International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 08 | March -2023 Impact Factor: 7.185 ISSN: 2582-3930

IoT Based Condition Monitoring of Induction Motor

Mrs.A.P.Mali [1], Ms.S.S.Kumbhar[2] , Ms.S.S.Mane[3] ,Ms.P.N.Mali[4]

[1] Lecturer, E &TC Engg. & NMPI, Peth
[2]Lecturer, E &TC Engg. & NMPI, Peth
[3]Lecturer, E &TC Engg. & NMPI, Peth
[4] Student, Electrical Engg. & NMCE, Peth

Abstract - Condition monitoring is a desirable for increasing machinery availability, reducing consequential damage, and improving operational efficiency.Correct evaluation of faulty motor performance is very significant part of condition monitoring in modern supervision system of electrical motors.This paper deals with the monitoring of various parameters of three phase induction motor based on Internet of Things.The aim of this system is to prevent induction motor failure by implementing preventative actions. The information from the sensors is received by the Arduino, which processes the sensed data. If any aberrant value is detected, the relay generates a control signal to switch on or off the motor. The implementation of this scheme will increase the working efficiency of machine by continuously monitor to avoid breakdowns and also to determine the preventive maintenance.

***Key Words*:** Induction Motor, Arduino Nano, Parameters Monitoring, Internet of Things.

1. INTRODUCTION

Three phase induction motors are commonly used in the industry due to its robustness, simplicity of its construction and high reliability[1].Although induction motors are reliable, they are subjected to various types of failures [2].Faults and failures of induction motors can lead to excessive downtimes and generate large losses in terms of maintenance and lost revenues [3]. Induction motor fault detection and online monitoring have become important aspects to improve productivity and reduce maintenance cost. Monitoring of induction motor is a fast-emerging technology for the detection of initial faults. It avoids an unexpected failure of industrial process[4].

This paper represented IoT based induction motor monitoring parameters are as voltage, current, temperature, humidity and vibration based on sensor and cloud. By continuous monitoring the parameters maintain the continuity of production in industry. If there is any fault takes place in this motor it should be determined by a sensor senses parameter values of voltage, current, temperature, humidity and vibration and this sensed value of the sensor gives a signal to Arduino nano, then from the cloud gives command to the motor should automatically be disconnected from the system and it gives alert message in mobile after the fault has cleared for further future work. Induction motors are the workhorse of many industries. IM fault detection and online monitoring have become important aspects to improve productivity and reduce maintenance cost. The IM faults can be classified into two categories: mechanical faults and electrical defects. Mechanical faults include: bearing defects, air gap eccentricity, shaft misalignment; electrical faults encompass stator winding defect, broken rotor bars, etc. [5]. It is very important to diagnose faults in very beginning as sudden outages can cause economical losses and upset deadlines. If faults are not identified ina prior stage, it may become disastrous operation of motor. It can hamper the deadlines of the tasks.Generally, fault detection is accomplished either online or offline. Offline detection method needs interruption of machine operationswhile online detection method will not disturb the whole operation of motor and fault can be diagnosed promptly with precision[6].

2. LITERATURE REVIEW:

A computer- based system applying fuzzy logic in order to identify and estimate the condition of an induction motor has been given in [1]. An interface system of the fuzzy logic was created and was able to classify the motor as acceptable of the vibration ranges from 1.8mm/s to 4.5mm/s or monitor closely of the vibration ranges from 4.5mm/s to 7.1mm/s.

An analytical redundancy method using neural network modelling of the induction motor in vibration spectra is proposed in [2] for machine fault detection and diagnosis. The short time Fourier transform is used to process to quasi-steady vibration signals to continuous spectra for the neural network model training. The faults are detected from changes in the expectation of vibration spectra modelling error.

In [3] system deals with the problem occurred in the cooling system under different operating condition and analyse them. The online information is gathered from the machine about temperature, current and vibration signature at different operating condition and the condition of cooling system is monitored.

To complete online condition monitoring system designed in [4] to detect incipient broken rotor bar fault in double cage induction motor using the stator current signature. Breakage in outer bars of a DCIM is known to less prone to exhibit fault signature in the stator current than that of a single cage induction motor.

