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Detection and Monitoring Of Induction Motor Faults Using Lab View

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***Abstract*— early detection of faults in stator winding of induction motor is crucial for reliable and economical operation of induction motor in industries. Whereas major winding faults can be easily identified from supply currents, minor faults involving less than 5 % of turns are not readily observable. The electric motor usually consists of two types of faults they are electrical and mechanical faults. In these two faults mechanical faults play a major part. In order to protect the motor from such kinds of faults we are implementing suitable methods for detecting and monitoring those using standard models and software tool. In this project we are using LABVIEW as the software tool for monitoring the faults. The main purpose of using this software is that we can display the results in graphical way which is useful for the comparing purposes.**

***Index Terms*—** ADC, UART, MUX, USART

I. Introduction

In today's world, our technology is propagating at a faster rate. As the increase in technologies there are various aspects needs to be checked based on its safety, accuracy, efficiency, reliability etc. To achieve these possibilities, we need the systems that satisfy all the requirements and provide us the quality output. The various fault analysis carried out in the industries depends on what type of technique is being carried out   Obtaining the motor with required efficient values is difficult task in the industries. Various faults in the motor vary from HP, phase of the motor, type of the motor. Detection of various faults in induction motor in its starting stages can avoid the wear and tear of contacts and various components from being damaged. There are different types of faults occurred in induction motor but the major fault is obtained due to the mechanical stress and increase in the load of the motor. Another major fault is occurred due to the minor short circuit within the motor.

The different type of techniques has been proposed for detecting the bearing fault in induction motor.

The different types of techniques used are:

1. **Mathematical modeling of the system**: in this technique the behavior of motor is analyzed for the no load and load condition.
2. **Frequency spectrum technique**: this technique is used for the analysis of the signals that is acquired this is done because signals are non-stationary behavior.
3. Motor fault analysis using stator current has been proposed for detecting broken bar.
4. Negative sequence impedance technique
5. Radial vibration machine analysis using higher order spectra technique
6. Extraction of useful data using wavelet package for determining non stationary signals.

Detection of fault using neural voltage is only applicable for star connected machines. This project work is an attempt to extract the induction motor fault using discrete wavelet transforms technique in order to obtain the reliable output. We have used various sensors to get more accurate and expected results

- The main objective of this project is to determine the induction motor faults using vibration and voltage analysis.
- In this type of method the induction motor fault is determined by the ATMEL LM 393 vibration sensor and ACS 712 voltage sensor that transfers the data into DAQ card arduino (atmega 32 chip, DB-02, crystal, capacitors, MAX232).
- The vibration data and the voltage data that is acquired by the DAQ card is monitored using the LABVIEW 2013 version in the PC to display the faults of an induction motor in graphical form.

II. Methodology

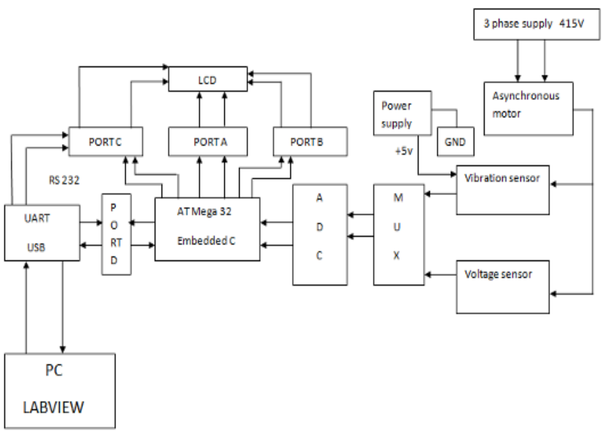

Figure 1: block diagram for the proposed methodology

Figure 1 shows the block diagram of proposed system that is used for our project. Initially the 3 phase induction motor of 415v is selected for the project. As we all know inductor motor faults are commonly classified as electrical and

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mechanical faults. But the induction motor is affected mainly by mechanical faults due to the various external and internal parameters. In the mechanical fault the most common and main aspect is the bearing fault which constitutes to about 38% of the total fault of the motor. In this project we have mainly concentrated on detecting the bearing or vibration and voltage faults which plays a major part in the induction motor faults.

So in this section first we will obtain the data using ATMEL LM 393 vibration sensor which is also called accelerometer by switching on the induction motor. Here we are using piezoelectric type of accelerometer we have selected the piezoelectric type of accelerometer because this generates the electric charge when the mechanical stress is applied to it. The vibration of the motor is taken as the data for detecting the faults in the motor similarly the voltage is taken as data using voltage sensor because as load increase the efficiency and the performance of the motor decreases. These two data that is acquired is then transferred to an arduino for further process.

