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Iot Based Condition Monitoring Of An Induction Motor

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Abstract: *Generally, predictive maintenance of induction motors is well suited for small to larger scale industries in order to reduce downtime, increase efficiency and reliability. The various parameters of the induction motor are analyzed in order to gather specific information that can predict motor's failure. Well analyzed vibration signal easily shows the difference between the running operation of the healthy and faulty motor. Using IoT, real Time Condition Monitoring System for Industrial Motors. The aim is to design and implementation of IoT technology to monitor and diagnose the condition of Induction motors by recording key operation indicators. The proposed method comprises of an IoT based platform to collect and process the induction motor parameters. The data collected can be stored in the cloud platform and same can be accessed through the web page. And also timely alerts will be received for any violation in desired limits of parameters under monitoring.*

Keywords: *Internet of Things; Arduino Uno; Induction Motor; Thingspeak; Sensors; Gateway; Node MCU.*

I. Introduction

Industries of this modern era are mainly concerned with quality and quantity of production over a period of time. More than 300 million industrial electric motors are installed worldwide [1]. AC motors are chosen prior to DC motors as it requires a single power source whereas DC machines require separate power sources to the rotor and stator of the motor. Apart from this, there are other factors which make induction motors well suited to industrial usage, [2] like robust in construction, low maintenance cost, high starting torque, efficiency and reliability makes difference from other motors. [3]

Furthermore, motors are an essential machine and it also has a tendency to fail at some point in time. Taking industrial motors as an example, factors such as amount of lubrication, electrical considerations, motor ventilation, alignments and motor load are some possibilities that can be reason for motor failure. These factors result into motor vibrations or rise in motor temperature to critical levels or any other failure. [4]

The health of an induction motor can be easily estimated by condition monitoring which overcomes the difficulties caused by the other method of maintaining motors condition on time basis. Maintenance of motors on time basis may cause shutdowns that are unexpected. On the other hand condition monitoring will provide information not only on motor status and performance but also the type of maintenance required. [5] Condition monitoring has got a great significance these days since it helps to predict equipment health, to optimize equipment performance and reduces maintenance cost. [6]

II. Hardware And Software Configuration

A. Hardware components—

For vibration measurement, accelerometer suited due to its light weight, easy placement and easy configuration. Microcontroller usage is best for acquiring data. ESP8266 board have been used for this research which has the ability to acquire sensor data, communicate with other devices, store information in local, cloud server and alert the user when fault is detected.

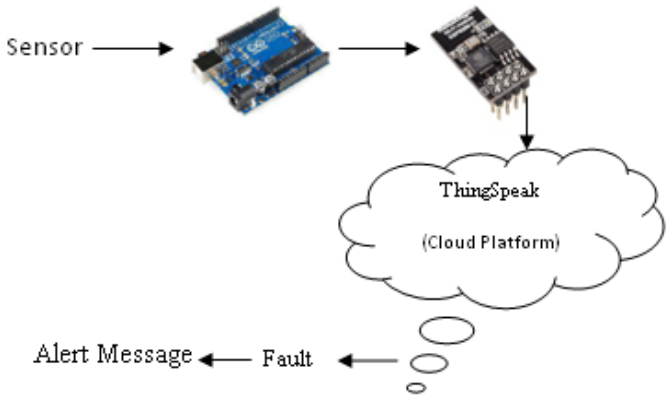

Fig.1. Block Diagram of hardware connections

B. Cloud storage–

Data that is obtained from the sensors are transferred wirelessly to the local and cloud server for analysis. Once the data is received, a system has been devised that analyzes the raw data. The program has been set to process real-time data and store it to the cloud with Thingspeak cloud computing platform. This saved data is accessible from anywhere via internet. [7]

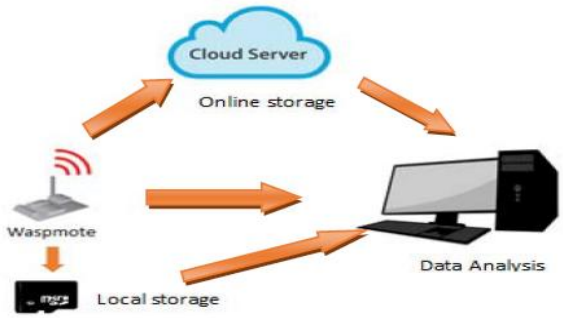

Fig.2. Data storage & analysis technique

III. Materials And Methodology

A. Materials–

Arduino: Arduino is an open source physical computing platform based on a simple input/output (I/O) board and a development environment that implements the processing language.