A spectrum synch technique is proposed in [5] for early induction motor defect detection using electric current signals. In bearing fault detection, the peakedness of the fault frequency components disturbed over several fault related local bands.

The design of an industrial data acquisition monitoring system using Arduino prototyping platform is presented in [6]. The prototype developed for experiment shows that data collection and monitoring system has features of being low cost, easy to use and wide range of application and has very important application for collection and monitoring data in industrial areas and laboratories.

A simple method for a single switch and double switch open circuit fault diagnosis in pulse width modulated voltage-source inverters for vector controller induction motor drives has been proposed in[7]. An open circuit fault of power switches introduces the repetitive current distortion, whose period is identical to that of three phase currents. The current distortion appears at faulty stages and disappear at healthy stages.

In [8] a method for protecting the machine from thermal overload is presented. Also, current based spectral analysis for rotor and rotating faults, as well as bearing faults is also presented. Each of these techniques are proved to provide condition and fault related information to the user without additional sensors.

An accurate modelling and analysis of rotor vibration in the machine are made in[9] using airgap flux simulation, and search coils are used for measuring the actual air gap flux. The characteristics changes caused by the motor vibration that occurs due to the eccentricity of the induction motor have studied. In the analysis, vibration changes were converted to air gap length changes to make model of induction motor using a finite element method.

An approach for identification of stator winding open circuit fault in induction motor based on d-axis versus q-axis current plot has been developed in[10]. The d-axis versus q-axis current plot is circular in nature during healthy condition of the motor and faulty condition, the plot reshaped to an ellipse with reference to x- axis changes with fault severity.

A scheme based on Hilbert transform and the interpolated Fast Fourier Transform(FFT) is proposed in[11]. The phase and amplitude fluctuations as the associated with the eccentricity harmonics is first demodulated by the Hilbert transform. IFFT is then performed to estimate the speed of induction motor running under constant speed and transient conditions.

In [12] use of fuzzy logic for fault detection and diagnosis in a pulse width modulation voltage source inverter induction, motor drive. The technique requires the measurement of the output inverter currents to detect intermittent loss of firing pulses in the inverter power switches.

In [13]the operating characteristics of a squirrel cage induction motor with a broken rotor bar, stator winding interturn fault has been developed by MCSA method. The experimental set to adjust the speed of induction motor with a permanent magnet synchronous generator connected to a load bank to confirm the fault characteristics of induction motor according to its slip cnditions are constructed.

Wireless monitoring system for three phase induction motor is realized using zig Bee protocol, has been developed in[14]. A low cost system for measuring the parameters of induction motor such as phase voltages, phase current, active power, reactive power, motor temperature with zig bee protocol connectivity is described.

The development of an intelligent diagnostic system for in d u ction machine health monitoring has been presented in[15]. The result of the developed intelligent algorithm for efficient and accurate identification of machine health are demonstrated. The system is tested with online data obtained from machine under test and result shows a good correlation with the machine conditions.

The application of a finite element method for predicting the performance of induction motor having electric and magnetic asymmetry of rotor cage due to some of broken rotor bars is presented in[16]. Quantities like magnetic vector potential, flux density, force components, rotor and stator currents, mutual and leakage inductance were determined very precisely.

3. OBJECTIVES:

1.. For safe and economic data communication in industry or any other fields, monitoring and controlling the operation of an induction motor depend on the internet of thing is to do.

2. By early fault detection, process interruption of the motor can be reduced, also reduced of the motor in an industrial process to a larger extent which makes motor should be more reliable.

2.To protect motor from overloading, over current, and high temperature.

3. To avoid system failures by start and stop the operation of an induction motor by automatic or manually control methods.

4. METHODOLOGY:

The block diagram shows five sensors for sensing the respective five parameters that are voltage, current, vibration, humidity and temperature. With the help of

sensor monitoring the condition parameters of motors and gives the current of induction motor to the Arduino nano, which it processes according to instruction. From Arduino nano through wi-fi, the module gives information to the cloud and information will received on Blynk web server whenever necessary. In case of any fault takes place in induction motor it should be automatically disconnected from the supply through relay contact. Whatever parameter is monitored that should be displayed on LCD one by one.

