Faculty of Electrical and Electronic Engineering Technology

SMART MOTOR MECHANICAL MULTIMETER

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Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honours

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HAZWAN HISHAM BIN BADRUL HISHAM

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DEDICATION

We would like to dedicate this project report to our family. We also want to dedicate this project report for our beloved supervisor, Ts. Dr. Aliza Binti Che Amran.

Next dedication would be for our future juniors who would make this report as their reference or source of information, we wish all of you good luck and just hang in there, and you will survive this.

Furthermore, to future users that might be interested in this project, we are glad to inform you that you pick the right project as this one will not let you down. Please have a deeper look and gain your understanding more regarding this project in our report.

Last but not least, we dedicate this project report to ourselves for all the sleepless night, our times spent to finish this project and for all the brilliant ideas that we have worked on together as a team to make this project a success. Hopefully this report will be useful for anyone who reads it.

ABSTRACT

Most of the industries use a high or low AC induction motor in their production line. These motors are used as industrial drives and they execute important processes in the industries such as manufacturing. Thus, a proper maintenance or services to these induction motors are vital to ensure all the process flow smoothly and not to be interrupted due to the induction motor broke down or not fully functioning. The objective of this project is to develop a prototype Smart Motor Mechanical Multimeter. This “mechanical multimeter” aims to provide facilitation and convenience to the maintenance technician where this device enables them to monitor vibration and temperature remotely, effortless yet reliable. The remotely monitored temperature and vibration can be viewed using Raspberry Pi. The Raspberry Pi is a micro-controller with touchpad that has GUI (Graphical User Interface) was implemented on this project to monitor vibration and temperature sensor of an induction motor. Two types of sensors were used. LM35 sensor and piezoelectric vibration sensor were implemented to measure temperature and vibration respectively. Both parameter monitoring can be viewed online and offline from the touchpad. To verify the data measured by the prototype, an industrial thermal gun, manufactured by Flir, is used. Both data were compared, and their comparison results showed that the error were relatively small. This shows that the temperature monitoring feature of the prototype is functional and more reliable compared to vibration sensor. Thus, future work for the prototype is to improvise the vibration monitoring. This prototype carries a commercial value because of its potential to assist temperature monitoring of a motor at an affordable cost, as compared to Distributed Control System (DCS). This will help Small Medium Enterprise (SME) local companies to grow supported by this prototype for motor’s health condition remote monitoring i.e. temperature.

ABSTRAK

Kebanyakan industri menggunakan motor aruhan AC tinggi atau rendah dalam satu-satu production line. Oleh itu, penyelenggaraan atau perkhidmatan yang betul kepada motor aruhan ini adalah perlu untuk memastikan semua aliran proses dan tidak terganggu akibat motor aruhan rosak atau tidak berfungsi sepenuhnya. Objektif projek ini adalah untuk merekabentuk, membangunkan dan menguji satu prototaip yang dinamakan Multimeter Mekanikal Motor Pintar. Projek ini memberikan kemudahan kepada juruteknik kerana alat ini membolehkan mereka untuk memantau getaran dan suhu motor secara jarak jauh dengan sangat mudah namun amat boleh dipercayai. Parameter yang boleh dipantau daripada jarak jauh ini boleh dilihat menggunakan teknologi Raspberry Pi. Raspberry Pi adalah satu mikro-pengawal dengan pad sentuh yang mempunyai GUI (Graphical User Interface) yang disambungkan kepada dengan penderia getaran dan suhu untuk memantau serta mengukur hasil motor. Dua jenis penderia digunakan. LM35 dan penderia getaran piezoelektrik masing-masing digunakan untuk mengukur suhu dan getaran. Kedua-dua parameter ini boleh dilihat secara atas talian dan secara lepas jalur di skrin lapik sentuh. Bagi menentusahkan data pengukuran suhu oleh alat ini, satu alat pengukur haba industri, dikeluarkan oleh Syarikat Flir, digunakan. Kedua-dua data iaitu data pengukuran prototaip dan data pengukuran alat pengukur haba Flir dibandingkan. Hasil perbandingan menunjukkan ralat yang kecil dan ini menunjukkan prototaip ini berfungsi dengan baik kerana berupaya mengukur data suhu dengan tepat berbanding data penggetar. Sebagai cadangan, fungsi pengukuran gegaran masih perlu ditambahbaik. Prototaip ini mempunyai nilai komersial kerana potensinya untuk memudahkan pemantauan suhu motor di kilang dengan kos yang berpatutan, berbanding dengan Sistem DCS. Ini bermakna banyak syarikat IKS tempatan boleh dibantu perkembangan mereka dengan disokong oleh alat ini bagi memudahkan mereka memantau keadaan kondisi motor dalam kilang mereka, iaitu pengukuran suhu, secara jarak jauh.