- **Arduino board –**

The Arduino UNO is a widely used open-source microcontroller board based on the ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards and other circuits. Here we are going to connect all sensors to arduino analog pins and take digital output from Thingspeak.com web server.

Fig.3. Arduino Uno

- **Arduino Integrated development environment (IDE) -**

The IDE (Integrated Development Environment) is a special program running on computer that allows writing sketches for the Arduino board in a simple language modeled after the Processing language. The code is uploaded to the board using Upload button on IDE.

- **Gateway -**

Gateway is a network node which connects two networks operating with different base protocols, that it joins two networks with dissimilarities. A gateway can be implemented either in software or in hardware or in combination of both. In this work the gateway used is ESP8266-01.

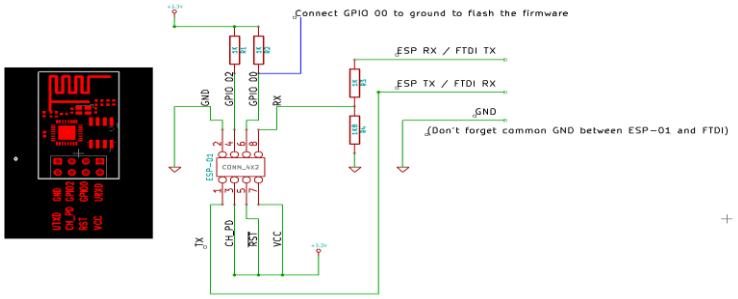

Fig.4. Gateway

- **ESP8266-01 -**

Basically ESP8266 has been designed for mobile, wearable electronics and Internet of Things applications with an aim of achieving the lowest power consumption with a combination of several proprietary techniques. It is an impressive, low cost Wi-Fi module which can be used for adding Wi-Fi functionality via a UART serial connection to the existing micro controller projects. ESP8266-01 includes firmware that runs on ESP8266 Wi-Fi SoC from Espressif systems. Its operating voltage is 3.3v and has 2 digital input/output pins. The board has a flash memory of 4MB.

B. Sensors--

Parameters considered for monitoring the health of induction motor are bearing and winding temperatures, current, voltage, vibrations and number of starts and stops. For this different sensors are used to record the parameters data.

- **Temperature sensor -**

For measuring winding and bearing temperatures a temperature sensor called LM 35 is used and is shown in figure below. The LM 35 is a precision temperature sensor and can be easily calibrated. It has a linear output. It operates over - 55°C to 150°C range. It has three pins namely Vcc, output and ground pins.

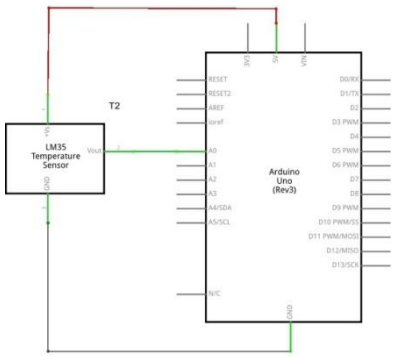

Fig.5. Pin Diagram of LM35

- **Vibration sensor -**

The vibration sensor or accelerometer used is ADXL335 which is a small, thin, low power and 3 axis accelerometer containing signal conditioned voltage outputs. It measures a full scale acceleration with a range of ±3g. It measures both static and dynamic accelerations. The dynamic acceleration resulting from motion, shock or vibrations is measured in here.

Fig.6.ADXL335

- **CT sensor -**

Current is measured by a hall effect current sensor called ACS712 is as shown in Fig.5. It is not only economical but also provides precise solution for AC and DC current sensing in different applications including industrial. It works on the principle of Hall Effect. It has an output sensitivity of 66 to 185 mV/A

Fig.7. Current Sensor

Voltage Sensor –

Voltage is measured by a voltage sensing circuit which produces an output voltage as per micro controller requirement and is shown in Fig.8. A potential transformer of 230v/9v is used whose output is converted to DC with a rectifier as required. A capacitor is used to ripple out the rectifier output. The output is still high to fed to micro controller. So a potential divider circuit is used to get required voltage of 5V and is given to micro controller's input.