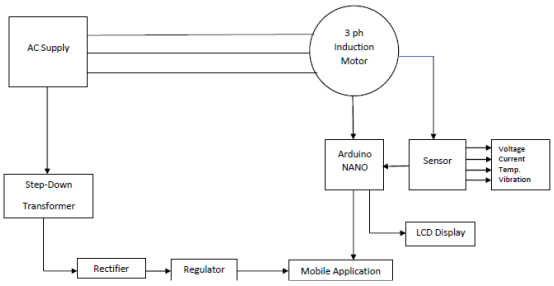

Fig1 Methodology used for Project

The block diagram represented the detailed view of the proposed system. It gives complete information about this proposed system.This diagram clarifies how the existing working system takes place and how the actual signals flows from one system to another and which are the main component used in this proposed system.In this project main control unit is an Arduino nano, for its operation required a 5V dc supply. Here for Arduino nano, get supply from stepdown transformer with rectifier and regulator for conversion and filter purposes used.

By anticipating motor health based on real time data, it improves operation efficiency, lowers maintenance cost, and prevent motor damage.

Fig.2 Current Sensor

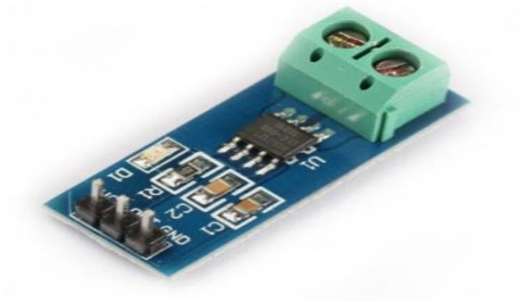

Fig.3 Current Sensor

4.1 DHT11

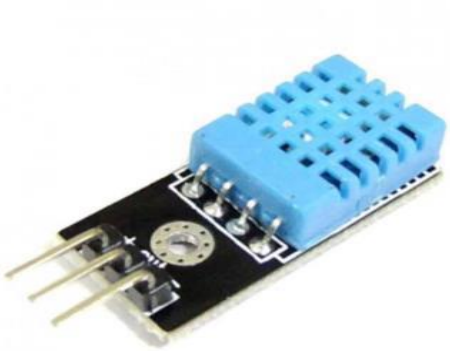

Fig. **DHT11**

The DHT11 sensor which has two primary elements for sensing temperature and humidity. An NTC sensor or thermistor is used to measure temperature. Thermistors are semiconductor materials that change resistance in response to temperature changes this allow us to determine the temperature of the surrounding. The DHT11 contains to electrodes for humidity measurement.The resistance between electrodes changes as the moisture level in our environment changes. The humidity of surroundings may be easily determined as a result of this shift.

4.2 Vibration Sensor-

Fig.4 Vibration Sensor

This module features and adjustable potentiometer, vibration sensor, and a LM 393 comparator chip to give an adjustable digital output based on amount of

vibration. The potentiometer can be adjusted to both increase and decrease the sensitivity to the desired amount. The module outputs a logic level high (VCC). When it is triggered and a low (GRD) when it isn't. additionally there is an on board LED that turns on when the module is triggered. many

4.3 Relay

Fig. 5 Relay

A 5 V relay is utilized in this project which is directly connected to the Arduino. The Arduino pulse signal is send to the relay. if the sensor data has an aberrant value, Arduino identifies it and sends a command to the relay a single pole single through relay was employed in this project. NO, NC, 5V, GND, and the common pin are the 5 pins on the relay. The relay does not require on additional power supply because Arduino supply adequate power. The relay operates on the electromagnet principal, which means that when power is applied to it and state of the switch is changed. The relay function as an electromagnet, controlling the device linked to it.

4.4 LCD

16*2 LCD is named so because, it has 16 column and 2 rows. There are a lot of combination available like 8*1, 8*2, 10*2, 16*1, etc. but the most used one is the 16*2 LCD and the same is used for our project. this is a basic 16 character by 2 line alpha numeric display. Black test on green background. Utilizes the extremely common HD 44780 parallel interface chipset. Interface code is freely available you will need minimum 6 general I/O pins to interface to this lcd screen. Includes LED backlight. Works in 4 bit and 8 bit mode.