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CHAPTER 1

INTRODUCTION

1.1 Background

Most of industries are using three phase induction motor. A three squirrel cage induction motors are the most popular motors in industries [1]. The squirrel cage induction motors are most widely used in electrical machines for industrial domestic and commercial applications [2]. Thus, to maintain the full potential of the motor it needs to be maintenance or service at one point to ensure the production line is smooth and not interrupted due to the motor broke down or not fully functioning.

To ensure the motor is in good condition, one of the causes that can make induction motor failure is the temperature. The thermal monitoring can be completed by measuring the temperature of the motor by the estimation of the parameter by using the temperature sensor. An induction motor also produce heat due to stator winding of current are very high. Hence, it produces excessive heat [2]. If this would not be taken seriously the results is the destruction of the motor itself. Next, vibration monitoring is widely used to detect the mechanically faults inside the induction motor such as, bearing failure or mechanical imbalance. By using piezo-electric sensor it can detect a vibration and giving a signal of voltage proportional to acceleration of an induction motor [2] [3].

Each of the data can be collected, observed, and can be analyzed by using predictive analysis and advanced method to significant data in form of graph and charts of trend of an induction motor. This real time data can help to utilize to monitor an induction motor.

This prototype concept is to monitor of an induction motor at an affordable cost. Due to micro-controller is Raspberry Pi, Internet of Things (IOT) will be applied in this prototype and touch screen panel with Graphical User Interface (GUI) will also be installed in this project. The major part for this project is to monitor the temperature and vibration of an induction motor and the data can be viewed data online and offline with real-time monitoring of each the parameters.

1.2 Problem Statement

In this modern era, the industrial revolution evolving. Currently in this generation industrial 4.0. What is industrial 4.0? Industry 4.0 is where the revolutionizing the way of manufacturer, improve and distribute their products by integrating new technology. Such as Internet of Things (IOT), cloud computing and analytics with Artificial Intelligence (AI) and machine learning into their production facilities and throughout the operation [4].

For this case, most of industries uses induction motor to manufacturer the product or to move the product. At time Induction motor needs to be maintenance to maintain the efficiency of the motor. To measure or monitor the induction motor it needs to monitor the vibration and the temperature of the motor [2]. In these cases, to monitor each parameter it needs a tools or separate devices to measure and to monitor the parameters of the induction motor. The technician needs to bring a lot of measurement tool just to measure and to monitor each of the parameters.

The technician also needs to record manually of the measured induction motor parameters. These can lead human error when the recording of the measured parameter was carried out manually by a human operator. Furthermore, manual data recording has limitation in terms of its data capturing frequency. Using manual method, a human only could read the meter and record one data in a time interval of two to three seconds. However, using automation, the data capturing will be automize and could reach more data capture, for example, one data recorded in a millisecond.

This prototype Smart Motor Mechanical Multimeter project is to aim make at ease for technician and to give the best analytic of the result measured vibration and temperature. The data can be seen through online and offline with line chart to know the condition of the induction motor itself.

1.3 Project Objective

The main aim of this project is to propose a prototype Smart Motor Mechanical Multimeter. Specifically, the project objectives are as follows:

a) To design and develop GUI system that can monitor vibration and temperature of a motor.

b) To save the monitored data online or can be view in offline mode.

c) To test the accuracy and reliability of the developed prototype.

