EFFICENCY MONITORING OF THE THREE PHASE INDUCTION MOTOR USING IoT

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ABSTRACT

In this study, Most of the failures in the industrial systems are due to motor faults which can be catastrophic and cause major downtimes. Hence, continuous health monitoring, precise fault detection and advance failure warning for motors are pivotal and cost-effective. The identification of motor faults requires sophisticated signal processing techniques for quick fault detection and isolation. This paper presents a real time health monitoring technique for induction motor using Arduino microcontroller.

Keyword : - *ardiuno controller, induction motor, motor parameter, IoT monitoring*

1. INTRODUCTION

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The estimated torque from the motor's electrical signals (i.e., current and voltage) makes the system less invasive, but it is less accurate when compared to direct measurement systems. There are problems, such as noise in signal acquisition, those related to numerical integration, and low levels of voltage signals at low frequencies. However, in many cases, high precision is not critical, and low invasiveness is required. There are different methods to measure efficiency in induction motors, which are based on dynamometer, duplicate machines, and equivalent circuit approaches. However, their application for in-service motors is impractical, because it requires interrupting the machine's operation to install the instruments.

There are some simple methods for in-service efficiency estimation, l like the nameplate method, the slip method, and the current method. These methods present as the main limiting factors the low accuracy, estimative based on nominal motor data and the need of typical efficiency-versus-load curves. In the ORMEL96 method, the efficiency is obtained from an equivalent circuit that is generated from the motor nameplate and the rotor speed measurement. In the OHME method, the efficiency estimation is performed from the input power measurement and data from the motor nameplate.

The air-gap torque (AGT) for energy efficiency estimation. In, the AGT is also used to measure efficiency in a much less invasive manner. The AGT method can be employed without interrupting the motor operation and it is not based on the motor nameplate. This method generally is more accurate than the other

methods describe dearlier. In this study, the AGT method was used for the estimation of the motor shaft torque and efficiency, because it is the noninvasive method for determining torque and efficiency that has less uncertainty. Traditionally, energy monitoring and fault detection in industrial systems are performed in an offline manner or through wired networks.

The installation of cables and sensors usually has a higher cost than the cost of the sensors themselves. Besides the high cost, the wired approach offers little flexibility, making the network deployment and maintenance a harder process. In this context, wireless networks present a number of advantages compared to wired networks as, for example, the ease and speed of deployment and maintenance, and low cost. In addition to that, wireless sensor networks (WSNs) provide self-organization and local processing capability. Therefore, these networks appear as a flexible and inexpensive solution for building industrial monitoring and control systems. Nevertheless, the use of WSNs, when developing automation systems for industrial environments, presents a number of challenges that should be faced.

Wireless networks have unreliable communication links, what can be aggravated with noise and interference in the communication spectrum range. The unreliability of the transmission medium in wireless networks makes it difficult to define quality of service guarantees. Studies on the application of WSNs in industrial environments, aiming at replacing wired systems, have been extensively explored in recent Years.

2. SIMULATION DIAGRAM

Figure 1 Shows a simulation circuit , It has the three phase AC supply is given the three phase induction motor.

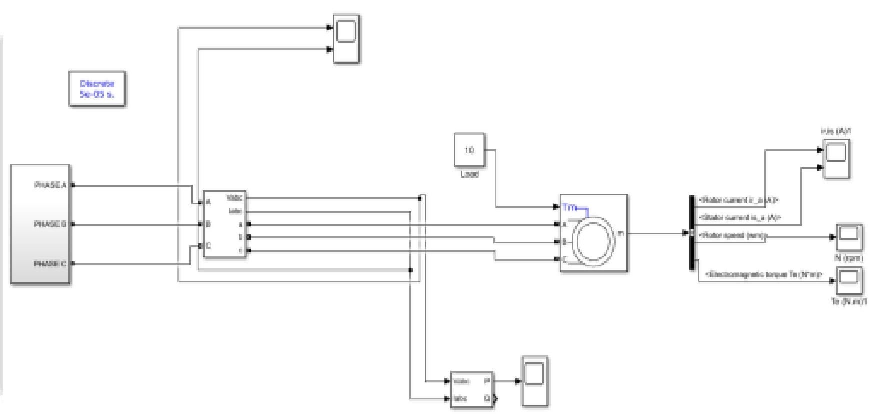

Figure 1 Simulation circuit

The voltage and current is measured from the Voltage and current measurement. The supply voltage and current are measured from one reference point and the input power is noted from the another reference point. Torque is kept as an fixed value set in the induction motor. Finally the output power as speed and torque are calculated.

