Prototype Health Monitoring of Induction Motor Using IOT

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Abstract - By this study, a induction motor can be monitored with wireless TCP/IP protocol in order to detect pre fault without occurring any fault in the induction motor. And the motor will perform smoothly without any disruption. By this method production process will not be affected and required maintenance or replacement can be performed without any least possible disturbance. In this study I have worked on the speed of motor, current drawn by motor and winding temperature. For this study various kind of sensors were used along with esp32 microcontroller. All sensors were interfaced with esp32 microcontroller and programming part was done on Arduino IDE software. All sensed real time data went to the microcontroller and then Python software was used to tabulate the sensed values verses real time. And with the help of table, graphs can be drawn using AWS (Amazon Web Service). This study will help in making predictive maintenance model for induction motor.

Keywords - IOT Based pre-fault monitoring of induction motor, motor parameters.

I. INTRODUCTION

In Industries, mechanical and electromechanical systems are driven by electric motors on the premises. The drivers of these motors are mostly on motor control – Open loop controls or Closed loop controls. These prime movers are the most important / Critical for any operations in Industry. In Industry, any failure of the prime movers affects the most. Availability or Healthiness of the motor is always a big question. The planned maintenance is being done in some of the organized industry. Rest of the SMES do not maintain regularly for reliable operations of these motors because of non-availability of skilled manpower and irregularity of the business. Sometimes the Techno- economic feasibility of such SMES does not work out because of the competitive markets. Whereas, with the advent of Technology and better work outs, proper scheduling of maintenance and production is possible now a days. Now the industry has started looking into planned maintenance, Preventive Maintenance, Predictive maintenance, Condition Monitoring, even Maintenance prevention has come into place. After going through the era of Preventive and Planned shut downs, we started looking for on-line condition monitoring to plan for planned, predictive and preventive maintenance. Hence motor maintenance has become very handy. This is a further advancement of technology called **IOT Based System for On Line Motor Health Monitoring.**

In this system the winding temperature, current drawn by motor and rpm speed of the induction motors were monitored using TCP/IP protocol via Wi-Fi. By using the existing Internet network, these parameters were read and transferred to the computer without the need for additional wiring. The computer collected the parameters of all the motors with help of sensors and microcontroller and determines the necessary maintenance schedules.

In this study, I have used 3 types of sensors which are: proximity inductive sensor to measure the speed of the motor, PT100 sensor to measure the winding temperature and ACS 712 Hall Based Liner Current Sensor to measure the current drawn by the motor. Along with all these sensors i have used one esp32 microcontroller, one breadboard for doing common connections, one 9V battery, Arduino IDE software, Python programming language and various resisters. All sensors were interfaced with esp32 on breadboard and sensed analog signals from various parts of motor and esp32 converted all signals into digital signals using programming on Arduino IDE and python module was used to tabulate the real time data and all collected data stores on cloud and using a hosting service for e.g. AWS (Amazon Web Service) hosting it can be displayed as a graph on a simple html web page.

II. PROPOSED WORK

This system has two sections. First one is hardware section and second is software section. All used equipments are in hardware section and all used software like python and arduino IDE are in software section. Both sections have equal importance in this project. So let's discuss each and every section one by one.

A) HARDWARE SECTION

PT100, Proximity inductive sensor, ACS712 current sensor, Bread board, ESP32 microcontroller, 9V solar cell were used along with 30kΩ and 150Ω registers.

a) PT100 Temperature Sensor

PT100 temperature works as a variable resister and resistance of this sensor varies according to the surrounding environment temperature. The used sensor has two pins. One pin is one end of the variable resister and other pin has other end of the variable resisters. This is also called Platinum Resistance Thermometer (PRT). Its sensing range is -200^{0}C to 850^{0}C. Its resistance range is 1.8k to 39kΩ .Accuracy of PT100 is ±0.1^{0}C. Normal resistance of PT100 is 100Ω at 0^{0}C. These sensors work according to the surrounding temperature. As surrounding temperature changes the variable resistance of sensor also changes. So we need to build a small circuit which can measure the voltage across it. It can be made simple circuit as potential divider or can be made complex as Wheatstone bridge with instrumentation amplifier. And design of the circuit will depend on our accuracy of the output. So let's look upon the interfacing of the two wire pt100 with microcontroller using simple potential divider circuit.