1.4 Scope of Project

This prototype project is to focus on integrating vibration and temperature sensor to monitor and measure the parameter with Graphical User Interface (GUI) with Internet on Things (IOT) to save the data and these data can be observed through online and offline mode. This prototype also a combination of hardware and software to measure and monitor each of the parameter i.e. temperature and vibration. This prototype focused on these two parameters and will be used to measure and monitor the real-time condition of an induction motor. This can be achieved by connecting the sensors to the micro-controller Raspberry-Pi that connects with the touch panel LCD (Liquid Crystal Display) is to display the GUI. This touch panel will display the information captured by both sensors. Since Raspberry-Pi has a built-in Wi-Fi, a database will be created to save and view the data of the measured parameters. This system is designed to ensure the condition of induction motor can be saved, logged and viewed real-time. The data also can be viewed in the touch panel LCD by offline mode.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

On this chapter will highlights of an existing projects or prototype such as that researched and that has been developed by the previous research group or manufactured products by companies. Most of the prototype projects involves in development by using Arduino or Raspberry Pi with Internet of Things (IOT). Next, literature review is conducted to identify the major reasons or justifications why preventive maintenance of an induction motor is important to ensure the motor runs on full potential in big or small scaled industries.

2.2 Overview of an Induction Motor

Induction motor in Figure 2.1 is commonly used in industrial as well as in main powered home appliances. It is an AC power source to power up the motor. The main advantage of the motor is the motor has simple and rugged design, low cost, low maintenance and direct connection of three phase power source [5]. An induction motor also can be control by using Variable Frequency Drive (VFD) or control system.

Figure 2.1: Example of an Induction Motor

An Induction Motor consists of two major part which is called the stator and a rotor that spins inside the case with engineered of air gap between the two of the part [5].

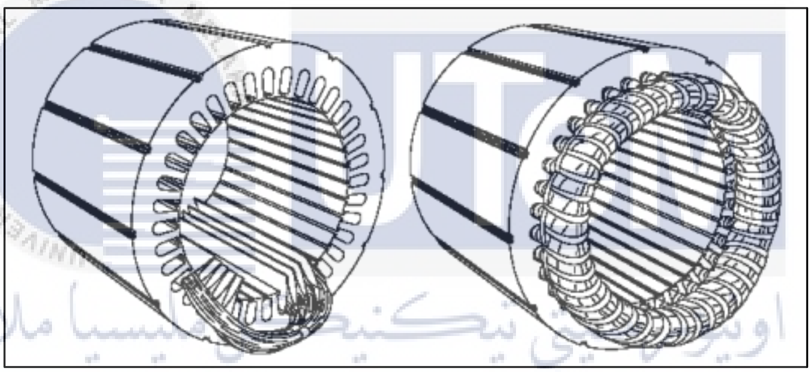

Figure 2.2: A common stator for an Induction Motor [5]

A stator in Figure 2.2 is made up from several thin lamination of aluminium or cast iron. They consist of holes that clamped together to form a hollow cylinder this form called a stator core with slots. Coil will be winded each slot. All the insulated wires are winded into the hole because it will form an electromagnet by connecting AC supplies, a rotating magnetic field are created [5].

For rotor in Figure 2.3 locates inside of an Induction Motor. Rotors are made up from several thin steel lamination with evenly spaced bar. They are made from aluminium or copper. Almost 90% of induction motors have squirrel cage rotor. This is because the squirrel cage rotor has a simple and robust construction. The rotor consists of a cylindrical laminated core with axially placed parallel slots for carrying the conductors. Each slot carries a copper, aluminum, or alloy bar. These rotor bars are permanently short-circuited at both ends by means of the end rings [5]. The rotor mounted on shaft by using the bearings on to each end of the shaft to normally kept longer than other for driving the load.

