Comparison of Different Induction Motor Monitoring Methods using IoT

Prof. Ashish R. Polke[1], Prof. Prasanna P. Titarmare[2], Prof. Priyanka Gaurkhede[3], Prof. Rahul D. Dekate[4], Nikhil Patil[5], Saumitra Kamethi[6],Akash Gajbhiye[7], Lucky Rane[8]
[1234]*Assistant Professor, SCET, Nagpur,*
[5678]*Student, SCET, Nagpur*

***Abstract*-- This study will give an overview of the literature on how to use the Internet of Things (IoT) to monitor and manage induction motors in a wide range of applications, including electric vehicles, industries, and agriculture. The review compares and contrasts variety of approaches to IoT based management and surveillance of induction motors. Induction motors have a significant advantage in terms of construction endurance and simplicity. It can function in any setting and is relatively affordable. as Temperature, vibrations, external moisture RPM, induction machine load current and voltage are all monitored by the transducer modules and sensors, which are then sent to the processing unit for analysis so that necessary actions can be taken, especially in abnormal conditions, to improve reliability and efficiency. Checks and presents options.**

***Index Terms*-- Induction Motor, Internet of Things (IoT), Ardunio, Vibration,Temperature.**

I. INTRODUCTION

DC motors have been widely used in a variety of industrial applications as electrical technology has progressed, Due to the sheer numerous advantages of induction motors, the outlook of industry has shifted since the advent of ac motors, particularly ac induction motors. The stationary and spinning sections of an induction motor are the two primary components. Mutual induction connects two pieces, which is the transformer principle. A spinning transformer is a type of induction. The main advantages of three phase induction motors are selfstarting, sturdy design, high power factor, and low cost, however the speed cannot be regulated without sacrificing efficiency. The various faults that can occur in an induction motor are:

Electrical faults involve unbalanced supply voltage or current, under or over voltage and current, overloading, single phasing etc.

Mechanical faults involve stator and rotor winding failure, bearing damage, broken rotor bar, mass unbalance, air gap eccentricity etc.

Environmental related faults involve ambient temperature, external moisture and Vibrations of machine

To achieve reliable, flexible, fault less and economical operation of the Induction Motor, continuous watching of the higher than factors is important in any field of application

To achieve this, IOT primarily based watching systems were planned by several authors. IOT is that the network of physical devices that connects and allows exchange of knowledge through these devices, the most purpose of IOT is to scale back intervention and supply pc primarily based automation. The IOT system includes of Sensors, actuators, GSM, Wifi, process unit etc. A comparison of IOT and conventional induction motor monitoring methods in many areas is mentioned in the next section listed below.

II. CLASSIC CONTROL

The power offer is turned on and is receiving the desired power for the Arduino and every one interface parts. The sensing element block determines the relevant motor parameters and sends them to the Arduino. The Arduino reads information from numerous sensors, analyzes it in step with the given directions, and so sends the knowledge from the sensors via Wi-Fi to the digital display and also the network entranceway. In parallel, the Arduino reads commands from the net and also the sends an effect signal to the relay through a contactor that controls the induction motor sensing element info is displayed visually on the server management of asynchronous motors is predicated on measured parameters whereas in manual mode management is predicated on warning messages received from the network. The management is finished by relay and contactor circuit. The motor is flip ON/OFF once abnormal price is detected.