2.1 Input Current And Voltage

Figure 2 Shows a input phase voltage and current ,It is measured from the input three phase power supply with have rated frequency from 50 to 60 HZ. The three phase voltage such as Va,Vb,Vc and the current ia,ib,ic are varies respected to the time.

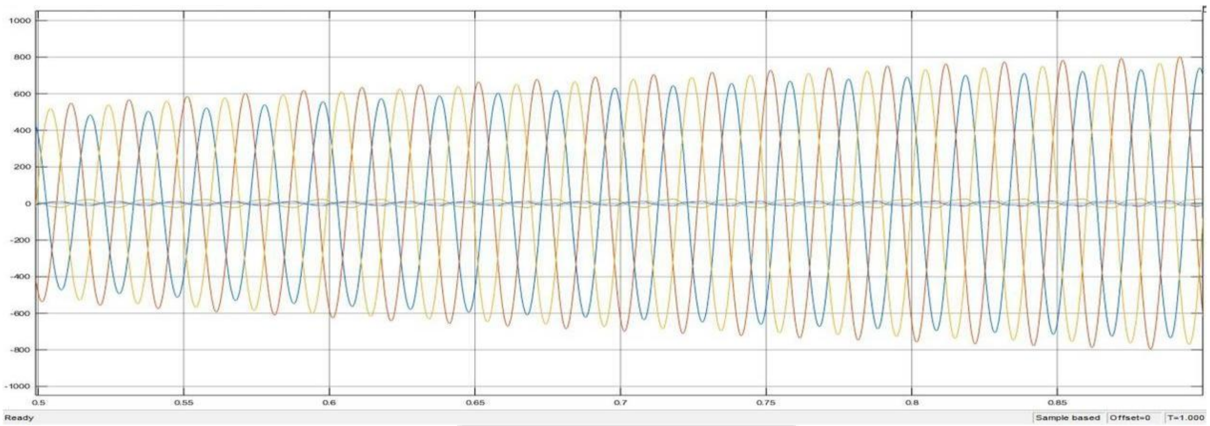

Figure 2 Input current &voltage of motor

2.2 Output Torque

Figure.3 Shows a output torque is directly proportional to the load and its varies with rotor speed and it varies to time.

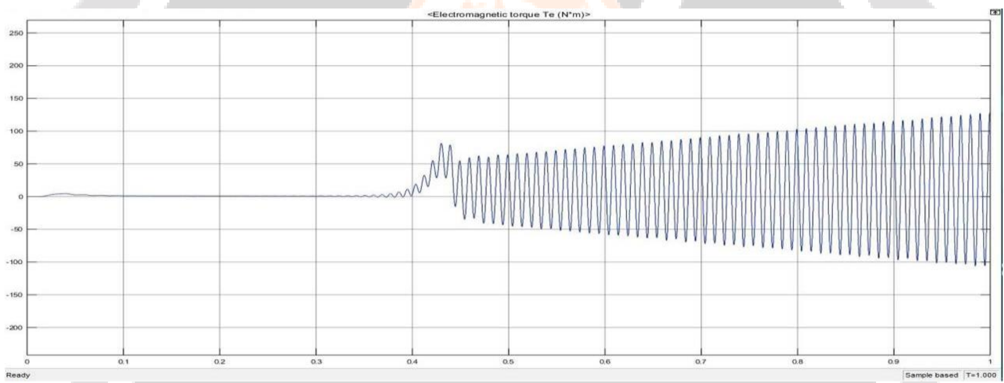

Figure 3 Output torque

2.3 OUTPUT SPEED

Figure 4 shows output speed measured by output power with respect to the load torque. When starting induction motor due to high starting current and torque, then speed decreased initially and gradually increased.

