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Analyzing The Role of IoT in the Condition Monitoring of Induction Motor

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Abstract - Induction motors are essential in many industrial processes, and maintaining their peak performance is vital for efficiency and cost savings. Conventional methods for condition monitoring have been constrained by their responsive characteristics and lack of capacity to offer immediate insights into the health of motors. IoT technologies provide a transformational option by allowing constant monitoring of motor characteristics and supporting predictive maintenance efforts. To guarantee safe and economical operations, this article details a system for remote control and monitoring of an induction motor in an industrial setting that makes use of the internet of things (IoT). Arduino receives data from transducer modules and sensors that measure things like voltage, temperature, vibration, external moisture, revolutions per minute, and current flowing through the induction machine's load. The parameters will be analyzed and shown. It provides a practical use for businesses looking to improve the efficiency and usability of their systems.

Keywords: - Monitoring, Control, Internet of Things, Vibration, Temperature

I.Introduction

Productivity and cost-effectiveness are two of the most important factors in today's industrial environment, and the efficient running of machinery is key to both of these elements. Although there are many other kinds of machinery that are used in industrial processes, induction motors are particularly important because of the extensive application of these motors across a variety of industries. In light of this, it is of the utmost importance to guarantee the best performance and longevity of these motors in order to keep operating efficiency at a high level and reduce downtime as much as possible. In this context, the introduction of the Internet of Things (IoT) has transformed traditional methods of condition monitoring and control. It has made it possible to gain real-time insights and capabilities of

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remote management that were before unreachable. Induction motors are the workhorses of a wide variety of industrial operations. They provide power to a wide variety of gear and equipment that is necessary for manufacturing, production, and automation. It is because of their durability, ease of use, and cost-effectiveness that they have become so widespread. This has made them the most popular option in a variety of different sectors. Nevertheless, induction motors are subject to degeneration over time owing to variables such as physical wear and tear, climatic conditions, and operating stress. This is the case despite the fact that induction motors are inherently reliable. The quick detection and resolution of possible problems is therefore of the utmost importance in order to avoid catastrophic failures, reduce the amount of time spent in downtime, and reduce the amount of money spent on maintenance. There have been traditional methods of condition monitoring that have depended on manual diagnostics and periodic inspections. These methods are frequently labor-intensive, time-consuming, and prone to human mistake. A further limitation of these conventional approaches is that they are unable to give real-time insights into the operational status of motors. As a result, their effectiveness in preventing unanticipated failures and improving performance is severely limited.

As a result of the introduction of Internet of Things technologies, a new age has begun in the field of condition monitoring and control. This new era offers a paradigm change from reactive maintenance techniques to proactive maintenance strategies. Real-time data collecting is made possible with the incorporation of sensors into induction motors and their integration with Internet of Things platforms. This makes it possible to continuously monitor a variety of characteristics, including temperature, vibration, current, and voltage. This stream of data gives predictive analytics algorithms the ability to recognize trends, abnormalities, and early signs of future faults, which in turn makes it easier to implement predictive maintenance projects. This vast amount of data can be processed, analyzed, and displayed in real time through the utilization of cloud-based platforms and edge computing capabilities. This provides maintenance workers and decision-makers with insights that can be put into action. Furthermore, the Internet of Things technologies make it possible to monitor and regulate induction motors from any location, which enables fast interventions and optimization of operating parameters. This is made possible by the remote accessibility that these technologies provide.

A comprehensive approach to motor management is made possible by the integration of condition monitoring and control systems that are based on the Internet of Things (IoT). This approach includes predictive maintenance, performance improvement, and increase of energy economy. These systems are able to foresee possible failures with a high degree of accuracy by utilizing machine learning algorithms and predictive analytics models. This enables proactive interventions to be taken before problems become more severe. Through the reduction of stress and wear, this predictive capability not only lessens the amount of unscheduled downtime that induction motors experience, but it also helps to extend their lifespan. In addition, control systems that are enabled by the Internet of Things allow for dynamic modifications to be made to operating settings based on real-time performance data. This ensures that optimal efficiency is maintained regardless of the load circumstances. It is

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possible for enterprises to improve resource allocation, expedite maintenance workflows, and reduce operational disruptions by utilizing condition-based asset management and predictive maintenance scheduling.

