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Research Article

IOT-BASED MONITORING OF INDUCTION MOTORS

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Abstract

The Internet of Things (IoT) is driving significant technological advancements, particularly in automation, where it enables efficient monitoring and control to enhance productivity. By tracking key operational parameters, IoT technology can be utilized to oversee and diagnose the condition of induction motors. The proposed solution involves an IoT-based platform designed to collect and process induction motor data. This information is stored on a cloud platform and can be accessed via a website. If predefined parameter thresholds are exceeded, timely actions can be taken to prevent unnecessary downtime, ultimately saving time and reducing costs. The key benefits of this system include continuous equipment monitoring, real-time alerts, and predictive maintenance to prevent unexpected failures.

Keywords : Wireless control and Monitoring System, Induction Motor, Internet of Things, Arduino, Vibration, Temperature.

INTRODUCTION

Induction motors are widely used across various industries, including railways, mining, woodworking, automotive, chemical processing, and paper mills. The demand for three-phase induction motors has grown considerably due to their simple and durable construction (Ali & Ahmad, 2023). Single-phase induction motors are also commonly utilized in domestic applications due to their efficiency and dependability. However, failures such as unbalanced stator conditions, winding defects, rotor parameter variations, eccentricity, bearing issues, and rotor bar failures can severely impact performance (Sharma & Gupta, 2023).

Monitoring parameters such as voltage, current, temperature, and vibration is crucial for ensuring motor reliability. Traditional monitoring techniques involve manual inspection, which is time-consuming and prone to errors. IoT technology offers a smarter solution by integrating real-time monitoring and predictive maintenance strategies (Verma & Yadav, 2023).

SIGNIFICANCE OF THE STUDY

IoT-based monitoring allows for real-time supervision and control of induction motors, ensuring efficiency and reliability. Key advantages include:

- Predictive Maintenance: Early detection of potential faults prevents unplanned downtime and extends motor lifespan.

- Real-time Alerts: Cloud-based monitoring provides instant notifications regarding irregular motor conditions.
- Energy Efficiency: Continuous tracking of power consumption helps in reducing operational costs (Kumar & Singh, 2023).

OBJECTIVES OF THE STUDY

The main aim is to improve the reliability of motor applications by utilizing the latest technological advancements. This approach ensures continuous monitoring and effortless management of induction motors across diverse industrial sectors. Implementing IoT-based monitoring and control enhances safe and efficient digital communication in industrial environments.

- Implement automatic and manual control methods to start or stop the induction motor, preventing system failures.
- Supervise and regulate motors used in electric vehicles.

PHYSICAL OVERVIEW

An IoT-based induction motor monitoring system consists of a transmitter and a receiver. The transmitter system includes sensors, transducers, and a microcontroller that gathers motor parameters. The collected data is sent to a PC for display and analysis. If any measured value exceeds predefined thresholds, the system takes corrective action such as shutting down the motor, activating a cooling fan, or adjusting speed (Lee & Kim, 2023).

COMPONENTS OF IOT BASED MONITORING INDUCTION MOTOR

Arduino Nano :

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo.

Microcontroller: Microchip ATmega328P
• Operating Voltage: 5 Volts
• Input Voltage: 7 to 20 Volts
• Digital I/O Pins: 14 (of which 6 can provide •
•PWM output)
•UART: 1
•I2C: 1
•SPPI: 1
•Analog Input Pins: 6
•DC Current per I/O Pin: 20 mA
•DC Current for 3.3V Pin: 50 mA
•Flash Memory: 32 KB of which 0.5 KB used by •boot loader
•SRAM: 2 KB

•EEPROM: 1 KB
•Clock Speed: 16 MHz

The Arduino/Genuino Uno has a number of facilities for communicating with a computer, another Arduino/Genuino board,or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual comport to software on the computer.

The 16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .in file is required. Arduino Software (IDE) includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1). A Software Serial library allows serial communication on any of the Uno's digital pins.