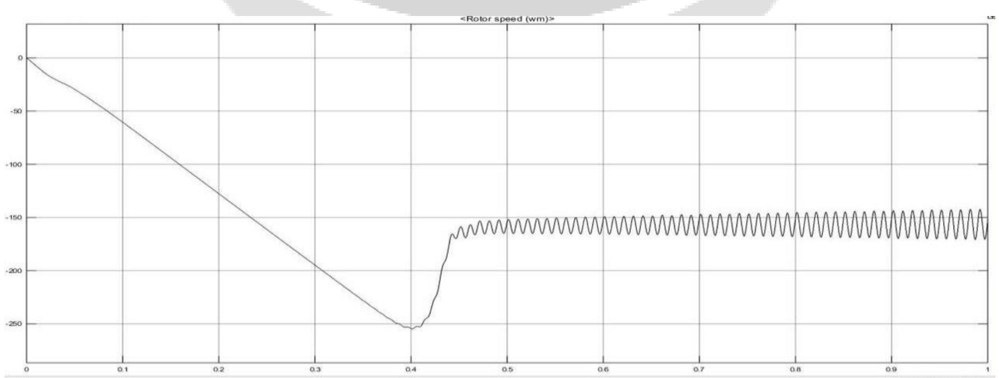

Figure 4 Output speed from simulation

3. HARDWARE IMPLEMENTATION

3.1 Hardwre Circuit Diagram Of Induction Motor Monitornig System

In Figure 5 describes about block diagram of proposed system .It consists of PT and CT on induction motor to measure voltage and current respectively to find input power , also it measures a torque and speed by using IR sensor and varies with current respectively to find the output power.

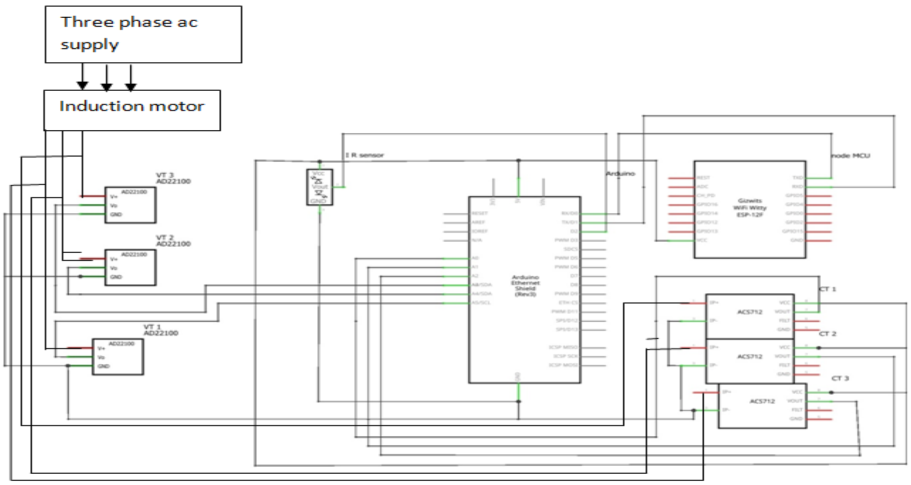

Figure 5 Hardware circuit diagram

4.3 Sensor

In the broadest definition, a sensor is a device, module, or subsystem whose purpose is to detect events or changes in its environment and send the information to other electronics, frequently a computer processor. A sensor is always used with other electronics, whether as simple as a light or as complex as a computer.

Sensors are used in everyday objects such as touch-sensitive elevator buttons (tactile sensor) and lamps which dim or brighten by touching the base, besides innumerable applications of which most people are never aware. With advances in micro machinery and easy-to-use microcontroller platforms, the uses of sensors have expanded beyond the traditional fields of temperature, pressure or flow measurement,[1] for example into MARG sensors. Moreover, analog sensors such as potentiometers and force-sensing resistors are still widely used. Applications include manufacturing and machinery, airplanes and aerospace, cars, medicine, robotics and many other aspects of our day-to-day life.

