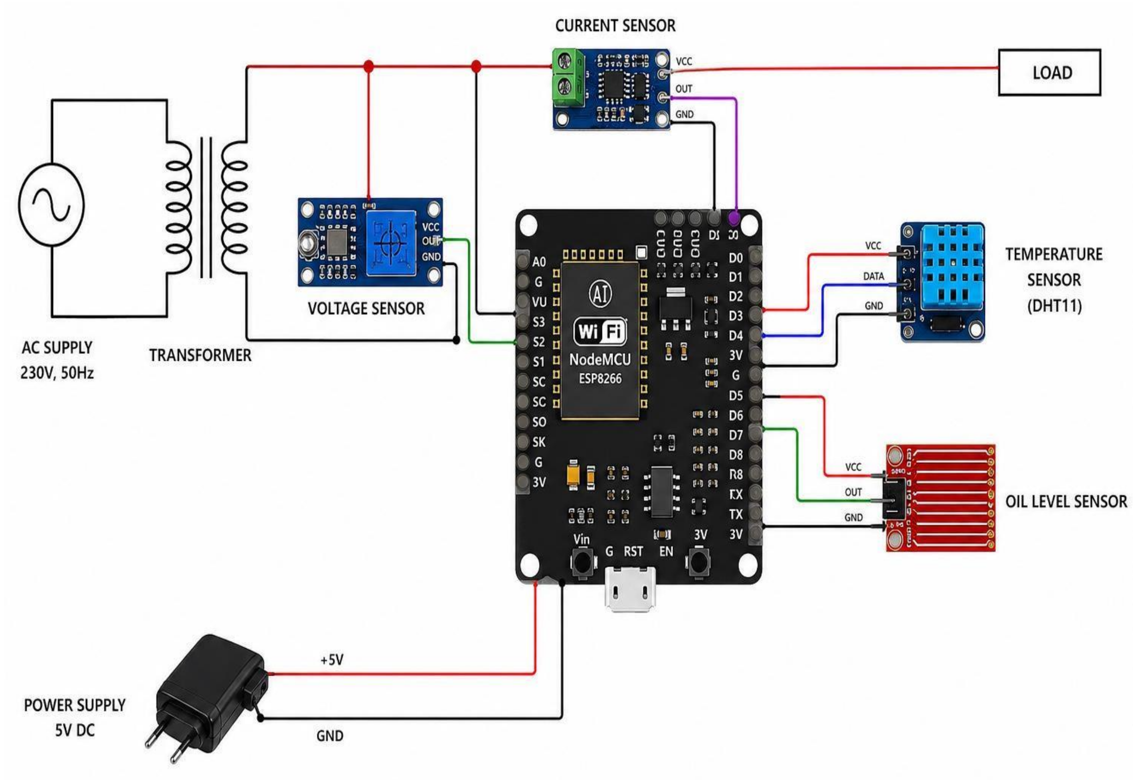
The circuit diagram of the proposed IoT Based Transformer Parameters Monitoring System illustrates the interconnection of various hardware components used for monitoring transformer parameters. The system mainly consists of NodeMCU microcontroller, temperature sensor, ultrasonic sensor, LCD display, buzzer, cooling fan, and power supply unit.

The NodeMCU acts as the central controller of the system. The temperature sensor is connected to the analog input pin of the NodeMCU for continuous temperature measurement. The ultrasonic sensor is connected through trigger and echo pins for monitoring transformer oil level.

The LCD display is interfaced with the NodeMCU to display real-time values of temperature and oil level. The buzzer and cooling fan are connected to the digital output pins of the controller for fault indication and temperature control.

The ESP8266 Wi-Fi module integrated within the NodeMCU enables IoT communication and sends the monitored data to the cloud platform. The entire circuit is powered using a regulated DC power supply.

The circuit diagram clearly shows the signal flow between sensors, controller, output devices, and cloud communication unit. The developed circuit provides continuous monitoring, fault detection, and real-time IoT-based transformer parameter monitoring.



VIII. WORKING PRINCIPLE

The proposed system works by continuously monitoring transformer parameters such as temperature and oil level.
The temperature sensor measures transformer temperature, and the ultrasonic sensor measures oil level inside the transformer tank. The sensor outputs are sent to the NodeMCU microcontroller for processing.
The NodeMCU compares the sensor values with predefined threshold limits. If the values remain within the safe range, the system continues normal operation.
When the temperature exceeds the threshold value, the cooling fan and buzzer are activated automatically. Similarly, when the oil level decreases below the safe limit, the system generates an alert.
The NodeMCU sends the monitored data to the cloud platform thr

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IX. RESULTS AND DISCUSSION

The proposed IoT Based Transformer Parameters Monitoring System was tested under different operating conditions to evaluate its performance. The system successfully monitored transformer parameters such as temperature and oil level in real time using NodeMCU and IoT technology.

The temperature sensor continuously measured the transformer temperature and displayed the values on the LCD screen. During high temperature conditions, the system automatically activated the cooling fan and buzzer, thereby reducing overheating conditions and improving transformer safety.

