Wireless Fault Detection System for Industrial Motor

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Abstract : **The electrical machine parameters under various operating conditions play a vital role in the considerations for the performance, efficiency, reliability and life of machine. Vibration signals measured at the external surfaces of a machine contain a great deal of information as to the internal processes. Hence it is considered as a very important parameter to monitor machine health. Hence such parameters should be constantly measured & monitored & its data acquisition should be carried out so that the data is available for the control of these parameters and also in the automation of different machine dependent processes. To monitor the machine condition remotely and detect the fault which reduces the losses. The system uses the accelerometer and temperature sensor which gives the proper analysis of a system.**

IndexTerms **- Accelerometer; Fault detection ; temperature sensor.**

I. INTRODUCTION

In the previous days, for monitoring vibrations there were mechanical arrangements but the mechanical movements resulted in wear and tear which directly affected the monitoring output. In order to reduce this, scheduled maintenance was required. Hence we have designed a circuit in which the mechanical part is completely replaced by an electronic circuit. Detection of faults play important role in the quest for highly reliable operations. Reducing maintenance and production cost, improving uptime, product quality, advance safety and reducing risks are some of the essential drivers for deploying vibration analysis [1]. Monitoring and analysing the vibrations in different places of the motors the cause of the vibration can be discovered. It is also important to discover and solve these problems in time. If not, long term damages or immediate failure can occur which leads in immediate loss of production. It is often very useful to measure the internal parameters of electrical machine under various operating conditions [2]. The parameters like voltage, current, flux, torque, speed, power factor are usually measured & considered parameters to study the performance characteristics of the machine to study its efficiency and torque for different applications. But it is also important to measure & monitor one more parameter which is also important viz. vibrations of machine for the considerations of performance, efficiency, reliability & life of machine. Sometimes it is very necessary to check internal parameters of motor at different condition [3]. It is usually complicated to have constant monitoring & recording & storing results of these parameters using the traditional measuring apparatus like meters. Hence a system is designed to have a monitoring the results of these parameters using various sensor connected to machine with micro controller.

Vibration is an unavoidable consequence of any pivoting machine. Vibration estimation and its examination can be a route for condition based upkeep of machines. Customarily machines are considered for upkeep as for working hour or run time. However condition based support gives a balanced approach to support as per the genuine condition instead of run time which spares time, exertion and cost for support. Vibration estimation is likewise essential device for breaking down transport vehicle solace and its motor execution. Vibration estimation is the main method for dissecting information of tremor. . Vibration can be measured utilizing accelerometer which gives increasing speed information of a protest it is joined to Increasing speed can be vibration, movement or stun. Contingent upon increasing speed sort and scope of recurrence of vibration extraordinary sorts of accelerometer can be utilized. As a rule for vibration estimation peizo-electric accelerometers are utilized however these are exorbitant. . Thus many inquires about has been occurred for discovering accelerometers which are less expensive than ordinary accelerometers however can give same or better execution than these. MEMS (Micro Electro Mechanical System) innovation makes ready for that. MEMS accelerometers are of minimal effort, better recurrence reaction, more extensive transfer speed, lower counterbalance voltage and so forth [10].

II .SYSTEM HARDWARE DESCRIPTION

This section describes the design of wireless fault detection. Figure1 shows the hardware structure of transmitter. In this transmission section, two sensors are used: one is accelerometer and another is temperature sensor, both sensor are connected to microcontroller. The data is transmitted through a RF module, which is also connected to a microcontroller.
The wireless system is physically connected via USB to the monitoring computer, where data is assessed and processed.

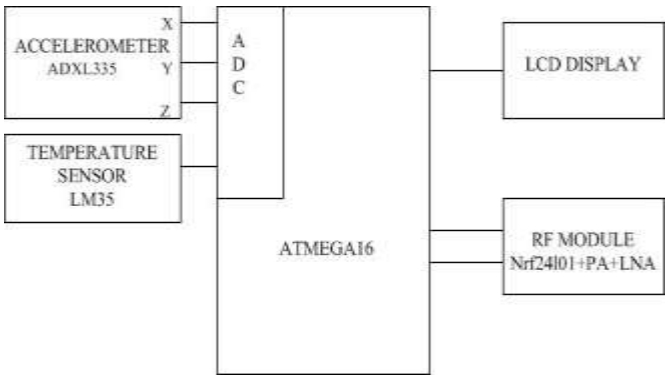

Fig.1 Block diagram of the hardware structure

1. Microcontroller

The ATmega16 is 8 bit microcontroller based on AVR and its responsible for executing the IEEE 802.15.4 standard. This microcontroller is collect the data from the sensor, microcontroller controls and synchronized the sensor data process. The output signal of the analog sensor is converted to binary values by using analog to digital converter (ADC) of the microcontroller. The microcontroller transmits the information through a RF module, which handles the wireless communication.