A sensor's sensitivity indicates how much the sensor's output changes when the input quantity being measured changes. For instance, if the mercury in a thermometer moves 1 cm when the temperature changes by 1 °C, the sensitivity is 1 cm/°C (it is basically the slope Dy/Dx assuming a linear characteristic). Some sensors can also affect what they measure; for instance, a room temperature thermometer inserted into a hot cup of liquid cools the liquid while the liquid heats the thermometer. Sensors are usually designed to have a small effect on what is measured; making the sensor smaller often improves this and may introduce other advantages. Technological progress allows more and more sensors to be manufactured on a microscopic scale as micro sensors using MEMS technology. In most cases, a micro sensor reaches a significantly higher speed and sensitivity compared with macroscopic approaches..

4.3.1 IR Sensor

A Figure 6 shows an infrared sensor is an electronic device, that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. These types of sensors measures only infrared radiation, rather than emitting it that is called as a passive IR sensor. If we make an analog IR sensor, then we will get an analog output in terms of voltage which can hold any value between 0 volts and the voltage that we have provided as Vcc.

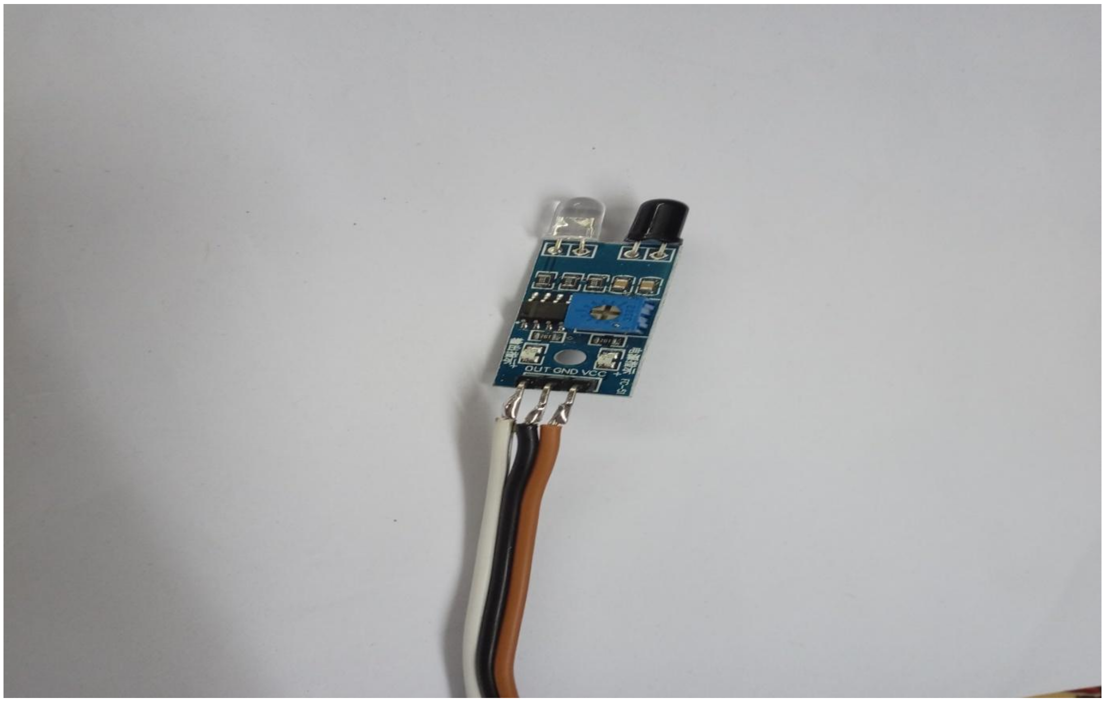

Figure 6 IR Sensor

Higher the intensity of the radiation falling on the photodiode, higher will be the output voltage.

4.4 CURRENT TRANSFORMER

Figure 7 shows a current transformer (CT) is a type of transformer that is used to measure alternating current (AC). It produces a current in its secondary which is proportional to the current in its primary.

