Design of Smart Device for Induction Motor Condition Monitoring

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Abstract. In industrial field, induction motors are used as a driving tools that requires a relatively constant speed. Power consumption in an induction motor with constant speed can cause a waste of electrical energy. A good performance of an induction motor will determine the quality of production in the industry. Every induction motor must be monitored regularly. This study aims to design a device for detecting the vibrations that occur in an induction motor. Besides, it would be an indicator of the maximum load limit on an induction motor which can later be used as protection on an induction motor. The result showed that the design could be used for providing a diagnosis of the vibration conditions that occur in an induction motor. On the other hand, the design was useful for monitoring and controlling through a simple control circuit designed based on the Internet of Things.

1. Introduction.

In the industrial sector, the induction motor is used as a driving machine for equipment that requires a relatively constant speed. Consumption of power at a constant speed can cause a waste of electrical energy. The good performance of the induction motor will determine the quality of production in the industry. Every induction motor must be checked, and maintained regularly. Many disturbances that occur in the motor can damage the engine or mechanical problems such as induction motor, bearing problems, clutch, motor position, and others. One of the disturbances that often occurs is mechanical bearing problems, the disturbances that often occur due to improper lubrication of the pillow, insufficient lubrication, increasing friction, and inappropriate operating conditions [1,2]. The length of time the motor operates requires regular maintenance to find out premature damage to the induction motor, if this damage is not detected it will cause continuous engine damage. To determine the condition of the machine and also a vibration characteristic that occurs in the machine, it is carried out by analyzing it using comparative analysis methods, descriptive analysis, and trending analysis. Comparative analysis, determined by comparing the results of the inspection with a predetermined standard, namely the Vibration Severity Standard ISO 10816.
Internet is a technology that allows several devices to communicate and interact with each other. Each device can send data to each other and also commands to be able to connect with other devices. Selection and layout of the right sensor is an important key in the construction and implementation of more effective monitoring system [4].

2. Related Research Studies

The previous research has focused on The Vibration Monitoring Methods and Signal Processing Techniques for Structural Health Monitoring: A Review” It has been explained that a machine without any vibration in the process is something that does not exist. During engine operation, vibrations are directly connected to problems in the system which have rotating or reciprocal parts, such as bearings, engines, gears, shafts, turbines and motors. Vibration analysis has been shown to be the benchmark for any cause of failure in the component manufacturing process or any maintenance decision related to the machine [5]. Research with the title "IoT Based Condition Monitoring Of An Induction Motor" In general, the results show that the predictive maintenance of induction motors is suitable for reducing downtime, increasing efficiency and reliability. Various parameters of the induction motor are analyzed to gather specific information that can predict failure of the motor. Using IoT, the IoT-based Condition Monitoring System for Induction Motors can monitor and diagnose the condition of an Induction motor by recording the key operating indicators [6].

The further research is “Online Diagnosis of Induction Motors Using MCSA” The online induction motor diagnosis system uses motor current analysis with signal and data processing algorithms. using MCSA for motor diagnosis of stator-current signals. The system has been able to confirm four types of motor failure and diagnose the fault status of the induction motor. Experimental results were obtained at 3,7-kW and 30-kW three-phase induction motors and voltage-source inverters with vector control techniques [7]. “Smart Panel System using Internet of Things” has produced a conventional overload voltage protection device that can cut off electricity from the point of load and selectively cut loads. Internet technology can be used not only for communication between individuals but also for communication between objects. Internet-based Smart Panel is designed to protect components, and remotely monitor the use of electrical energy and control equipment via a smartphone [8]. "LED control system with cayenne framework for the Internet of Things (IoT)” has produced an LED control system using cayenne via the internet as a control with wifi network connection media [9].

