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SMART MONITORING AND CONTROLLING OF SINGLE PHASE INDUCTION MOTOR BY USING IOT

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ABSTRACT:

This paper presents an Internet of Things (IoT)-based smart monitoring and control system for single-phase induction motors aimed at enhancing operational reliability, safety, and efficiency in industrial environments. The system continuously monitors critical parameters such as voltage, current, temperature, and vibration using embedded sensors interfaced with an Arduino microcontroller. Real-time data acquisition is processed locally and transmitted to a cloud platform via an ESP8266 Wi-Fi module, enabling remote monitoring and data logging. A rule-based threshold mechanism is employed for fault detection, identifying abnormal conditions such as overheating, over current, and excessive vibration. Upon detection, protective actions including alert generation and automatic speed control through relay-based interfacing with a Variable Frequency Drive (VFD) are executed. The proposed system reduces downtime, enables predictive maintenance, and improves energy efficiency, offering a cost-effective and scalable solution for smart industrial automation.

KEYWORDS:

IOT, INDUCTION MOTOR MONITORING, ARDUINO, ESP8266, PREDICTIVE MAINTENANCE, SMART CONTROL, VFD, INDUSTRIAL AUTOMATION.

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INTRODUCTION

Induction motors are widely used in industrial applications due to their robustness, low maintenance requirements, and cost-effectiveness. However, continuous operation under varying load conditions can lead to faults such as overheating, overcurrent, and vibration-related issues. Early detection of these faults is critical to avoid system failures and economic losses.

Recent advancements in IoT technologies have enabled real-time monitoring and control of industrial equipment. IoT-based systems provide continuous data acquisition and remote accessibility, thereby improving maintenance strategies and operational efficiency [1]. Smart monitoring systems integrated with cloud platforms allow centralized data analysis and fault prediction [2]. Several studies have demonstrated the importance of sensor-based monitoring for electrical machines to enhance system reliability [3].

The integration of wireless communication modules such as ESP8266 enables seamless data transmission and remote supervision [4]. Additionally, microcontroller-based systems like Arduino offer a flexible and low-cost platform for implementing such smart solutions [5]. IoT-enabled motor control systems have shown significant improvements in energy efficiency and fault management [6].

Traditional monitoring techniques lack real-time capability and depend heavily on manual inspection, which increases the risk of delayed fault detection [7]. Modern approaches emphasize automation and intelligent control using embedded systems [8]. The use of threshold-based fault detection is a simple yet effective approach for industrial applications [9]. Moreover, integrating control mechanisms such as VFD-based speed regulation enhances system safety and efficiency [10].

In this context, the present work proposes an IoT-based smart monitoring and control system for single-phase induction motors, focusing on real-time data acquisition, fault detection, and adaptive speed control.

MATERIALS AND METHODS:

The proposed system consists of sensors, a microcontroller (Arduino Uno), communication module (ESP8266), and control elements such as relays and indicators. The sensors measure voltage, current, temperature, and vibration. The analog signals obtained from sensors are converted into digital form using the Arduino microcontroller. RMS values of voltage and current are calculated, while temperature and vibration data are continuously monitored. The ESP8266 module transmits real-time data to a cloud platform (ThingSpeak), enabling remote monitoring, visualization, and storage of motor parameters.A rule-based threshold logic is implemented to detect abnormal conditions:

- Overcurrent condition
- Overheating
- Excessive vibration
- Voltage imbalance

When abnormal conditions are detected:

- Alerts (buzzer + LED) are activated
- Motor speed is reduced via relay/VFD
- Normal operation resumes once parameters return to safe limits

RESULTS:

The performance of the proposed IoT-based motor monitoring system is evaluated through real-time experimental observations.

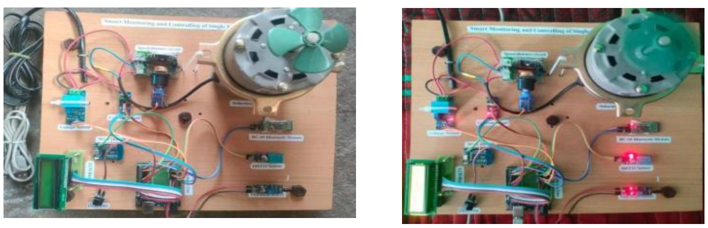

FIG. 1: IOT-BASED REAL-TIME MONITORING DASHBOARD OF INDUCTION MOTOR PARAMETERS.

Fig. 1 shows the real-time monitoring dashboard displaying motor parameters such as voltage, current, temperature, and vibration. The graphical visualization enables continuous tracking of motor health. The system successfully updates sensor data in real time, ensuring accurate monitoring. It can be observed that parameter variations are clearly represented, allowing operators to detect anomalies quickly. The cloud-based interface provides remote accessibility, improving operational convenience. The data logging feature helps in historical analysis of motor performance. The system demonstrates stable communication between hardware and cloud. Overall, Fig. 1 validates the effectiveness of IoT integration for monitoring applications.

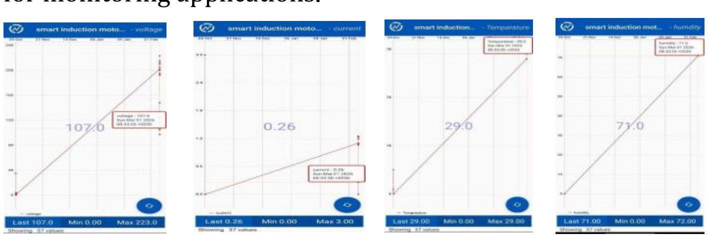

FIG. 2: FAULT DETECTION AND AUTOMATIC SPEED CONTROL RESPONSE OF THE PROPOSED SYSTEM.

Fig. 2 illustrates the system response under fault conditions. When parameters exceed predefined thresholds, the system activates alerts and reduces motor speed automatically. The response time is observed to be minimal, ensuring quick protection. The buzzer and LED indicators provide immediate local alerts. The relay-based control mechanism successfully adjusts motor operation. The system prevents damage by avoiding prolonged abnormal operation. It is evident that the control mechanism enhances system reliability. The results confirm that the proposed system effectively performs both monitoring and control functions

DISCUSSION:

The proposed system demonstrates significant improvements over traditional motor monitoring methods. Unlike conventional systems, it provides continuous real-time monitoring and remote accessibility. The integration of IoT enables centralized data management and predictive maintenance.

The rule-based fault detection approach simplifies implementation while ensuring reliable operation. Although machine learning techniques could enhance accuracy, the threshold-based system offers a cost-effective solution suitable for small and medium industries.

The automatic speed control mechanism improves motor lifespan by preventing operation under unsafe conditions. The system also contributes to energy efficiency by optimizing motor performance. Compared to SCADA-based systems, the proposed approach is more economical and easier to deploy.

CONCLUSIONS:

This paper presented an IoT-based smart monitoring and control system for single-phase induction motors. The system successfully integrates real-time data acquisition, cloud-based monitoring, and automated control mechanisms. It effectively detects faults and prevents damage through adaptive speed control.The proposed solution enhances reliability, reduces downtime, and improves energy efficiency. It is scalable and suitable for industrial, agricultural, and smart home applications. Future work can focus on integrating machine learning techniques for advanced predictive maintenance and fault classification.

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