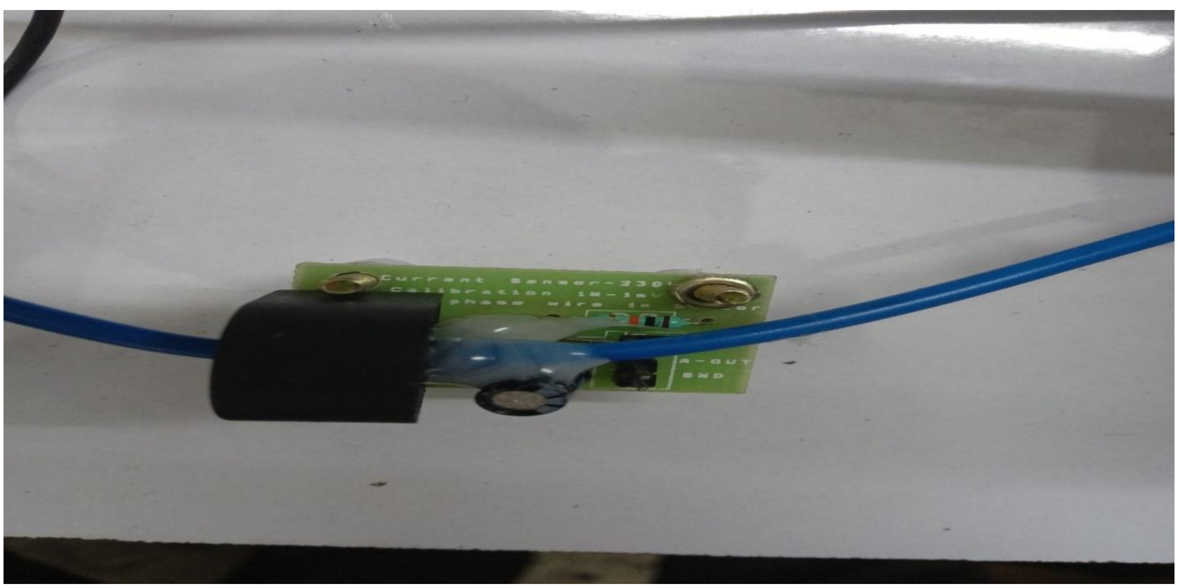

Figure 7 Current transformer

Current transformers, along with voltage or potential transformers, are instrument transformers. Instrument transformers scale the large values of voltage or current to small, standardized values that are easy to handle for instruments and protective relays. The instrument transformers isolate measurement or protection circuits from the high voltage of the primary system. A current transformer provides a secondary current that is accurately proportional to the current flowing in its primary. The current transformer presents a negligible load to the primary circuit. Current transformers are the current-sensing units of the power system and are **Current transformer** used at generating stations, electrical substations, and in industrial and commercial electric power distribution.

4.5 POTENTIAL TRANSFORMER

Voltage transformers (VT) Figure 8 describes about also called potential transformers (PT), are a parallel connected type of instrument transformer. They are designed to present negligible load to the supply being measured and have an accurate voltage ratio and phase relationship to enable accurate secondary connected metering.