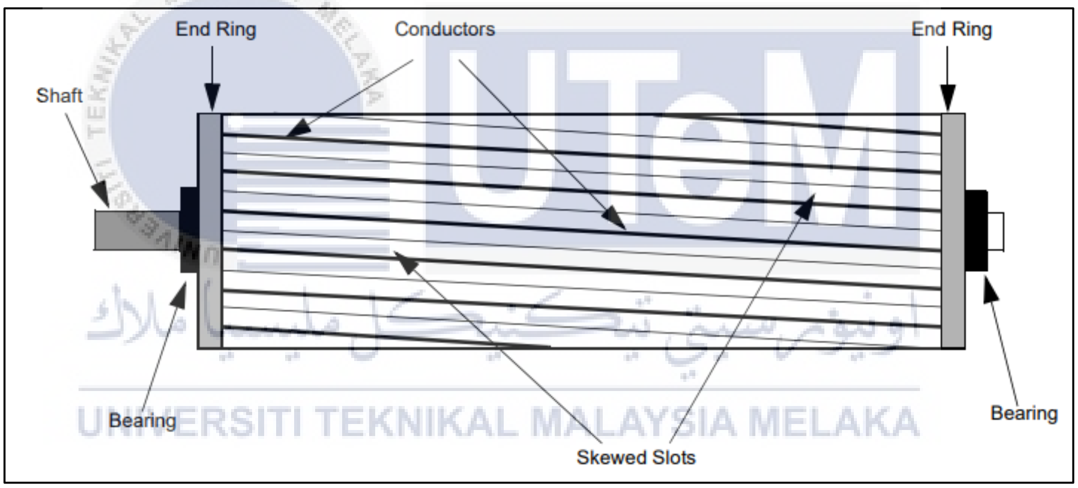

Figure 2.3: An Induction Motor Rotor for squirrel cage design with labelling [5]

2.3 Preventive Maintenance Overview of an Induction Motor

All industry has their own maintenance to maintain the equipment of each specific system to make production runs smoothly and minimize downtime of the production line. One of the maintenances for induction motor is preventive maintenance. System improvement through preventive maintenance is important. Preventive maintenance is important due to improve reliability and lifespan of an equipment [6]. Next, preventive maintenance aim is to reduce health and safety risk this is to ensure that induction motor running smoothly and does not harm any of worker that handling a system that equipped with that induction motor [3]. A good preventive maintenance is schedule should prevent the induction motor from failing unexpected, reducing cost, saving time and to ensure the operation continues smoothly. It is also effective and efficiently to the system equipment. Below Table 2.1 shows an example of differences between predictive maintenance and proactive maintenance.

Table 2.1: Shows a difference between Predictive and Proactive Maintenance

	Predictive Maintenance	**Proactive Maintenance**
Looking for:	Failure symptoms and faults	Root causes
Example analysis:	Vibration analysis, Thermography analysis	Contaminant monitoring balance, alignment tools
Benefits:	Early detection fault and failure	Fault free machine life extension
Reduced:	Impact of failure	Number of failures

2.3.1 Thermal Monitoring of an Induction Motor

The first important to maintain an induction motor is to monitor the temperature of the induction motor or thermal monitoring. Figure 2.4 shows an induction motor with its exploded parts. Usually, an induction motor temperature rises it is because of the stator interturn faulty. This causes lead long-term thermal aging and deterioration of winding insulation the effect is may lead to severe damage and excessive heating [1]. Thus, to ensure this will not happen in future, thermal monitoring on to an induction motor is a must.

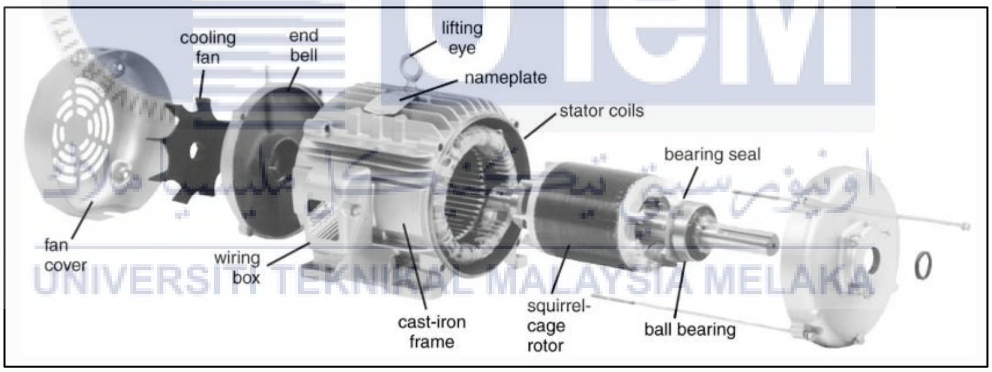

Figure 2.4: An induction motor with its labelling part by part

To measure and monitor the temperature of an induction motor a temperature sensor Figure 2.5 can be used to monitor and measure the parameter. Temperature parameter will be measured in Celsius or ˚C.