IoT-based condition monitoring and control systems contribute to sustainability objectives by increasing energy efficiency and limiting environmental impact. In addition to improving reliability and efficiency, these systems also contribute to the achievement of sustainability goals. These systems find chances for improvements in energy conservation and optimization by continually monitoring the amount of energy consumed and the efficiency with which operations are carried out. It is possible to operate induction motors at peak efficiency levels by implementing intelligent algorithms and control techniques. This will result in a reduction in the amount of energy that is wasted and the amount of carbon emissions that are produced. Additionally, Internet of Things-enabled devices reduce wasteful energy losses that are linked with poor motor performance. This is accomplished by aiding the early diagnosis and repair of inefficiencies. Not only does this convergence of maintenance optimization and energy efficiency result in cost savings, but it also goes hand in hand with the overarching goals of sustainability and corporate responsibility.

II.Review Of Literature

Shukla, Abhinab et al., (2022) The monitoring of the status of spinning machines that are used for crucial applications is a key factor in limiting the amount of downtime that occurs. Considering the advent of Industry 4.0, the Internet of Things (IoT) has assumed a significantly more important role in the online condition monitoring of electrical machinery. Using the Internet of Things (IoT) to perform online monitoring of motor parameters such as current, temperature, vibration, and humidity, as well as viewing the online trends of these data through the use of a web server, is the primary objective of this study. Visiting the website will allow you to view the data in the form of graphs and widgets whenever you want to. The real-time monitoring of the motor from any distant location is one of the benefits of this project. In the event that there is any anomaly, the operational personnel will be able to take the required actions to avoid the motor from completely breaking down. People working in the sector may benefit from the work that is being suggested in terms of online monitoring of motors, and in the future, the work can be expanded to include fault prediction and categorization.

Renold, Pravin & Venkatalakshmi, B. (2022) A typical electrical device with many uses is an electrical motor. There is a great need for durable and dependable motors due to the many functions they perform. There are many different types of motor problems, such as rotor bar breaking, short turn, bearing outrace, and many more. Workplace productivity is negatively impacted when these motors have unforeseen defects or breakdowns. Organizational profit is cut in half by the time it takes to fix the problems. About 42% of all defects are bearing failures. The majority of electrical motors with rolling bearings develop an asymmetrical form as a result of prolonged operation. This results in the motor overheating, breaking, vibrating, and breaking its elastic limit. Predictive maintenance, which relies on tracking the motor's operational state, is a great alternative to planned maintenance. An IoT-based solution

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that captures and continually monitors the induction motor's vibration is proposed in this chapter. By utilizing log data and the Naïve Bayes classifier, a decision support system assesses the effects of vibration. The suggested decision-support system may identify the threshold of vibration and alert the user when the motor is operating abnormally.

ME, Ms & Madhunisha, Ms. (2021) Automation refers to the utilization of different control systems to operate machinery, industrial processes (such as boilers and heat treatment ovens), telephone networks, ships, and aircraft with little to no human intervention. In this study, we offer state-of-the-art methods for secure and cost-effective data transmission via an IoT-based wireless monitoring system for induction motors. In the first method, an induction motor defect detection strategy that is considered state-of-the-art is demonstrated. The evaluation of the recorded voltage, current, earth leakage, rotor state, and speed is crucial to this study article. Isolated and surveyed the seriousness of disappointment using a progressed embedding technique. This method involves attaching several sensors to the motor and then using a microcontroller to extract the values. Data is transmitted from the base station to the remote station using the Graphical User Interface (GUI) in conjunction with the Internet of Things (IoT) cloud server. The client is able to communicate with the framework using this setup. The induction motor control system that was suggested in the study report is verified by running simulations in a Raspberry Pi 3 environment.

Artono, Budi et al., (2020) Induction motors are commonly employed in industrial settings as driving instruments that need a steady pace. An induction motor's power usage while running at a constant speed could lead to power loss. How well an industry's products are made depends on how well induction motors work. Consistent monitoring of all induction motors is essential. One of the main goals of this research is to figure out how to detect vibrations in induction motors. Not to mention that it may serve as a safeguard for induction motors by indicating their maximum load limit. This design has the potential to diagnose vibration issues in induction motors, according to the results. Conversely, the design served its purpose for regulating and monitoring using an Internet of Things–based basic control circuit.