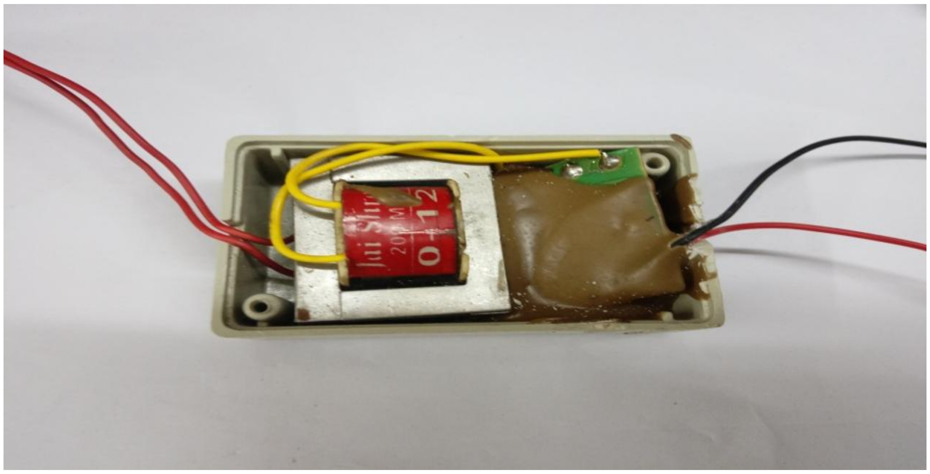

Figure 8 Potential transformer

4.6 HARDWARE SETUP OF INDUCTION MOTOR MONITORING

Figure 9 shows our hardware project implemented. It consists of three Potential transformers and three current transformers. An Ardiuno uno with node MCU hardware circuit is used data monitoring of induction motor and also manipulation of data. Voltage and current sensing circuit is involved in the hardware for sensing voltage and current of the induction motor. The IR sensor is used measure the speed and torque is calculated according to variation of current. The above values are know then we can calculate the power input and power output, so we can find the efficiency of motor and data is send to an internet using IoT we can monitoring the system.

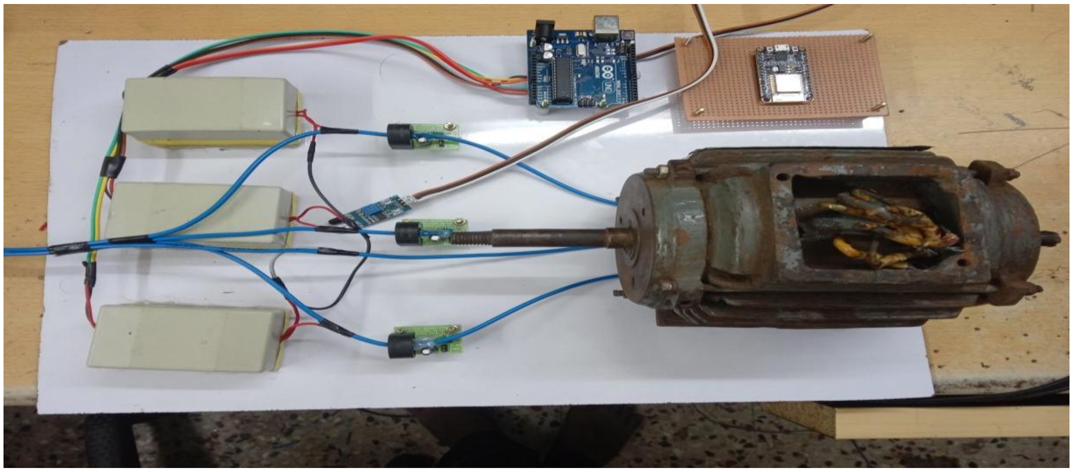

Figure 9 Snap shot

4.7 PRACTICAL CALCULATION

4.7.1 Efficiency Estimated

The motor efficiency can be estimated by the relation between the electrical power supplied to the motor (i.e., input power *P*in) and the mechanical power supplied to the shaft by the motor (i.e., output power *P*out), according to the following equation

η = Pout/Pin (4.1)

where,

Pin-input power

Pout- output power

4.7.2 Input Power

Pin of a three-phase induction motor can be calculated by the instantaneous currents and voltages, according to the following equation

$$pin = v_a i_a + v_b i_b + v_c i_c \quad (4.2)$$

Where,

i_a, i_b, i_c-currents in 3 phase,

v_a, v_b, v_c- voltage in 3 phase.

4.7.3 Output Power

Pout can be determined by the estimated shaft toque and the rotor speed as follows:

Pout = Tshaft*ωr (4.3)

Where,

Tshaft- torque in the shaft ,

ωr – rotor speed.

5. CONCLUSIONS

The system developed in this study has yielded successful results for production environments where there is little variation in the load on the motors. This learning method can be used for motor power ratings, Especially for 7/24 machines. This study has provided statistics not only for creating mathematical models but also for enabling the CMS operator to establish a motor maintenance schedule.

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