3. Materials

3.1. Induction motor

Induction motors or machines are also referred to as Asynchronous Machines. The word asynchronous means that the machine is never running at synchronous speed. Induction motors are mainly of two types. It can be a single phase or three phase induction motor.
3.2. Variable Speed Drive (VSD)

Variable speed drive or also known as variable frequency drive or simply called inverter is an application solution that requires further motor control capabilities, for example: setting the motor speed according to the load or according to the value we want. The use of VSD can be used for AC or DC motor applications.

3.3. Arduino Uno

Arduino Uno is a microcontroller board with an ATmega328P Processor. Arduino Uno has 14 digital input / output pins (of which 6 pins can be used as PWM outputs), 6 analog / ADC inputs (Analog to Digital Converter), 16 MHz crystals, equipped with USB type B connection, ICSP header and reset button. This board uses power that is connected to a computer with a USB cable or external power with an AC-DC adapter or battery, for Arduino Uno programming it can be programmed using the Arduino IDE application.

3.4. ACS712 Sensor

ACS712 or Hall Effect current sensor is a sensor that detects the flow of electric current through it. Hall effect allegro ACS712 is a precision sensor as an AC or DC current sensor in reading current in industrial, automotive, commercial and communication systems.
3.5. ZMPT101B Sensor

The ZMPT101B Voltage Sensor is designed using a transformer so that it can be used to read AC voltages. The ZMPT101B sensor module has small dimensions, high measurement accuracy, and a consistent, stable output for voltage and power measurements.

3.6. Accelerometer Sensor

An accelerometer is a transducer that functions to measure acceleration, detect and measure vibrations, or to measure acceleration due to Earth's gravity. Accelerometer can also be used to measure vibrations that occur in machines with dynamic distances.

4. Schema Tools

In order to make it easier to understand the working principles in the process of designing and making all work drawings, a block diagram of the system is provided in Fig. 8. From a three-phase power source connected to a Variable Speed Drive (VSD) which functions to regulate the motor
speed, a relay is used to turn off the induction motor when the set point is met. The motor is given a load with a certain weight to get the desired vibration in the motor. If the vibration exceeds the set point, the LED as an indicator will light up, the relay and buzzer will be activated automatically. Arduino Uno as a processor will control the entire circuit. The sensors used in the design of this tool are the ADXL345 accelerometer sensor used to record vibrations, the ACS712 current sensor for current and the ZMPT101B voltage sensor circuit to measure voltage. The ESP8266 Wi-Fi module is used, so that Arduino can transmit sensor data and can upload it to the Thingspeak cloud platform. To be able to upload sensor data to the Thingspeak platform, an account for the user must be created and then create a new channel, in a new channel, the channel will be selected for parameters to be monitored. The monitored parameters are represented in the form of data and graphical displays.

Fig. 8. Schema Tools

Thing Speak is an internet platform that has provided facilities to apply Internet of Things (IoT) technology. Thingspeak is made based on the analysis of an algorithm. On this platform, users can upload sensor data from various existing development boards. Data uploaded on thingspeak can be made as personal data or public data. The data is presented in the form of a channel in which there is a visualization that is processed by thingspeak.

Fig. 9. ThingSpeak Platform [10]
5. Result
This section describes the process of making equipment that will monitor induction motors using IoT Cloud ThingSpeak.

![Fig. 10. Induction Motor Monitoring Circuit](image)

After the hardware has been designed, then it is prepared to create a cloud project at ThingSpeak which functions to monitor the vibrations that occur in the induction motor, then the data generated can be used as a reference to determine the performance of the induction motor so that the condition and performance of the induction motor will be known.

![Fig. 11. Project ThingSpeak for monitoring vibration in induction motors](image)

6. Conclusion
The new design prototype has been developed and presented to detect the vibrations occurring in the induction motor. The system has been able to provide a diagnosis of the vibration conditions that occur in an induction motor. In this study we have seen that induction motors can be easily monitored and controlled through a simple control circuit designed based on the Internet of Things. The system operation has been tested under the IoT cloud Thingspeak platform which has displayed the results of accelerometer sensor data.
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