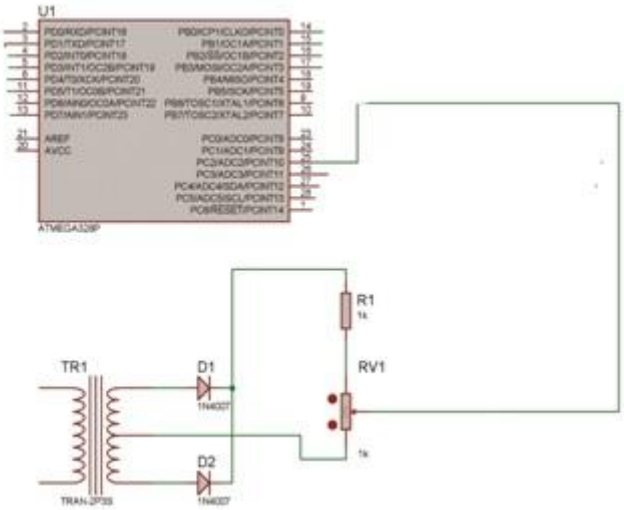

Fig.8. Voltage sensor

C. Technology Adapted --

In this paper industrial motor is monitored using Internet of Things technology (IoT)

Internet of Things (IOT): Internet of Things is a network of devices/objects that are made smarter by equipping with sensors; actuators and network connectivity which enable them collect and interchange data among them and also users becoming an integral part of the network.

IoT/cloud 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 Thingspeak which is an analytic platform service that allows visualizing and analyzing 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 systems regularly uses Thingspeak. [8]

Fig.9. ThingSpeak Platform

IV. Block Diagram With Explanation

The block diagram shows the entire picture of the work. The objective of condition monitoring of induction motor is achieved by continuously recording the considered parameters using various sensors. Accelerometer is used to record vibrations; LM 135 temperature sensors are used to record winding and bearing temperature, ACS712 current sensor for current, and ***a*** Voltage sensing circuit to measure voltage. All the sensors are connected to arduino microcontroller board which is to be installed at the motor site. [9] The sensors will sense the parameters and are analyzed by the micro controller board to the instruction coded. The data sensed by different sensors can be seen on the serial monitor of Arduino IDE.

The collected data can be stored on the IoT platform using Wi-FI module. Using serial communication between the micro controller and the ESP8266-01 board the data is initially transferred to ESP8266-01 board which can be seen on the serial monitor. Then using wi-fi functionally the data available at ESP8266-01 is uploaded to Thingspeak cloud platform. In order to upload the data to Thingspeak platform, an account is to be created and then a new channel is to be created, while creating a channel number of fields are to be selected depending on the number of parameters under monitoring. Each field is assigned with one parameter which is represented in graphical form. A web application is developed for continuous monitoring of parameters. Instant alert will be received on the web page for any abnormal operation of motor.

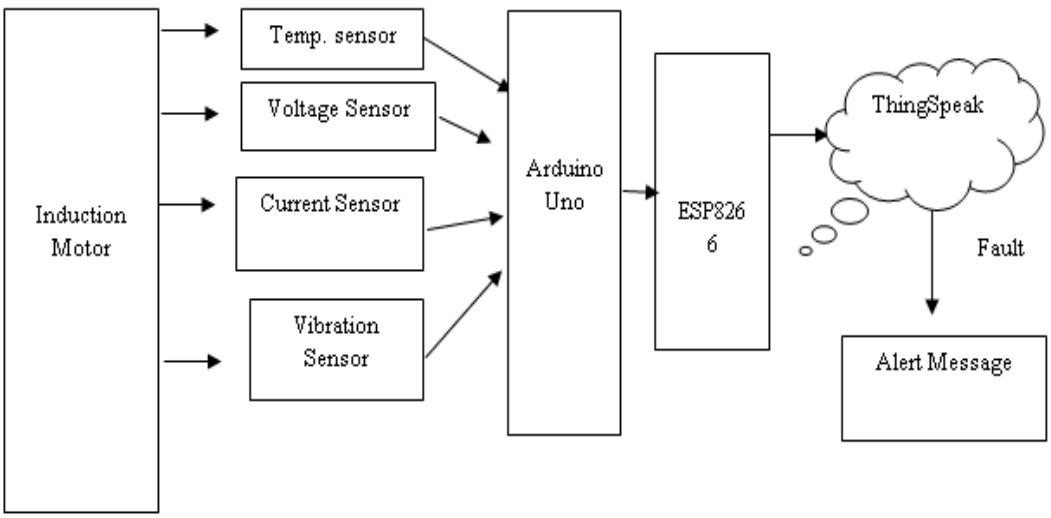

Fig.10. Block Diagram

V. Result

Sensors are connected to micro controller Arduino Uno and serial communication arrangement is made between the Arduino and Node MCU boards. By powering the boards respective codes are uploaded to respective boards. Then the parameter Data sensed is received on the serial monitor of arduino IDE. Then by serial communication data from micro controller is transferred to Node MCU board.