2. Accelerometer

The ADXL335 is a micro-electro-mechanical system (MEMS). It is a three axis accelerometer which has been chosen to measure the vibration of a motor. It is a small, thin, low power, 3-axis accelerometer with signal conditioned voltage outputs. The full-scale range of adxl335 is ±3 *g*. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration. The ADXL335 uses a single structure for sensing the X, Y, and Z axes.

Following steps are taken to characterize the vibration acquisition are: analog value is converted to a decimal value,

V= analog value *5.00/ 1023

Where analog read is the analog integer value collect by microcontroller and V is a read data in volts.

$$DEF = \sqrt{\frac{x^2+y^2+z^2}{3}}$$

Where, x, y and z are axis of accelerometer.

3. Temperature Sensor

The LM35 is a precision IC temperature sensor which output is proportional to the temperature (in C°). The temperature can be measure more accurately with lm35, it also posses low self heating and does not cause more than 0.1°C temperature rise in still air. Its operating temperature range is from -55°C to 150°C. The output voltage varies by 10mV in responses to every °C rise/fall in ambient temperature, i.e., its scale factor is 0.01 V/°C.

The data transmitted to the receiver side from the sensor also require a direct conversion:

Temperature = analog read *(500.0/1023)

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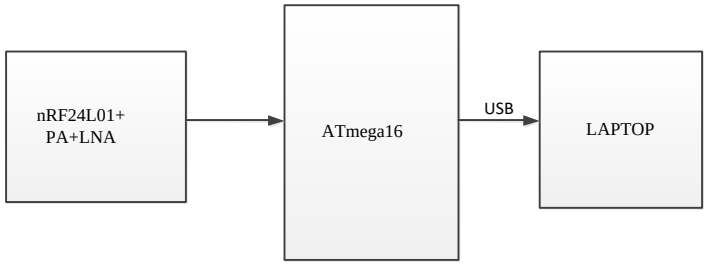

Fig.2 Block diagram of receiver section.

The data receiving system gathers all the information send by the transmitter and the receiver section is used a RF transceiver module which receives the data and that data is displayed on computer with the help of USB cable. The status of motor vibration and temperature is observed at receiver side.

III. SOFTWARE

1. PROGRAMMING

Firmware for the modules has been developed with the help of AVR GNU C compiler and AVR. Atmel studio 6 is integrated development environment by Atmel. The program is return in c language and compiler using the open source compiler AVR-GCC.

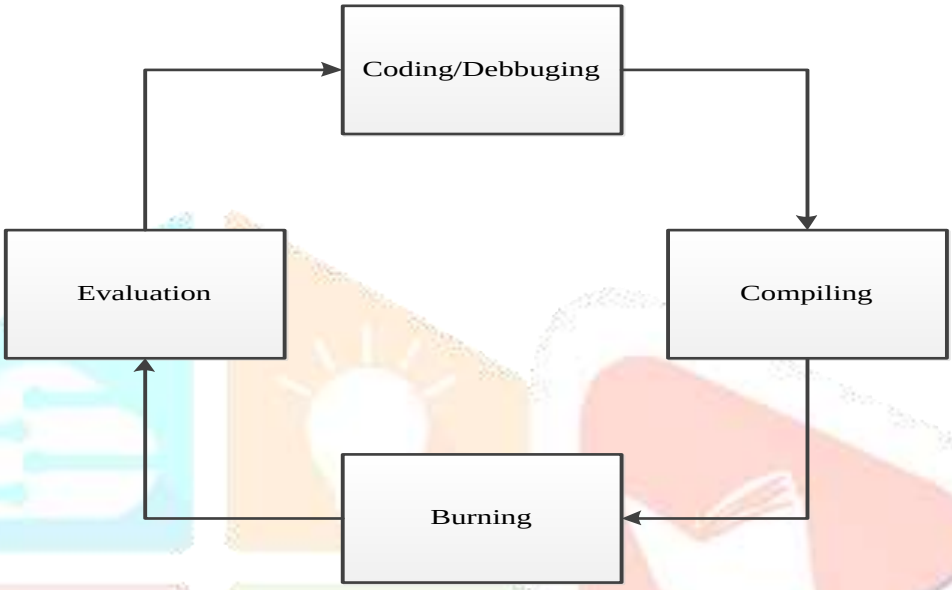

Fig.3 Steps of program development

At mega16 microcontroller is programmed in Atmel studio. Coding / debugging through Atmel studio 6, compiling through GCC compiler and burning through GCC programmer. Microcontroller has been programmed to test the hardware.