Kumar, Dileep & Daudpoto, Jawaid (2019) The induction motor (IM) is commonly utilized in the industry because of its uncomplicated design and cost-effectiveness. Given the widespread usage of induction motors in many manufacturing processes, ensuring their continuous and cost-efficient operation is crucial. Monitoring the state of an induction motor allows for the identification and forecast of various defects. Several methods have been documented in literature for detecting problems in induction motors. This article provides a concise overview of various strategies. Significant instant messaging errors and their origins are also explained.

Potturi, Sudharani & Mandi, Rajashekar (2018) A block diagram method to Internet of Things-based monitoring and control of induction motors is shown in this paper. This approach was offered by a number of writers. It is possible to remotely monitor the characteristics of an induction motor, such as its temperature, speed, current, and voltage, and then transmit this information to the processing unit for analysis. This allows the processing unit to take the appropriate steps, particularly in the event of abnormal conditions, in order to improve the motor's dependability and efficiency. Through the use of WiFi, the information may be accessible from any location on the planet.

Sen, Mehmet & Kul, Basri (2017) In this study, a factory induction motor (IM) was monitored using wireless TCP/IP protocol to detect and predict when the motor will fail by looking for abnormalities in its typical operating characteristics. Consequently, the manufacturing process is not hindered in any way, and the necessary maintenance or replacement may be carried out with the least amount of disturbance that is feasible. During the course of this investigation, the Hall-effect current sensor was utilized to get readings of the motor cycle, the current drawn by the motor, and the voltage of the motor. Additionally, the needed power consumption was computed. In order to accomplish this goal, the architecture that was built read the parameters of the motor that were considered acceptable and then reported them to the software that was used for central management. After that, the software for central management that was working in real time was able to put together these characteristics and create models for predictive maintenance.

Sampath Kumar, Sridhar et al., (2016) The induction motor, often known as an IM, is an essential component in the vast majority of industrial applications. Consequently, this makes it even more vital for the purpose of condition monitoring. The monitoring of the stator current is recommended because the stator current contains primary discriminative qualities. These features are essential for the efficient identification and categorization of defects in the IM. An approach to wirelessly monitoring the stator currents of the IM is presented in this research. The purpose of this monitoring is to determine the state of the IM as well as the characteristics of the supply. A ZigBee-based Wireless Sensor Network (WSN) with a sampling frequency of 1.8 kHz is utilized in order to gather the IM stator current in a wireless manner. I.

Chaturvedi, D. et al., (2015) Induction motors are often utilized as electric drives and play a crucial role in industrial systems. Induction motors with high power ratings are commonly utilized in industrial settings, generating substantial amounts of heat. Heat is generated in the motor as a result of many forms of losses occurring within the motor. Hence, a good cooling system is essential to disperse the heat and keep motor temperature within limits. This study addresses issues that arise in the cooling system under various operating situations and conducts an analysis of them. Online data is collected from the machine to monitor temperature, current, and vibration signatures under various operating conditions, as well as the status of the cooling system. Soft computing techniques are used for this purpose.

III. Research Methodology

The Arduino and all of the interface components get the power they need when the power source is switched on. The sensor device relays the pertinent motor properties to the Arduino after detecting them. Through Wi-Fi, an LCD display and a network gateway receive data collected by several sensors, which Arduino processes according to instructions. The Arduino controls the induction motor in parallel by reading instructions from the internet and sending control signals to the relay via a contactor. On the server, the data from the sensors is shown clearly. In manual mode, alarm signals received from the web are used to drive the induction motor, while in detection mode, parameters are used for control. A circuit using a relay and

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contactors accomplishes the control. When a value that is not normal is detected, the motor is either turned on or off.

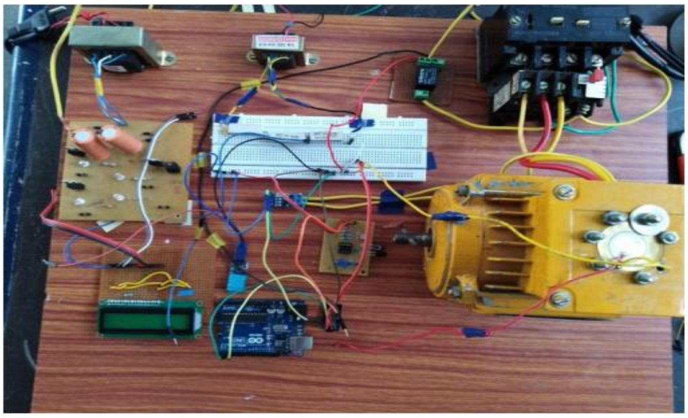


Figure 1: Experimental setup

IV.Results And Discussion

Each sensor is examined and implemented independently in this study.The WI-FI module and LCD panel are properly connected. During motor operation, the detected values are continually presented on the serial monitor and visually on the ThingSpeak website. The motor is being examined for any abnormal conditions. Below are the sensor data presented on the serial monitor, LCD display, and Thinkspeak website.,