Fig.6 LCD

4.5 ZMPT 101B

AC single phase voltage sensor module is based on a high precision ZMPT101B voltage transformer. ZMPT101B sensor is the best for the purpose of the DIY project, were we need to measure to accurate ac voltage with voltage transformer. This is an ideal choise to measure the AC voltage using Arduino. Onboard precision miniature voltage transformer, the active face AC output voltage transformer module. On board precision op-amp circuit, the signal sampling appropriate compensation for precise function.

4.6 ARDUINO –

Fig. 7 ZMPT 101B

Arduino NANO version 3 is the open source smallest embedded development board launched by Arduino based on AT mega 328 SMD package microcontroller. It is a surface mount green board friendly board integrated with mini USB port. DC power jack is not available on this board, so power can big even trough mini USB cable. It automatically sense and switch to the higher potential source of power, there is no need for the power select jumper.

4.7 IoT platform-

The central piece of the internet of things architecture is IoT platform which enables the connection between the real and virtual worlds hence providing communication between objects. The IoT platform used in this paper is thing speak which is analytic platform servicethat allows to visualize and analyse live data available in the

cloud and is operated by math works. It produces visualizations for the data uploaded by the devices to the platform instantly. Prototyping and proof of concept IoT system regularly uses think speak.

There are two parts of proposed system. The first is software, and the second hardware, for monitoring and controlling motors in normal and abnormal situations utilizing various sensors and IoT. Different defects are simulated in software section, such as over voltage, over current, over temperature and so on, and the results are observed. The data from various sensors is delivered to the controlling device, which is an Arduino nano, under the hardware section. The data processing program is programmed into Arduino nano.

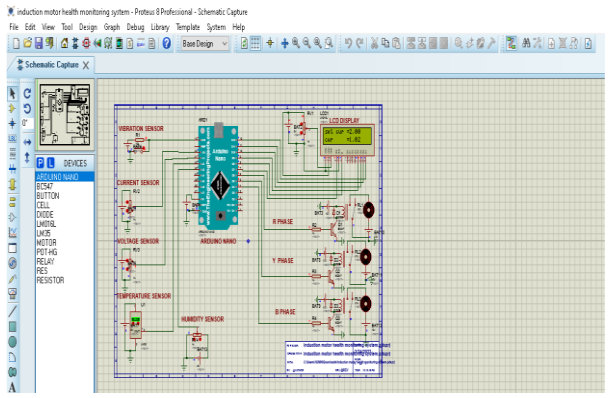

Fig.8 Output Result Window

CONCLUSIONS:

In case the motor gets over current, over voltage and excessive temperature than its rated value it will get automatically disconnected from the supply. With such a function, the critical failure of induction motor system can be avoided and the reliability and efficiency of the motor can be increased. By analysing the motor parameters make the motor to be operated in safe and protective in nature. With the help of this device, it is very easy to have the real time parameter of induction motor which will help us in various aspects leading to the growth of the industry and increase working efficiency of motor.

It is expected that this constructed system will able to help the personnel involve in machine to early detect the motor condition and do predictive maintenance. Monitoring and control of induction motor is very essential to increase reliability, maintaining performance condition monitoring means to monitor the real time data of machine. The operating efficiency of the machine will increase due to continuous monitoring. Also, the accurate health monitoring technique of the induction motor can improve the reliability and reduce the maintenance costs.

ACKNOWLEDGEMENT

We gratefully acknowledge the help & cooperation offered by Professor M.B.Joshi Principal, of our college and Management of NMPI,Peth for providing help and support to carry out the project.

REFERENCES

[1] J. B. Janier and M. Fazrin Zaim Zaharia, “Condition monitoring system for induction motor using fuzzy logic tool,” *Proc. - 1st Int. Conf. Informatics Comput. Intell. ICI 2011*, pp. 3–7, 2011, doi: 10.1109/ICI.2011.11.

[2] H. Su and K. T. Chong, “Induction machine condition monitoring using neural network modeling,” *IEEE Trans. Ind. Electron.*, vol. 54, no. 1, pp. 241–249, 2007, doi: 10.1109/TIE.2006.888786.

[3] D. K. Chaturvedi, M. S. Iqbal, and M. P. Singh, “Condition monitoring of induction motor,” *2015 Int. Conf. Recent Dev. Control. Autom. Power Eng. RDCAPE 2015*, pp. 135–140, 2015, doi: 10.1109/RDCAPE.2015.7281383.

