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# Design and Development of IoT Based Health Monitoring System of an Industrial Motors and Power Transformer

**Mrs. Jagruti Kiran Pawar, Mr. Yash Raju Shendre, Mr. Akash Ashokrao Gophane**
Jawaharlal Darda Institute of Engineering and Technology, Yavatmal, Maharashtra

**Abstract***: The research presents an IoT-based health monitoring system for industrial motors and power transformers to improve operational safety, reliability, and efficiency. The system uses sensors, ESP32, and cloud platforms to track temperature, load, current, and oil level in real-time. It facilitates remote monitoring, anomaly detection, and predictive maintenance, minimizing downtime and maintenance expense. Its principal advantages are scalability, cost-efficiency, and integration with the IoT, offering the possibility for future innovations such as AI-powered maintenance and application in renewable sources and smart grids.*

**Keywords:** IoT, power transformers, industrial motors, real-time monitoring, anomaly detection, predictive maintenance, ESP32, scalability, energy efficiency

## I. INTRODUCTION

Industrial and power systems heavily rely on transformers and motors for driving equipment and efficient energy transmission. Conventional monitoring practices are based on manual checks, which are time-consuming and subject to human errors, resulting in unplanned downtime and increased maintenance expenses. In order to avoid these drawbacks, this project presents an IoT-based health monitoring system. The system utilizes sensors, ESP32 microcontrollers, and IoT platforms such as Blynk and Thing-Speak to track key parameters like temperature, current, oil level, and load conditions in real-time. Data is presented locally on LCDs and remotely on cloud platforms, facilitating remote monitoring and anomaly detection. This method guarantees improved operational reliability, safety, and efficiency by automating maintenance and anticipating probable failures. The system minimizes downtime, optimizes performance, and facilitates scalable applications in sectors such as power utilities, renewable energy, and smart grids, opening the way for smarter industrial ecosystems.

## II. MONITORING TECHNOLOGIES

### 1. IoT-Based Monitoring Systems

IoT-powered systems transform health monitoring of power transformers and industrial motors through using networked devices to gather, analyze, and process real-time data. IoT-based systems flag anomalies, prevent failures, and schedule maintenance based on real- time data to improve equipment efficiency and reliability.

### 2. Sensors

Sensors drive these systems, taking parameters such as vibration, temperature, pressure, voltage, and current. For instance, vibration sensors signal motor unbalance, whereas temperature sensors can measure transformer overheating. Sensors provide early defect identification via uninterrupted accurate data.

### 3. Blynk Mobile Application

Blynk is a smartphone application that has an easy-to-use interface to monitor real-time data, push notifications, and distant equipment monitoring. Its adaptive dashboards and cross-platform usage facilitate industrial on-the-move monitoring.

## III. METHODOLOGY

Research consists of some primary steps to conceptualize and create an IoT-based health monitoring system for power transformers and industrial motors. Initially, a detailed review of the literature will be undertaken to study available research on IoT monitoring technologies, sensor uses, and predictive maintenance systems. Depending on this, the issue with conventional monitoring systems will be explored, highlighting the necessity of real-time IoT systems to improve equipment reliability and decrease maintenance costs. Then, system design will be done by choosing suitable sensors (e.g., vibration and temperature sensors) and combining them with microcontrollers for data reading and using the Blynk app for remote monitoring and visualization. Performance analysis will be carried out by testing the accuracy of the system's fault detection, data latency, and reliability. Challenges and limitations that may be faced, such as hardware limitation and communication delay, will also be discussed and addressed in the study, suggesting ways to optimize them. Comparative analysis will be carried out to analyze the developed system with regard to cost, efficiency, and functionality compared to existing solutions. Last but not least, the research will present recommendations for future development, such as the addition of AI for sophisticated predictive maintenance.

**Protective Schemes:**

**1. Overheating Protection:**

LM35 and DS18B20 temperature sensors continuously track motor and transformer temperature. When the temperature is beyond a pre-specified level, an alarm is raised, and the systemcan automatically turn off the motor or transformer to avoid thermal damage.

**2. Overcurrent Protection:**

The ACS712 current sensor senses excessive current consumption due to overloading or short circuits. When the current goes beyond the safe operating limit, the relay module cuts off the power supply to avoid motor burnout or transformer failure.

**3. Overvoltage and Undervoltage Protection:**

The voltage sensor ZMPT101B detects voltage variation. When voltage levels exceed safety limits, the system can provide warnings or de-energize the transformer to prevent insulation failure or component damage.

**4. Oil Level Protection (for Transformers):**

The HC-SR04 ultrasonic sensor detects transformer oil levels. When the oil level falls below the safe level, an alert is raised to maintenance staff to avoid overheating and insulation failure.

**5. Short Circuit Protection:**

The relay module serves as a circuit breaker to cut power in the event of short circuits or high surges of current. Fuses and rectifiers are also incorporated in the system to protect components.

**6. Remote Monitoring and Predictive Maintenance:**

IoT implementation through ESP32 and cloud platforms (Blynk/ThingSpeak) enables real-time monitoring of parameters such as temperature, current, and oil level. Operators are notified and alerted for abnormal conditions, facilitating timely maintenance and minimizing unexpected failures.