Visual studio 6 is used for plotting the real time graph on laptop. Visual studio is a fully featured IDE for android, web and cloud. The window form designer is used to build GUI application using windows form, it also display data like text box, list box and grid view. The user interface is link with code using an event-driven programming model. The designer generates c# code for the application. The data designer can show the graphically added data such as base schemas, including tables, keys and constraints.

3.2) MONITORING

The graphical user interface receives the data and saved it in database according to the data transmission. The data is processed and analyzed, then graphically visualised in real time. The threshold is set to the maximum allowable values of temperature and vibration. If the values are arising, the system triggers a danger alert.

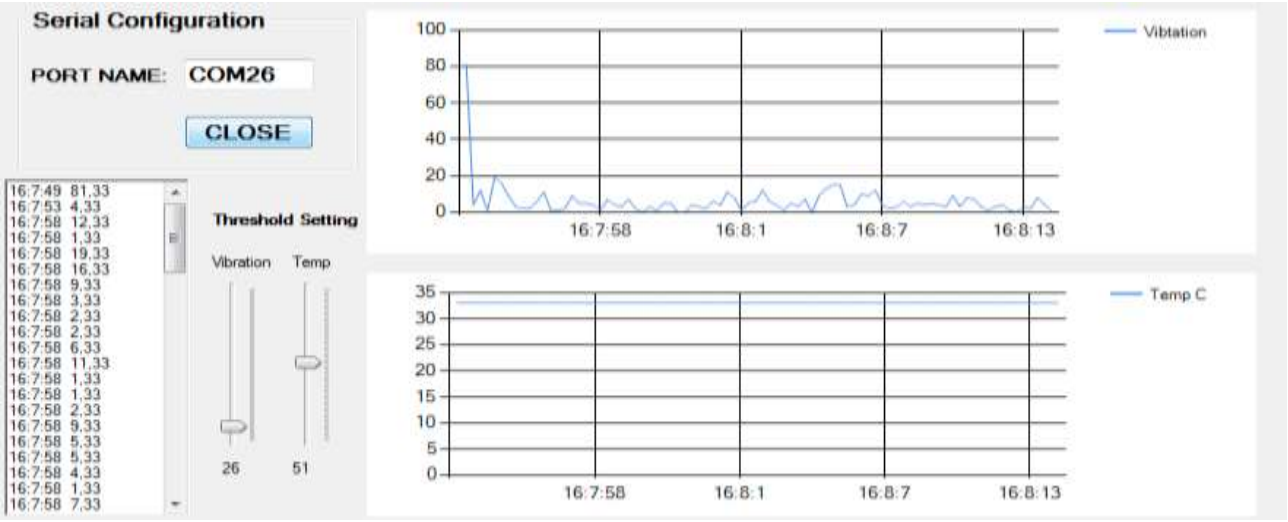

Fig. 4 Graphical view of monitoring application.