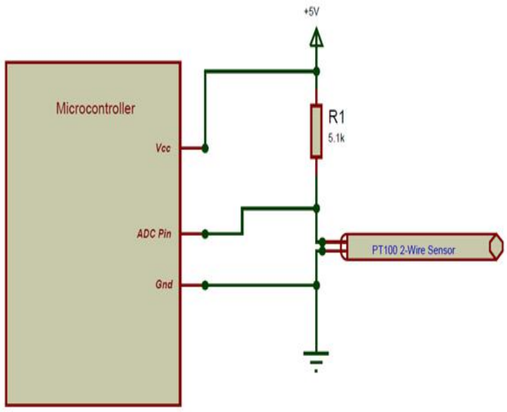
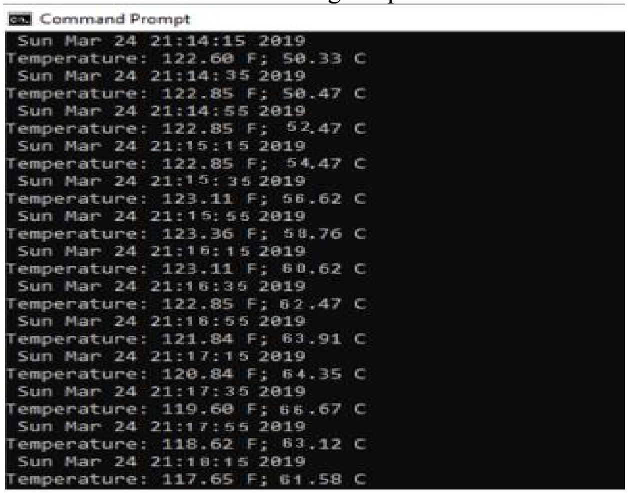


fig1. Interfacing of PT100 temperature sensor with ESP32 microcontroller.

I have designed this circuit by assuming the fixed resistance of 1.8k to 39kΩ. So I have to convert this variable resistance to a voltage value of 0 to 5V so that microcontroller can understand it. PT100 can measure high range temperatures with a decent accuracy.

Measured output result of the PT100:

This result was formed by programming of python language and it is showing the real time data which was sensed by the sensor in real time. By using this data we can monitor the winding temperature of the motor.



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Command Prompt
 Sun Mar 24 21:14:15 2019
Temperature: 122.60 F; 50.33 C
 Sun Mar 24 21:14:35 2019
Temperature: 122.85 F; 50.47 C
 Sun Mar 24 21:14:55 2019
Temperature: 122.85 F; 52.47 C
 Sun Mar 24 21:15:15 2019
Temperature: 122.85 F; 54.47 C
 Sun Mar 24 21:15:35 2019
Temperature: 123.11 F; 56.62 C
 Sun Mar 24 21:15:55 2019
Temperature: 123.36 F; 58.76 C
 Sun Mar 24 21:16:15 2019
Temperature: 123.11 F; 60.62 C
 Sun Mar 24 21:16:35 2019
Temperature: 122.85 F; 62.47 C
 Sun Mar 24 21:16:55 2019
Temperature: 121.84 F; 63.91 C
 Sun Mar 24 21:17:15 2019
Temperature: 120.84 F; 64.35 C
 Sun Mar 24 21:17:35 2019
Temperature: 119.60 F; 66.67 C
 Sun Mar 24 21:17:55 2019
Temperature: 118.62 F; 63.12 C
 Sun Mar 24 21:18:15 2019
Temperature: 117.65 F; 61.58 C
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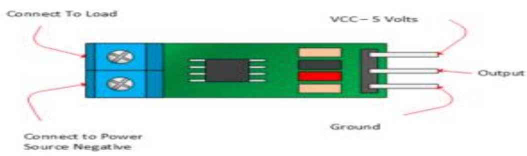
b) ACS712 Hall Effect- Based Liner Current Sensor:

ACS712 current sensor was used to measure AC and DC current upto20A in industrial and commercial systems. The device consists of a precise, low-offset, linear Hall sensor circuit with a copper conduction path located near the surface of the die. Applied current flowing through this copper conduction path generates a magnetic field which is sensed by the integrated Hall IC and converted into a proportional voltage. Device accuracy is optimized through the close proximity of the magnetic signal to the Hall transducer. It operates on 5V supply and output analog voltage proportional to current measured on the sensing terminals. And we can use microcontroller to convert analog into digital values. It has low-noise analog signal path. Total output error of this device is 1.5% at $T_A = 25^0$C. It has a internal conductor resistance whose value is 1.2mΩ. Its output sensitivity is 66 to 185 mV/A. Output voltage is proportional to AC or DC currents.