[4] M. A. Hmida and A. Braham, “An On-Line Condition Monitoring System for Incipient Fault Detection in Double-Cage Induction Motor,” *IEEE Trans. Instrum. Meas.*, vol. 67, no. 8, pp. 1850–1858, 2018, doi: 10.1109/TIM.2018.2806009.

[5] D. Z. Li, W. Wang, S. Member, and F. Ismail, “Health Condition Monitoring,” vol. 30, no. 4, pp. 1348–1355, 2015.

[6]P. Sharma and S. R. Kapoor, “Evaluation of arduino based das for condition monitoring of induction motor,” *IEEE Int. Conf. Information, Commun. Instrum. Control. ICICIC 2017*, vol. 2018-Janua, pp. 1–4, 2018, doi: 10.1109/ICOMICON.2017.8279084.

[7] J. Zhang, J. Zhao, D. Zhou, and C. Huang, “High-performance fault diagnosis in PWM voltage-source inverters for vector-controlled induction motor drives,” *IEEE Trans. Power Electron.*, vol. 29, no. 11, pp. 6087–6099, 2014, doi: 10.1109/TPEL.2014.2301167.

[8] T. G. Habetler, R. G. Harley, R. M. Tallam, S. Bin Lee, R. Obaid, and J. Stack, “Complete current-based induction motor condition monitoring: Stator, rotor, bearings, and load,” *Int. Power Electron. Congr. - CIEP*, vol. 2002-Janua, pp. 3–8, 2002, doi: 10.1109/CIEP.2002.1216628

.[9] D. H. Hwang, K. C. Lee, J. H. Lee, D. S. Kang,

J. H. Lee, and K. H. Choi, "Analysis of a three phase induction motor under eccentricity condition," *IECON Proc. (Industrial Electron. Conf.*, vol. 2005, pp. 2609–2613, 2005, doi: 10.1109/IECON.2005.1569318.

[10] R. Chawla, B. Akhil Vinayak, and G. Jagadanand, "Modelling and Detection of Stator Incipient Open Circuit Fault in Three-Phase Induction Motor," *Proc. 2018 IEEE Int. Conf. Power Electron. Drives Energy Syst. PEDES 2018*, pp. 1–6, 2018, doi: 10.1109/PEDES.2018.8707681.

[11] D. Shi, P. J. Unsworth, and R. X. Gao, "Sensorless speed measurement of induction motor using Hilbert transform and interpolated fast Fourier transform," *IEEE Trans. Instrum. Meas.*, vol. 55, no. 1, pp. 290–299, 2006, doi: 10.1109/TIM.2005.860870.

[12] F. Zidani, D. Diallo, M. E. H. Benbouzid, and R. Naït-Saïd, "A fuzzy-based approach for the diagnosis of fault modes in a voltage-fed PWM inverter induction motor drive," *IEEE Trans. Ind. Electron.*, vol. 55, no. 2, pp. 586–593, 2008, doi: 10.1109/TIE.2007.911951.

[13] Y. S. Park, S. M. Jang, J. Y. Choi, and C. S. Goo, "Fault detection of squirrel cage induction motor by analyzing motor current signals," *2012 IEEE Veh. Power Propuls. Conf. VPPC 2012*, vol. 61, pp. 219–222, 2012, doi: 10.1109/VPPC.2012.6422532.

[14] R. R. Patil, T. N. Date, and B. E. Kushare, "ZigBee based parameters monitoring system for induction motor," *2014 IEEE Students' Conf. Electr. Electron. Comput. Sci. SCEECS 2014*, 2014, doi: 10.1109/SCEECS.2014.6804469.

[15] G. K. Singh and S. Ahmed Saleh Al Kazzaz, "Development of an Intelligent Diagnostic System for Induction Machine Health Monitoring," *IEEE Syst. J.*, vol. 2, no. 2, pp. 273–288, 2008, doi: 10.1109/JSYST.2008.924129.

[16] R. Fišer and S. Ferkolj, "Application of a finite element method to predict damaged induction motor performance," *IEEE Trans. Magn.*, vol. 37, no. 5 I, pp. 3635–3639, 2001, doi: 10.1109/20.952679.