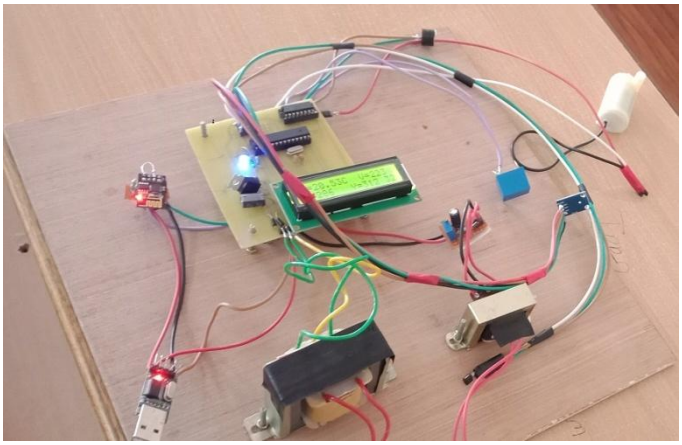

Fig12. .Experimental Setup

Using its Wi-Fi connectivity, the data is uploaded to cloud platform and each parameter is represented in the form of graphs as shown in the Figure below. A web application is designed in such a way that it needs an authentication for cyber security. Authorized personnel are provided with login credentials to enter and monitor the motor condition and performance. Web page has options to monitor all the parameters.

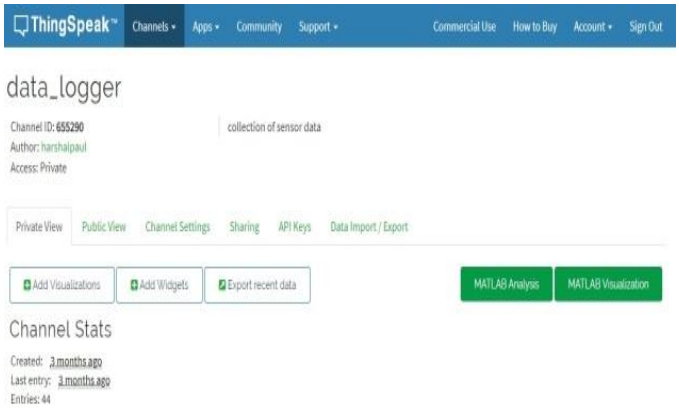

Fig.13. Private Channel details

VI. Conclusion

A new portable design prototype has been developed and presented for reliable detection of faults and abnormalities in induction motor. The system provides diagnostics about the condition of motor. When combined with computerized data processing techniques this acquisition hardware can be used successfully in the monitoring of motor without requiring access to motor.

In this study we have seen that an induction motor can be easily monitored & controlled through an simple control circuit designed under Arduino environment. The system operation was tested under MATLAB environment which showed us positive & stable results. The use of Arduino as a controlling unit is preferred due to cheaper price & simple circuitry compared to other systems.