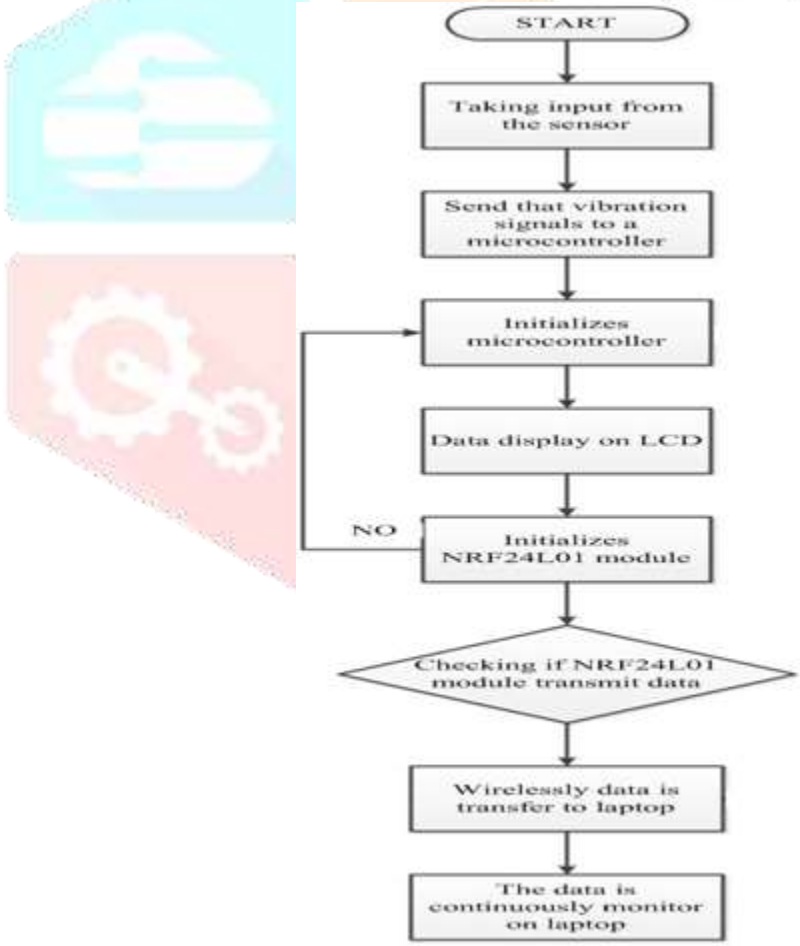

Fig.5 flow chart of detection and monitoring

IV. EXPERIMENTAL RESULTS

1. LABORATORY EXPERIMENT SETUP

We used a single phase induction motor. The motor is powered at 220V. Machine vibration signals have been taken from stator part of the motor.

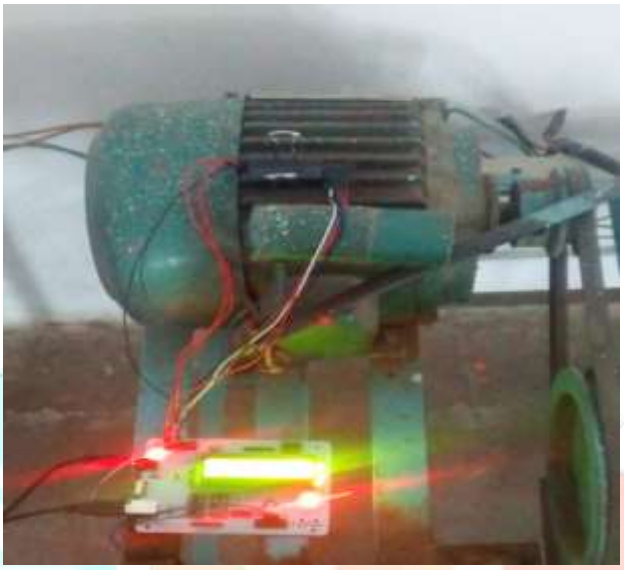

Fig. 6 Setup of sensors

Figure 6 shows the connection between motor and sensors. In ac motors, vibrations can be caused by several types of faults. To detect those types of fault, we use accelerometer and temperature sensor which measure vibration and temperature of the motor.

2. MOTOR 1 AND MOTOR 2 CONDITION

Fig. 7 vibration signal of motor in off condition

For figure 7, it is evident that when the motor is on vibration signal is published. If plotted graph show minimum amplitude in the waves, it mean machine is healthy.