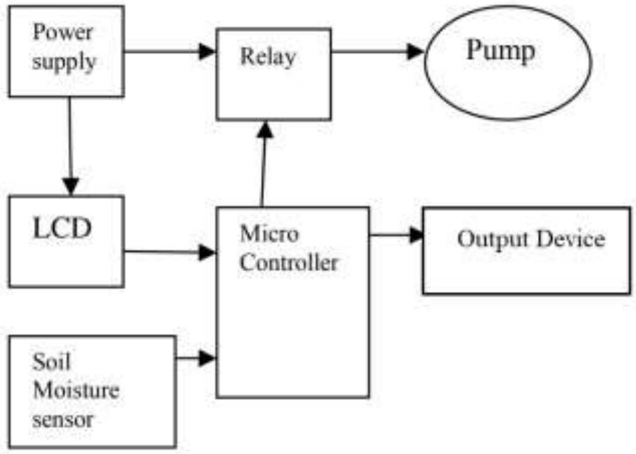

Fig. 1. Classic Control Strategy

III. PLC SCADA

To get reliable operation of VFD, observance of the drive is as necessary as management. Planned a IOT primarily based observance and management of Induction Motor mistreatment PLC(Programmable Logic management) and SCADA (Supervisory Control and knowledge Acquisition). PLC consists of I/O points for interfacing the electrical signals and might be simply programmed for sensing, dominant and activating the economic instrumentality. SCADA systems square measure crucial for industrial organizations since they assist to take care of potency, method knowledge for smarter choices, and communicate system problems to assist mitigate time period. PLC will be used for numerous forms of speed management ways by programming it as per the management technique.

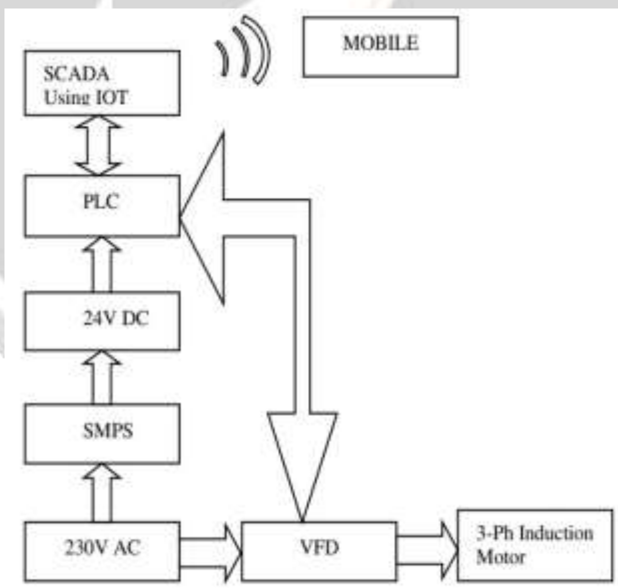

Fig. 2. Plc Scada Strategy

The VFD acts as negotiator between Induction Motor and PLC. VFD takes input from the PLC and processes the info and offers its out place to the Induction Motor once process the info received. Then VFD controls and adjusts the position of the rotor in Induction Motor. To run the SCADA ladder logic program, Indu Soft computer code is employed and it permits the operator to regulate and monitor the Motor from any wherever and satisfactory results were obtained by testing a zero.75KW 3ph Induction Motor with conveyer belt load[15]. however the SCADA systems suffer from the drawbacks of high price, increase of complexness with system complexness and wish of trained workforce.

IV. PIC

Most industries prefer automated monitoring using remote or computer controlled devices. A block diagram for monitoring the health of an industrial engine using IOT is shown in Figure 5. 1. The sensor detects the parameters and is analyzed by the microcontroller (Aurdino UNO board) according to the instructions. Now this data is sent to the node MCU and we have a monitor to display it. Data available on the NODE MCU is uploaded to the cloud platform (Thingspeak). In general, gateways can be implemented as hardware or software, or a combination of the two.