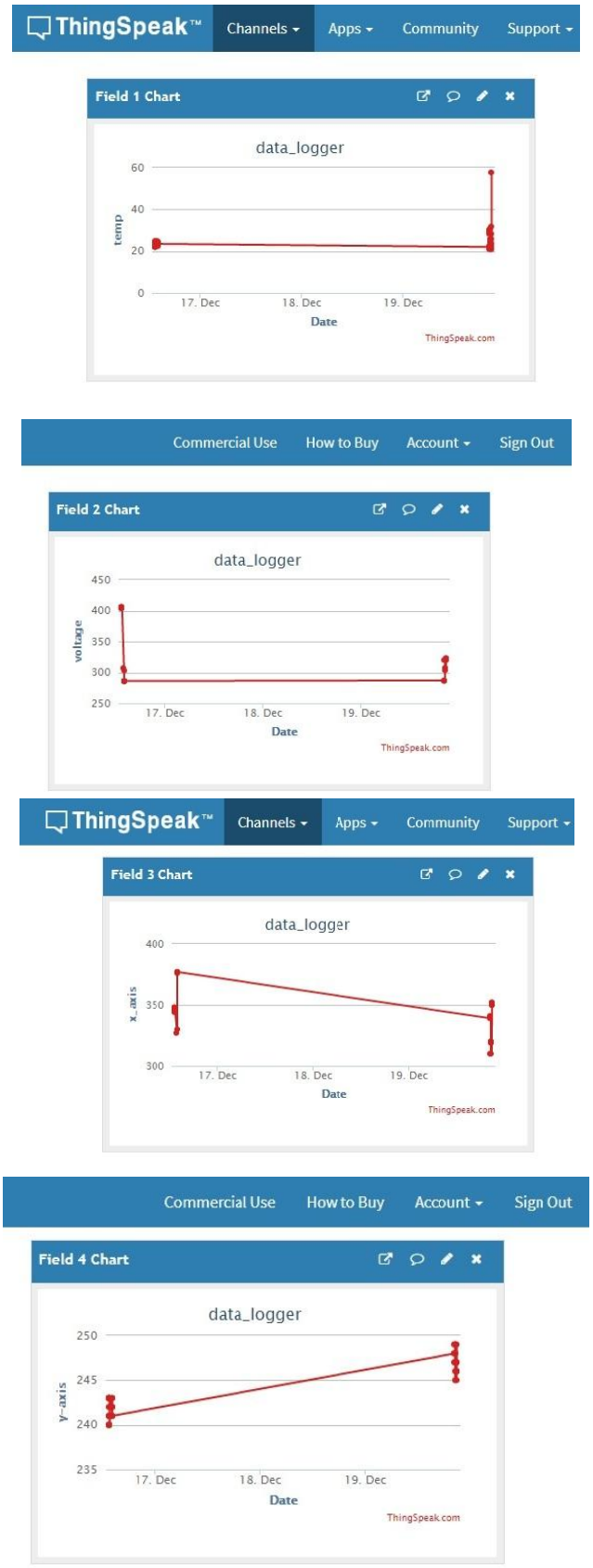

Fig.14. Data uploaded to IoT platform

Reference

[1]. P. Waide, C. U. Brunner, Energy-Efficiency Policy Opportunities for Electric Motor-Driven Systems, Cedex, France: Intl. Energy Agency, 2011.

[2]. C. Woodford, "Induction Motors", [Online]. Available: http://www.explainthatstuff.com/induction-motors.html. [Accessed: 4- November- 2015].

[3]. Christopher J. Schantz, Steven B. Leeb," Self-Sensing Induction Motors for Condition Monitoring" DOI 10.1109/JSEN.2017.2700386, IEEE.

[4]. Dr. M. Muller, "Motor Maintenance – A Survey of Techniques and Results", ACEEE organization New Jersey, 1997.

[5]. Chilaka Ranga, Ashwani Kumar Chandel,"Advanced Tool Based Condition Monitoring of Induction Machines by Using LabVIEW–A Review," IEEE UP Section Conference on Electrical Computer and Electronics (UPCON),2015,DOI:10.1109/UPCON.2015.7456693.

[6]. Praveen Kumar Shukla, Ankur Namdeo, Abhishek Dixit,"Condition Monitoring of 3-F A.C Induction Motor Using PLC,"International Journal of Science and Research (IJSR), ISSN (Online): 2319-7064, vol.1,Issue 5, May 2015.

[7]. S. S. Goundar, M. R. Pillai, K. A. Mamun, F.R.Islam, R. Deo "Real Time Condition Monitoring System for Industrial Motors", School of Engineering and Physics, Faculty of Science, Technology and Environment. The University of the South Pacific Suva, Fiji

[8]. A.Ajitha, J.Laxmi Prasanna, D.Swathi, D.Shyamala" IoT platform for Condition Monitoring of Industrial Motors'', 2nd International Conference on Communication and Electronics Systems (ICCES 2017) IEEE Xplore Compliant - Part Number:CFP17AWO-ART, ISBN:978-1-5090-5013-0

[9]. B. Nicholas, "Logging to the cloud using NI wireless Sensor Networks and Lab view", August, 2010. [Online}. Available: https://decibel.ni.com/content/groups/wire/blog/2010/08/27/logging-to-the-cloud-using-ni wireless-sensor-networks-and lab view. [Accessed: 17- November- 2015].

[10]. Real Time Condition Monitoring System for Industrial Motors. DOI: 10.1109/APWCCSE.2015.7476232 IEEE