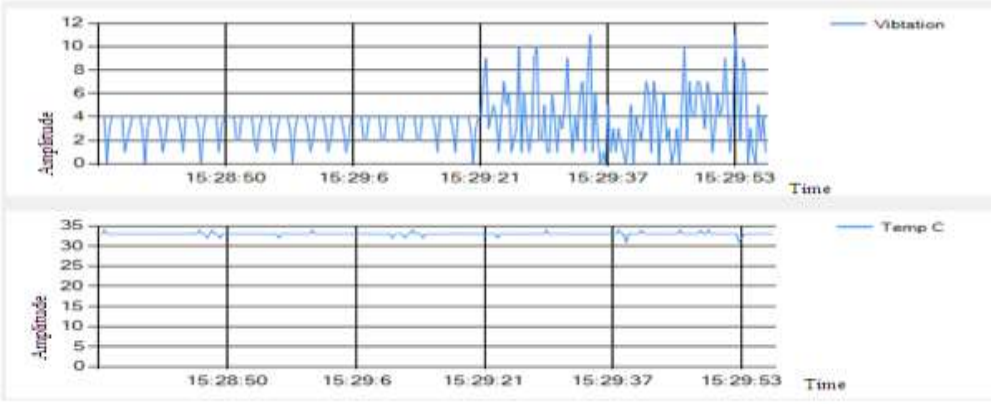

Fig. 8 vibration signal of motor in on condition

In figure 8, the plotted graph is evident that the accelerometer is placed at stator part of motor. The motor was started and vibration signal is published, as seen the plotted waveform has maximum level of amplitude it means the condition of is not good.
The plotted graph is considered as a result of the experiment. In figure 7 shows the minimum amplitude in the waves, it means machine is healthy, and in figure 8 the plotted graphs waveform have maximum level of amplitude it means the condition of machine is not good, machine is faulty.

V. CONCULSION

This paper presents a wireless fault detection and data observing system which provides early fault detection with the help of accelerometer and temperature sensor. The data is transmitted and received by RF module. The received data is stored and access in laptop, that data is graphically presented by real time.

REFERENCES

[1] M.Divya, S.Ramgowri, T. Mangayarkarasi, Dr. A. Vimala Juliet," A novel method of vibration measurement using MEMS accelerometer", International Conference on Computing and Control Engineering (ICCCE 2012), 12 & 13 April, 2012]

[2] Stein, R. Chmúrny, V. Rosík," Measurement and Analysis of Low Frequency Vibration", G. J. MEASUREMENT SCIENCE REVIEW, Volume 7, Section 3, No. 4, 2007.

[3] T. Aizawa, Toshinori Kimura, T. Matsuoka, T. Takeda and Y. ASANO, "Application of MEMS accelerometer to geophysics" International Journal of the JCRM, Volume 4, Number 2, December 2008, pp.1-4.

[4] A. Albarbar, A. Badri, J. K. Sinha, A. Starr,"Performance evaluation of MEMS accelerometers".

[5] M. Arraigada, M. Partl, "Calculation of displacements of measured accelerations, analysis of two accelerometers and application in road engineering", Conference paper STRC 2006.

[6] S. Han, "Measuring displacement signal with an accelerometer", Journal of Mechanical Science and Technology 24 (6) (2010) 1329~1335

[7] Cheap MEMS accelerometers compete with expansive piezoelectric accelerometers for detection of bearings faults / failures,POM Prognostics for Optimal Maintenance, IWT-SBO-090045.

[8] Jonathan Medina-Garcia, Trinidad Sanchez-Rodriguez, Juan Antonio Gomez Galan, Aranzazu Delgado, Fernando Gomez-Bravo & Raul Jimenez "A wireless sensor system for real time monitoring and fault detection of motor arrays," Feb 2017.

[9] R.Piyari and S.Lee "Performance analysis of Xbee ZB module based wireless sensor network," International journal of scientific and engineering research, volume 4, april 2013.

[10] S.P. Patil and S.C. Patil "A real time sensor data monitoring system for wireless sensor network,"International conference on image processing,978146737758-4 , 2015 IEEE.

[11] Xin-min CAO " the research on wireless sensor network for mechanical vibration monitoring," © 2013. International conference on image processing,978146737758-4 , 2015 IEEE.

[12] Alka Thakur "Dr. Sulochana Wadhwani" Vandana Sondhiya "Health monitoring of rotating electrical machine using soft computing techniques" International Journal of scientific and Research publication , volume 3, Issue 11, November 2013.

[13] Dr.R. Udayakumar, Dr. V. Khanaa "Health monitoring system for Induction motor" International

Journal of Engineering And Computer Science ISSN: 2319-7242, Volume 2, Issue 4 April 2013.

[14] S.H Chetwari, M.K Shah & M. Ramamoorty "Multi technology approach to motor condition monitoring"

[15] Ozdemir Gol "Condition monitoring of large electrical machines" Zeszty Problemowe- Maszyny Elektryczne Nr 77/2007.

[16] Prabhakar Neti and Brant Wilhelm "Online Health Monitoring of motor insulation"

[17] S.H. Yang. (2014). Wireless Sensor Networks: Principles, Design and Applications.

[18] J.K. Sinha, Vibration Analysis,Instruments, and Signal Processing, First Edition ed.: CRC Press, 2014.

[19] A. Albarbar, S. Mekid, A. Starr, and R. Pietruszkiewicz, "Suitability of MEMS accelerometers for condition monitoring: An experimental study," *Sensors*, vol. 8, pp. 784-799, 2008.