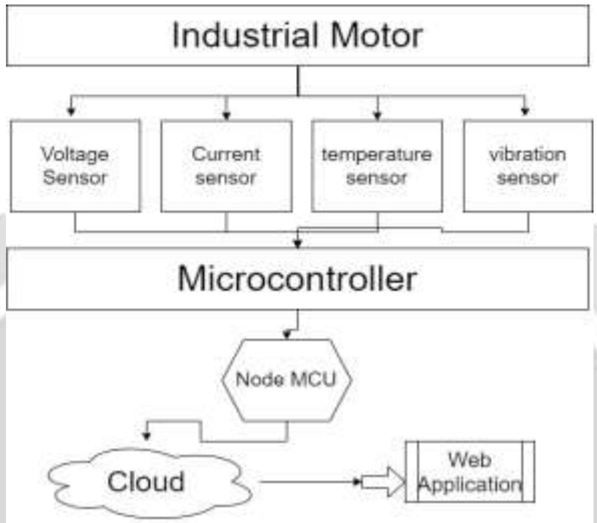

Fig. 3. PIC Strategy

V. RESEARCH METHODOLOGY

In this modern age, induction motors (IM) are widely used in industry, automotive, aerospace, military, medical, and domestic equipment and appliances because of their low costs, robustness, high power, and low maintenance [1]. The bulk of the electric power that is being consumed globally, is by single-phase induction motors (SPIMs) driving either a fan, pump, or compressor type of load, including their applications in heating, ventilating, and air conditioning [2]. Traditionally, motor-driven systems run at a nearly constant speed and are usually designed to provide a load margin of 20–30% over the full load value for a long duration. A significant portion of the input energy is wasted for controlling their outputs to meet the variable load demands where the power drawn from the utility remains essentially the same as at full load. This energy loss can be avoided by driving the motors at a speed that results in the desired regulated outputs. The input power decreases as the speed is decreased. This decrease can be estimated by recognizing that in induction motor,

$$\text{Torque} \approx k_1(\text{speed})^2 \quad (1)$$

and therefore, the power required by the motor-driven system is,

$$\text{Power} \approx k_2(\text{speed})^3 \quad (2)$$

where k1 and k2 are the constants of proportionality.

If the motor efficiencies can be assumed to be constant as their speed and loadings change, then the input power required by the induction motor would also vary as the speed cubed. Thus instead of constant speed operation of induction motors the variable speed driven system can result in significant energy conservation. Several methods exist for the variable speed operation of a single-phase induction motor. Considering simplicity and low cost, the most common type is the control of applied voltage to the motor. Also, bidirectional rotation control is important in various applications, like a conveyor belt, exhaust fan, etc. By reversing the direction of rotation, the same motor can be used as a water feed pump and smoke exhauster in a boiler.

Present-day industries are increasingly being shifted towards automation. As the internet has become widespread today, remote accessing, monitoring, and controlling of systems are possible [3]. With rapidly increasing

IoT (Internet of Things) technology the network of physical objects or things that are interconnected with electronics can be communicating with each other and be managed by computers. IoT has provided a promising way to build powerful industrial automation by using wireless devices, sensors, and web-based intelligent operations. For web-based solutions for controlling and monitoring single-phase induction motors (SPIM), diverse research, design, and implementations have been performed. In the authors proposed schemes to observe IM parameters using the ZigBee protocol. But because of the low data speed and high cost of ZigBee, the proposed systems are not suitable to cover a longer distance. P.S. Joshi et al. have proposed wireless speed control of IMs using GSM, Bluetooth, and Wi-Fi technology which has a low range of communication features as compared to IoT. In IoT based IM monitoring system is developed based on analyzing sensor data collected from local and cloud servers, Wi-Fi enabled Raspberry Pi and a web application. For predictive maintenance of motors to avoid delayed interruptions in the production, an IoT based Induction Motor monitoring scheme is proposed using ARM-Cortex in . The authors in have proposed an IoT based Induction Motor controlling and monitoring using PLC and SCADA. But the system is costly, complex, and requires trained manpower. Authors in implemented wireless sensor networks based on IoT and Bluetooth Low Energy to monitor and control the speed, torque, and safety of SPIM. In three separate SPIM or one three-phase induction motor is controlled (ON/OFF) simultaneously according to voltage and current data collection through the internet embedded with an Ethernet board. The majority of web-based implementations has been for monitoring and speed control of induction motors. While bidirectional rotation of motors has not been widely investigated.

This paper addresses this gap by providing a simple web-based communication solution for bidirectional speed control and monitoring of multiple single-phase induction motors. The speed control of the induction motors has been performed by the stator voltage control method using the pulse width modulation (PWM) technique. The direction of rotation of the motor has been changed by reversing the stator magnetic field by swapping the connection of auxiliary stator winding with simple, low cost relay switching. The parameters of the prototype design are observed in LCD by a microcontroller and shared to remote computer/mobile using IoT through GPRS which makes the system flexible and user friendly.