**Power Quality & Its Impact:**

Power quality has a direct influence on the efficiency, reliability, and life of power transformers and industrial motors. Problems like voltage sags, swells, harmonic distortions, low power factor, frequency drifts, and overloading can cause overheating, insulation breakdown, energy wastage, and sudden failures. In this project, an IoT-based health monitoring system employing voltage (ZMPT101B) and current (ACS712) sensors with ESP32-based cloud tracking facilitates real-time monitoring, remote tracking, and predictive maintenance. The system detects voltage sags/swells impacting motor torque, harmonics that cause heating, power factor inefficiencies, and load imbalances. Through real-time monitoring of such parameters, it aids in preventing failures, minimizing downtime, and maximizing system performance, leading to an efficient and reliable industrial power system.

**Proposed Unified Framework**

In a bid to bridge the gaps in monitoring and protection highlighted above, the paper submits a unified framework bringing together:

1. IoT-Based Monitoring: Real-time data collection and faults prediction.
2. Advanced Protection Systems: Digital differential protection and numerical relays with proper fault isolation
3. Big Data Analytics: Multi-source data processing and predictive maintenance

This framework is centered around scalability, cybersecurity, and flexibility to dynamic power situations and therefore suitable for renewable energy integration and varying load.

## IV. CHALLENGES AND FUTURE DIRECTIONS

**1. Sensor Accuracy and Reliability:**

One of the main difficulties with an IoT- based health monitoring system is providing the reliability and accuracy of sensors. Sensors measuring parameters such as vibration, temperature, and current are prone to environmental noise, calibration, and aging effects. The system has to ensure steady performance despite variable conditions, which can prove hard to provide in a wide range of industrial environments.

**2. Data Security and Privacy:**

Since IoT systems tend to send sensitive information to cloud platforms for processing and analysis, data security becomes imperative. Industrial systems are vulnerable to cyber-attacks, which can compromise system integrity and result in false readings, downtime, or even destruction of critical infrastructure. Protection against unauthorized access, data breaches, and secure communication channels are major challenges that must be addressed.

**3. Edge Computing:**

Since IoT systems produce enormous quantities of data, the latency and bandwidth needed to send this data to cloud systems for processing might slow down performance. Edge computing can be applied to future IoT systems, in which data is processed locally at devices or by the data source. This would reduce latency, decrease network dependence, and enable quicker decision-making at the network edge.

## V. CONCLUSION

the IoT-enabled health monitoring system for industrial motors and power transformers provides a strong solution for predictive maintenance and real-time diagnostics, thus improving operational efficiency and reducing downtime. Through the combination of advanced sensor technologies and data analytics, this new approach greatly enhances asset management and decreases long-term maintenance costs in industrial settings.

## REFERENCES

**[1].** Bansode, S., S. Kawde, H. Shinde, and M. N. Namewar. "Industrial IoT Based Health Monitoring System of Motor and Transformer." *International Journal of Mechanics and Design* 10, no. 1 (June 2024): 13–19. https://doi.org/10.37628/IJMD.

**[2].** Kumar, R., and R. S. Anand. "Health Monitoring and Fault Analysis of Induction Motors: A Review." *Engineering Research Express* 2024 (November 2024). https://doi.org/10.1088/2631-8695/ad8b10.

**[3].** Suryawanshi, A., V. Ghule, N. Patil, S. Korade, and V. Kannake. "Optimizing Performance of Single Phase Induction Motor Using IoT." *International Research Journal of Modernization in Engineering, Technology and Science* 6, no. 5 (May 2024). https://doi.org/10.56726/IRJMETS56485.

**[4].** Beheshti Asl, M., I. Fofana, and F. Meghnefi. "Review of Various Sensor Technologies in Monitoring the Condition of Power Transformers." *Energies* 17 (2024): 3533. https://doi.org/10.3390/en17143533.

**[5].** Syawali, R., and S. Meliala. "IoT-Based Three-Phase Induction Motor Monitoring System." *Journal of Renewable Energy, Electrical, and Computer Engineering* 3, no. 1 (2023): 12–18. https://doi.org/10.29103/jreece.v3i1.9811.

**[6].** Pangul, N. G., A. G. Taley, P. S. Pawar, V. S. Raut, and A. A. Gophane. "Review on Effect of Power Quality of Transformer." *International Journal of Creative Research Thoughts (IJCRT)* 12, no. 1 (2024).

**[7].** Thakare, C. S., V. S. Raut, and A. A. Gophane. "A Review on Design Parameters and Testing of Transformer." *International Journal of Advanced Research in Science, Communication, and Technology (IJARSCT)* 4, no. 1 (January 2024).

**[8].** Pawar, P. S., R. R. Borkhade, N. G. Pangul, A. G. Taley, and A. A. Gophane. "A Review on Comparative Study on Two Current Transformers Using Calibration Systems." *International Journal of Creative Research Thoughts (IJCRT)* 12, no. 1 (2024).

**[9].** Guzman, A., H. Altuve, and D. Tziouvaras. "Power Transformer Protection Improvements with Numerical Relays." Presented at the *CIGRE Study Committee B5 Colloquium*, Calgary, Canada, September 14–16, 2005.

**[10].** Sahu, V. K., and Y. Pahariya. "A Review of Various Protection Schemes of Power Transformers." *Turkish Journal of Computer and Mathematics Education* 12, no. 9 (April 2021): 3220–28