The ultrasonic sensor effectively monitored the transformer oil level. When the oil level decreased below the safe limit, the system generated warning alerts through the buzzer and displayed the fault indication on the LCD display.

The monitored data was transmitted successfully to the cloud platform through Wi-Fi communication. The system provided continuous monitoring and remote access to transformer parameter values through IoT technology.

The proposed system achieved reliable performance under different operating conditions. The implementation of real-time monitoring and fault detection reduced manual inspection requirements and improved operational efficiency.

The developed system successfully identified abnormal conditions such as overheating and low oil level at an early stage, thereby preventing transformer damage and improving reliability.

Analysis of Results

The proposed system provided accurate monitoring of transformer parameters and successfully detected fault conditions during operation. The NodeMCU microcontroller effectively processed sensor data and transmitted it to the cloud platform through IoT communication.

The temperature monitoring section responded quickly during overheating conditions by activating the cooling fan and buzzer automatically. Similarly, the oil level monitoring system accurately identified low oil conditions and generated warning alerts.

The LCD display continuously showed real-time parameter values, enabling easy monitoring of transformer conditions. The system demonstrated stable and reliable operation throughout the testing process.

The obtained results confirmed that the proposed system is suitable for real-time transformer parameter monitoring applications. The implementation of IoT technology improved system reliability, reduced maintenance effort, and enhanced transformer protection.

X. CONCLUSION

The proposed IoT Based Transformer Parameters Monitoring System successfully monitored important transformer parameters such as temperature and oil level in real time. The system effectively used sensors, NodeMCU microcontroller, and IoT communication technology for continuous monitoring and fault detection.

The implementation of the proposed system improved transformer safety by detecting abnormal conditions such as overheating and low oil level at an early stage. The integration of Wi-Fi communication enabled remote monitoring through the cloud platform, thereby reducing the need for manual inspection.

The system is simple, reliable, cost-effective, and easy to implement in modern power distribution systems. The obtained results confirmed that the proposed system provides efficient transformer monitoring and improves operational reliability.

The proposed model can be effectively used in industries, substations, and smart electrical networks for real-time transformer parameter monitoring applications.

Hence, the proposed system provides an efficient and smart solution for modern transformer monitoring applications.

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XI. FUTURE SCOPE

The proposed system can be further improved by implementing additional advanced monitoring and protection features. Future enhancements can increase system accuracy, reliability, and automation capabilities.

Future improvements of the proposed system include:

- Integration of GSM technology for SMS alert notifications.
- Addition of voltage and current sensors for complete transformer parameter monitoring.
- Development of a mobile application for real-time monitoring.
- Implementation of Artificial Intelligence (AI) for predictive fault analysis.
- Cloud data storage for long-term performance analysis.
- Automatic transformer shutdown during severe fault conditions.
- Integration with smart grid systems for advanced power management.
- Use of advanced sensors for improved monitoring accuracy.

The future scope of the project provides opportunities for developing a fully automated smart transformer monitoring system for modern electrical power systems.

REFERENCES

[1]. *Afkar, H & Vahedi*, A 2014, 'Identifying and Locating Connection Fault of Layer Winding Turn in Distribution Transformer', Journal of World's Electrical Engineering and Technology.

[2]. *Ahmad, A, Javed, I & Nazar*, W 2013, 'Short Circuit Stress Calculation in Power Transformer Using Finite Element Method', International Journal of Emerging Technology and Advanced Engineering, vol. 3, no. 11, pp. 301-308.

[3]. *Behjat, V & Vahedi,* A 2011, 'Numerical modelling of transformers interturn faults', IET Electric Power Applications, vol. 5, no. 5, pp. 415-431.

[4]. *Basak, D, Tiwari, A & Das*, SP 2006, 'Fault diagnosis and condition monitoring of electrical machines – A Review', IEEE ICIT, pp. 3061-3066.

[5]. *Bellini, A et al. 2008,* 'Advances in diagnostic techniques for induction machines', IEEE Transactions on Industrial Electronics, vol. 55, no. 12, pp. 4109-4126.

[6]. *Benbouzid, MEH et al.* 1999, 'Induction motor faults detection using signal processing techniques', IEEE Transactions on Power Electronics, vol. 14, no. 1.

[7]. Bouzid, MBK et al. 2008, 'Neural approach for stator interturn fault detection', IEEE Transactions on Industrial Electronics, vol. 55, no. 12.

[8]. *Bouzida, A et al.* 2011, 'Fault diagnosis using discrete wavelet transform', IEEE Transactions on Industrial Electronics, vol. 58, no. 9.

[9]. *Cabanas, MF et al.* 2011, 'Wireless instrument for early fault detection', IEEE Transactions on Industrial Electronics, vol. 58, no. 10.

[10]. *Cardoso, AM & Saraiva, ES* 1993, 'Detection of airgap eccentricity using Park's vector approach', IEEE Transactions on Industry Applications.