VI. Raspberry Pi

The above system consists of various sensors and a wifi enabled Raspberry pi3. A web Application need to be developed for continuous monitoring of parameters. Once any abnormality is detected, an alert will be received on the webpage and based on the abnormality the necessary action can be taken. The data collected from the sensors is sent to local and cloud servers for analysis. The working of the architecture is described with the help of flowchart shown in Fig. 3. The data received by the nodes will be stored and graphically using Visual Basic Application. In [4], a hardware model is developed using a 1/8Hp Motor and the following analysis were carried out.

i. Temperature analysis

ii. Current consumption analysis (with or without load)

iii. Vibration analysis (with and without speed control)

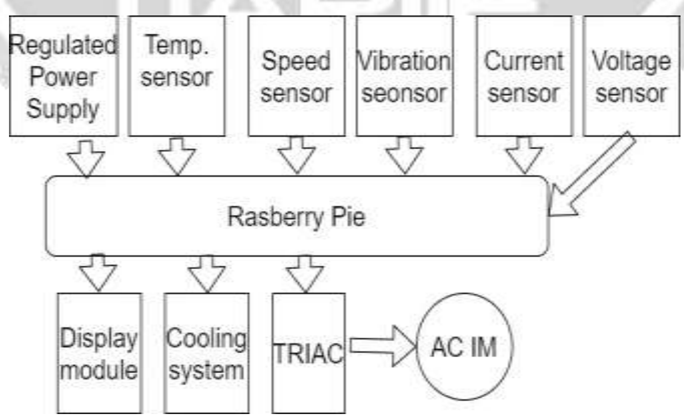

Fig. 4. Raspberry Pi Strategy

VII. Comparison Table

The comparison is made between the various strategies discussed above. The conclusion can be made by making the comparison based on various aspects which defines the working of the strategies.

The following table shows the comparison.

	Classic Control	PLC-SCADA	PIC	Rasberry Pie	IoT
Development Cost	Low	Low	Moderate	Low	Low
Physical Structure	Big	Small	Small	Small	Very Small
Production Planning	N/A	Very Easy	Very Easy	Very Easy	Very Easy
Resistance To The Work Environment	Low	High	Additional Security	High	Very High
Finding Fault	Difficult	very Easy	very Easy	Very Easy	Very Easy
Communication	N/A	very Easy	Very Easy	Very Easy	Very Easy
Monitoring Data	N/A	Very Easy	Very Easy	Moderate	High
Security	Low hi	High	Moderate	Very High	Very High
Renewal Opportunities	N/A	Easy	Moderate	Very Easy	Very Easy
Adding Modular System	N/A	Possible	Additional Design	Possible	Possible
COST	Low	High	High	Low	Low

Table 1. Comparison of Strategies

VIII. Conclusion

In this study, a parametric observation system for IoT-enabled induction motors is implemented and tested successfully. The developed system can perform operations such as running the engine, stopping the engine, measuring and observing the main engine parameters such as temperature, speed. All of these values can be transferred to the IoT platform, displayed on the interface, plotted, transferred to an relevance overflow file to store them for long-term observation, the values The fundamental value of induction motors has been realized and implemented in other ways. . A comparison of the positive and negative aspects and its value has been made. The comparison of IoT with alternative mainstream systems is shown in Table 3. The system developed during this research has been tested experimentally and it has been found that the system works without errors and its additional performance compared to similar systems. Throughout the experimental tests, no inconvenience was found, either communicating with the IoT platform or integrating the hardware units used to dominate and observe the induction motor. The developed system can be used not only for industrial applications but also for educational purposes; this suggests that the system as a whole is also useful for secondary schools with vocational, technical and industrial training. Instructors will use the given system as a teaching aid and it can be successfully adapted in experimental research.