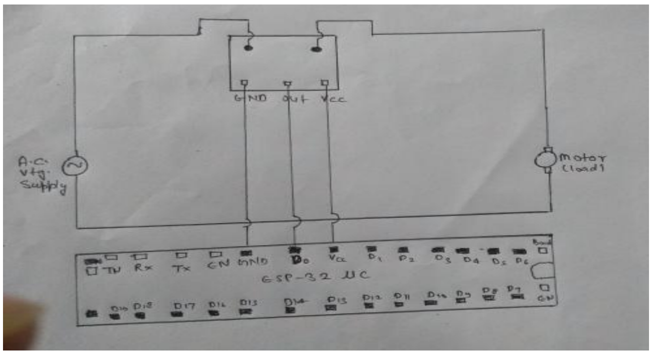
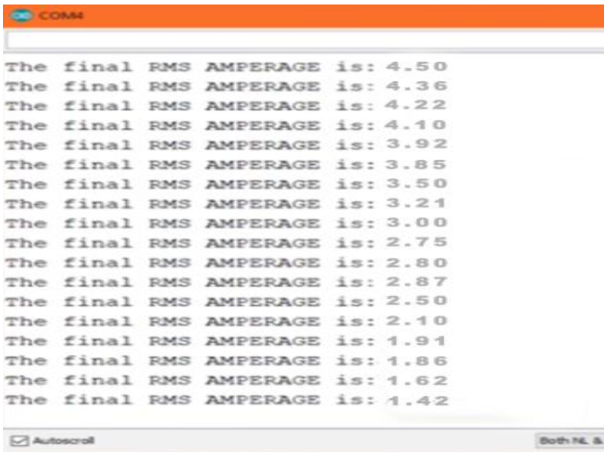


Fig.2. Interfacing of ACS712 current sensor with ESP 32 Microcontroller.

In my project I have used 20A module which was interfaced with esp32 microcontroller which was programmed on Arduino IDE software and the measured output data was obtained in real time data form by using python language.

Measured output results of the ACS712 Current Sensor:


COM4

The final RMS AMPERAGE is: 4.50
The final RMS AMPERAGE is: 4.36
The final RMS AMPERAGE is: 4.22
The final RMS AMPERAGE is: 4.10
The final RMS AMPERAGE is: 3.92
The final RMS AMPERAGE is: 3.85
The final RMS AMPERAGE is: 3.50
The final RMS AMPERAGE is: 3.21
The final RMS AMPERAGE is: 3.00
The final RMS AMPERAGE is: 2.75
The final RMS AMPERAGE is: 2.80
The final RMS AMPERAGE is: 2.87
The final RMS AMPERAGE is: 2.50
The final RMS AMPERAGE is: 2.10
The final RMS AMPERAGE is: 1.91
The final RMS AMPERAGE is: 1.86
The final RMS AMPERAGE is: 1.62
The final RMS AMPERAGE is: 1.42

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c) Proximity Inductive Sensor

The inductive sensor is based on Faraday's Law of Induction. Induction is the phenomenon. Where a fluctuating current, which is by definition, has a magnetic component, induces an electromotive force (emf) in a target object. To amplify a device's inductance effect, a sensor manufacturer twists wire into a tight coil and runs a current through it. An inductive proximity sensor has four components; the coil, oscillator, detection circuit and output circuit. The oscillator generates a fluctuating magnetic field the shape of a doughnut around the winding of the coil that locates in the device's sensing face. When a metal object moves into the inductive proximity sensor's field of detection, Eddy circuits build up in the metallic object, magnetically push back, and finally reduce the Inductive sensor's own oscillation field. The sensor's detection circuit monitors the oscillator's strength and triggers an output from the output circuitry when the oscillator becomes reduced to a sufficient level. It is a non contact proximity sensor. It is used for detecting the metal object. Iron and steel has a longer sensing distance whereas aluminium and copper has lower sensing distance.

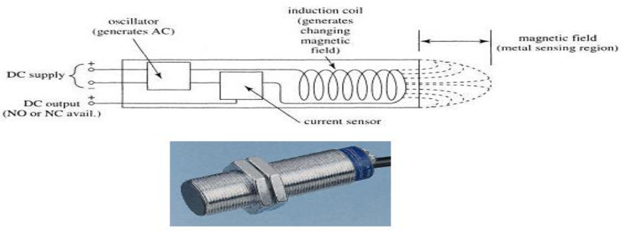


Fig.3. Proximity inductive sensor

I have used this sensor for measuring the speed of the motor. As this sensor detect only the metal surface. So I fixed a thin metal rod on the running rotor shaft of the motor and counted the number of detection of the rod in a minute. That number of detection of rod is called number of oscillation (frequency) in a minute. And by using Ш= 2Пf this formula we can calculate the rpm speed of the motor.

Measured Output Results of Proximity Inductive Sensor:

B) Software Section

I have used two types of software in my project first one is Arduino IDE and second one is Python. The Arduino Integrated Development Environment (IDE) which is written in the Java programming language. It is used to write and upload programs to Arduino compatible boards. It supports the languages C and C++ using special rules of coding structuring. Python software is used to tabulate the real time data of the sensors by python programming.