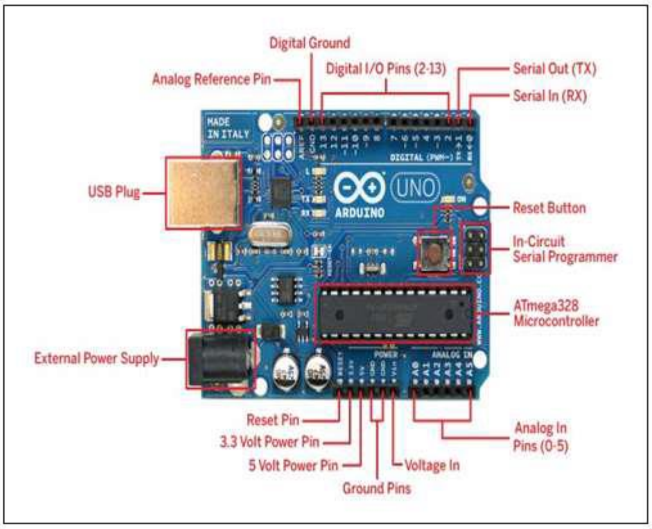

Fig. 1 -The Arduino Uno microcontroller

Induction Motor:

Induction motors operate on the principle of electromagnetic induction and can be classified as wound-type or squirrel-cage type. These motors are widely used due to their self-starting capabilities, reliability, and cost-effectiveness. The integration of variable-frequency drives (VFDs) enhances their efficiency by allowing speed control and optimizing energy consumption. The adoption of IoT-based solutions further enhances their performance by enabling condition-based monitoring and fault diagnosis (Sharma & Gupta, 2023).
Asynchronous or induction motors are AC electric motors that use electromagnetic induction from the stator winding's magnetic field to generate the torque required by the rotor's electric current.

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Fig. 2 - Induction Motor

Due to their durability, dependability, and affordability, three phase squirrel cage induction motors are frequently found in industrial drives. Fans and other household appliances with lower demands are common applications for single-phase induction motors.

Fixed-speed services, variable frequency drives (VFDs), variable-torque centrifugal fans, pumps, and compressors are among the applications for three-phase induction motors.

- ADVANTAGES
  - **Real-time Monitoring: Enables continuous observation of motor performance.**
  - **Predictive Maintenance: Reduces repair costs and minimizes downtime.**
  - **Energy Efficiency: Helps identify inefficiencies and optimize power consumption.**
  - **Remote Access: Allows users to monitor motor conditions from any location.**
- DISADVANTAGES
  - Limited Communication Range: The Bluetooth Low Energy (BLE) protocol used for data transmission has range limitations.
  - Potential Sensor Failures: Sensors may degrade over time, affecting data accuracy.

CONCLUSION

The implementation of IoT technology in monitoring induction motors offers a revolutionary approach to industrial automation. Real-time data collection and predictive maintenance ensure that potential motor faults are detected early, improving operational efficiency and reducing costs. The system integrates sensors, microcontrollers, and cloud storage to provide a robust solution for continuous monitoring. Future enhancements could include machine learning integration for more accurate fault classification and real-time mobile alerts for immediate intervention

FUTURE SCOPE

The application of IoT (Internet of Things) in induction motor monitoring is revolutionizing efficiency and reliability. Key developments include:

- **Early Fault Detection**: IoT enables the timely identification of motor faults, enhancing performance and ensuring operational safety.
- **Real-Time Monitoring**: With IoT, operators can remotely track and analyse motor parameters anytime, anywhere.

- **Automated Protection**: IoT systems automatically safeguard motors from irregular conditions such as voltage fluctuations, excessive speed, high current, and overheating.
- **Machine Learning Integration**: Combining IoT with machine learning allows for accurate fault classification and predictive maintenance.
- **Minimized Manual Intervention**: Cloud-based storage of fault data reduces the need for frequent manual inspections.
- **Instant Mobile Notifications**: IoT-based systems provide real-time alerts via mobile apps, enabling quick responses to potential issues.

AUTHOR(S) CONTRIBUTION

The writers affirm that they have no connections to, or engagement with, any group or body that provides financial or non-financial assistance for the topics or resources covered in this manuscript.

CONFLICTS OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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