IX. Project Image

X. References

[1] Mr. R. Deekshath, Ms. P. Dharanya, Ms. K. R.Dimpil Kabadia & Mr. G. Deepak Dinakaran "IoT Based Environmental Monitoring System using Arduino UNO and Thingspeak", IJSTE - International Journal of Science Technology & Engineering | ISSN (online): 2349-784X | Volume 4 | Issue 9 | March 2018

[2] Sharmad Pasha, "Thingspeak Based Sensing and Monitoring System for IoT with Matlab Analysis" International Journal of New Technology and Research (IJNTR) | ISSN: 2454-4116 | Volume-2, Issue-6 | PP 19-23 | June 2016

[3] S. S. Darbastwar, S. C. Sagare, V. G. Khetade "IoT Based Environmental Factor Sensing and Monitoring System over Wireless Sensor Networks." International Journal of Advanced Research in Computer Science and Software Engineering Research Paper | ISSN: 2277 128X| Volume 6 | Issue 12 | December 2016

[4] B. Lu, T. G. Habetler, and R. G. Harley, "A nonintrusive and in-service motor-efficiency estimation method using air-gap torque with considerationsof condition monitoring" IEEE Trans. Ind. Appl | vol. 44 | pp. 1666–1674 | Nov./Dec. 2008.

[5] J. Pedro Amaro_†, Fernando J.T.E. Ferreira, "low cost wireless sensor for in field monitoring of induction motor" IEEE Trans. Ind. Appl. | vol. 44, no. 6 | pp. 1666–1674 | Nov. /Dec. 2010.

[6] Soualhi et al. Fault detection and diagnosis of induction motors based on hidden Markov model. Electrical Machines (ICEM), 2012 XXth International Conference on. IEEE, 2012.

[7] L. Hou, N. W. Bergmann. Novel industrial wireless sensor networks for machine condition monitoring and fault diagnosis. IEEE Transactions on Instrumentation and Measurement 61.10 (2012): 2787-2798.

[8] M. R. Mikhov et al. An application of wireless standards for remote monitoring of electric drive systems. International Journal of Engineering Research and Development 2.12 (2012): 30-36.

[9] M. J. Picazo-Rodenas, R. Royo, J. Antonino-Daviu, and J. Roger-Folch, "Energy balance and heating curves of electric motors based on Infrared Thermography," 2011 IEEE Int. Symp. Ind. Electron. pp. 591–596, 2011.

[10] A. Medoued, A. Metatla, A. Boukadoum, T. Bahi, and I. Hadjadj, "Condition monitoring and diagnosis of faults in the electric induction motor," Am. J. Appl. Sci., vol. 6, no. 6, pp. 1133–1138, 2009.

[11] J. Ilonen, J. K. Kamarainen, T. Lindh, J. Ahola, H. Kälviäinen, and J. Partanen, "Diagnosis tool for motor condition monitoring," IEEE Trans. Ind. Appl., vol. 41, no. 4, pp. 963–971, 2005.

[12] O. Thorsen, M. Dalva, "Failure identification and analysis for high voltage induction motors in the petrochemical industry" IEEE Trans. Ind. Appl. 35(4), 810-818, 1999.

[13] G. K. Yamamoto, C. da Costa, and J. S. da Silva Sousa, "A smart experimental setup for vibration measurement and imbalance fault detection in rotating machinery," Case Stud. Mech. Syst. Signal Process. vol. 4, pp. 8–18, 2016.

[14] Stone G. C. Boulter E. A. , Culbert I., Dhirani H. " Electrical insulation for rotating machine, design, evalution, aging, testing and repair " Wiley -IEEE Press New York 2004.

[15] Pilloni et al. Fault detection in induction motors. AC electric motors control: Advanced Design Techniques andApplications (2013): 275-309.

[16] M. Seera et al. Fault detection and diagnosis of induction motors using motor current signature analysis and a hybrid FMM–CART model. IEEE Transactions on Neural Networks and Learning Systems 23.1 (2012): 97-108.

[17] E. T. Esfahani, S. Wang, V. Sundararajan. Multisensor wireless system for eccentricity and bearing fault detection in induction motors. IEEE/ASME Transactions on Mechatronics 19.3 (2014): 818-826.