III. PHILOSOPY OF OPERATION

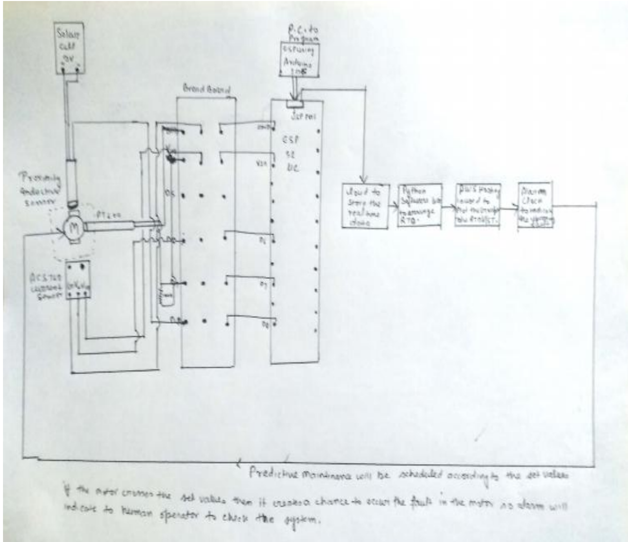


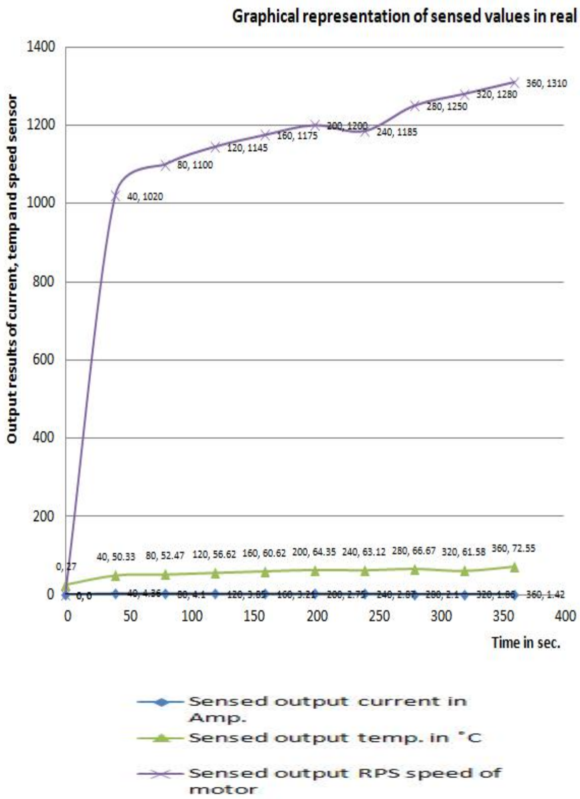
Fig4. Block diagram of project

An induction motor was taken to monitor the health of the motor using various sensors and esp32microcontroller. ACS712 current sensor was used to measure the current drawn by motor, Inductive proximity sensor was used to measure the RPM speed and PT100 Sensor was used to measure the winding temperature. So all the sensors were connected to motor and interfaced with ESP32 microcontroller with the help of breadboard and esp32 microcontroller converted analog values into digital values. Arduino IDE software was used to program the microcontroller. After interfacing the sensors, the real time data went to the cloud using router and python language was used to tabulate the data. AWS (Amazon Web Service) hosting can be used to draw the graph between operating sensed values v/s time. A peak value will be decided for every sensor to operate in between those values. And an alarm will be set to indicate during requirement, if the system goes beyond to the set value (sensed by sensor) the alarm will start buzzing until the human operator will not fix the condition of motor using maintenance or replacement of the equipment. So monitoring the motor in real time can save from getting the fault in the motor and fault can be predicted before occurring. So this method is called predictive maintenance of motor.

IV. OBSERVATION TABLE AND GRAPHICAL REPRESENTATION

Output results and graphical representation in real time

Time (sec)	Sensed output current in Amp.	Sensed output temp. in °C	Sensed output RPS speed of motor
0	0	27	0
40	4.36	50.33	1020
80	4.1	52.47	1100
120	3.85	56.62	1145
160	3.21	60.62	1175
200	2.75	64.35	1200
240	2.87	63.12	1185
280	2.1	66.67	1250
320	1.86	61.58	1280
360	1.42	72.55	1310



IV. CONCLUSION

As the production work is increasing day by day in industries then the usage of motors will also increase and then the maintenance of motors is big concern in 24/7 running industries. So for the checking the health of motor this system can be used to get real time operating data of the motor and according to the data we can get to know about the predictive faults in the motor and then required maintenance or replacement work can be done. This model will help in saving the time of routine check up of the motor. And it will also help in preventive, predictive and planned maintenance. Recently SIEMENS and ABB manufactured a motor in which they have used 12 different sensors to monitor every possible conditions of motor.

V. REFERENCE

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