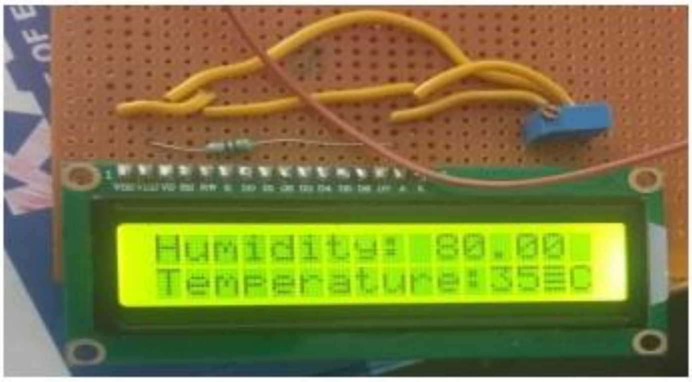
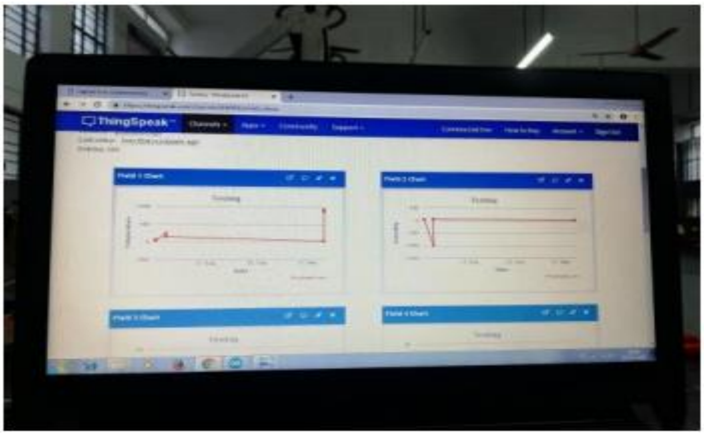
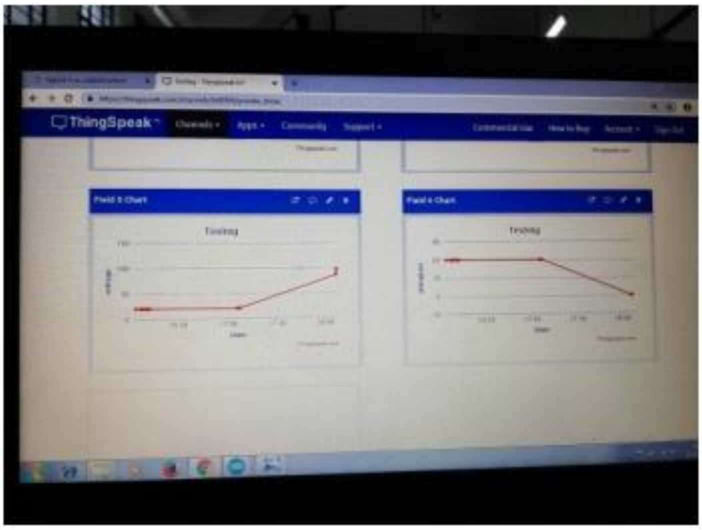


Figure 2: Sensor Information



(a)

(b)



(c)

Figure 3: Data uploaded to IoT platform

Figure 4: Thinkspeak website

V.Conclusion

Incorporating Internet of Things (IoT) technology into monitoring and controlling induction motor conditions represents a significant development in industrial maintenance procedures. IoT-based solutions provide a disruptive alternative to traditional reactive maintenance by allowing real-time data collecting, predictive analytics, and remote management capabilities. By consistently monitoring and taking preventative measures, businesses may reduce downtime, prolong the lifespan of crucial assets, and enhance operational efficiency. The

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integration of maintenance optimization and energy efficiency through IoT systems supports sustainability goals, leading to cost savings and environmental responsibility. Despite ongoing issues with data security and interoperability, the advantages of implementing IoT technology are unquestionable.

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