In this section the data that is collected from the voltage and vibration sensor is acquired using DAQ card arduino (filter capacitors, noise reduction capacitors, DB-02). In this project we are using atmega 32 chips for programming the analysis in embedded C language. In the arduino board there will be four ports A, B, C, D. The data that is obtained is indicated by LCD. The data to the LCD is sent through the ports A, B, D of atmega 32 chips. Next the data in the LCD is sent To the UART through port C. UART is mainly used for transmitting serial communication data to the connected devices. UART consists of LED which glows when the USB in the board is connected to a PC. When an LED does not glow then the suitable drivers has to been inserted. And this serial data is transferred to the PC consisting of LABVIEW

2013 version for displaying the results in the graphical way.

2.1 Initialization of Ports

In this section we are initializing the suitable data for the ports such as

a) Baud rate: Baud rate is the speed at which the serial information is transferred in a communication channel. For this project we assuming the baud rate to be 9600

b) Checking parity: In this project we are checking for no parity. A parity bit is the single bit added to the binary string. It is always set to either 0 or 1.

c) Stop bit: It is mainly used for asynchronous data transfers. Stop bit is type of bit which indicates the end of the string or of the entire transmission. In this project we are setting the stop bit as 1.

2.2 Read the Data Using DAQ Card

In this section we are reading the data from the sensors to read the data there are three main steps to be followed

a) Checking the bytes at the port
b) Read the data using USB port
c) Segregate the data for the channels A and B: In this project we have chosen two channels A and B. channel A represents voltage data and channel B represents voltage data.

2.3 Reduction Of Noise Using Wavelets

Wavelets are usually sinusoidal waves. They are well suited for transient signals which mainly concentrate on frequency method. Wavelets are the families of one single function called mother wavelet, which is carried out by scaling operations. Wavelets must be oscillatory, should decay quickly to zero. The scaling operations are nothing but the stretching and compressing operations on the mother wavelets. There are different types of wavelets used as mother wavelet such as Haar, symlet, coiflet, and daubechies 2. Multi resolution analysis decomposes the signal into various signals with different resolution providing information in time and frequency domain.

It uses wavelet function and the scaling function to decompose the signal into high frequency and low frequency component by processing signal into LP filter and HP filter. The wavelet transform is also called as resolution of the signal and it is associated as the set of functions for wavelets.

A noise signal model can be obtained as:

$$s(k) = f(k) + \in .e(k), k = 0,1, \ldots .n-1 \quad - 1)$$

Where, s (k) is the original signal.
f (k) is the obtained signal.
e (k) is the noise.

Usually the signals are obtained in high frequency range. Next step is to process the decomposed signals into the above equation with the small threshold voltage.

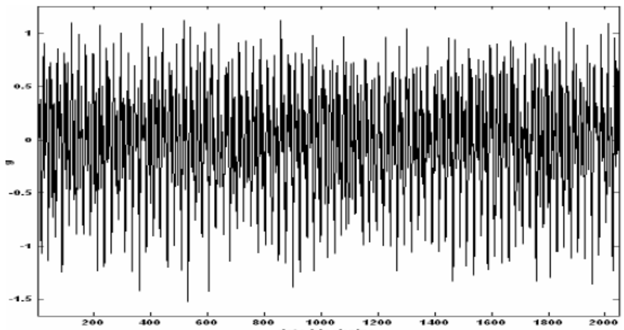

Figure 2: original vibration signals from the motor

Figure 2 represents the vibration signals that are directly obtained from the shaft of the motor. From the fig we can understand that the obtained real time signals of the motor has large amount of noise in it due to which there is a chance of getting the components to be damaged. The results also displays that the obtained output does not give motor any kind of reliability, efficiency etc. The noisy signal then has to be decomposed using the suitable wavelets. For that we need to select any one of the mother wavelet such as daubechies, symlet, coiflet, haar etc. but in our project we are selecting daubechies 2 for the decomposition of the signals. Where there will be five levels of processing to reduce the noises in the signals.

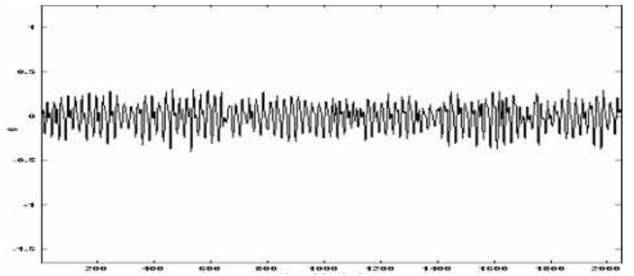

Figure 3: purified signals after de noising using daubechies wavelet

From figure 3 we can notify that purified signals are obtained by de-noising using DB-2 wavelet by applying it to the wavelet theory. The purified signals now will be able to determine the required output graph for comparing and monitoring purposes. The obtained graph is clear from all kind of noises in the signals which results in the error signal. DWT can be defined as

$$F(a, b) = \Sigma f(t)\, \psi a, b(t) - \quad 2)$$

Where, ψa, b (t) is mother wavelet a, b are scaling and translating factor.
Figure 4 shows the simulation model of multi resolution of the signals in the wavelets during fault extraction process. Model shows de-noising of thing signal at different levels using wavelet.

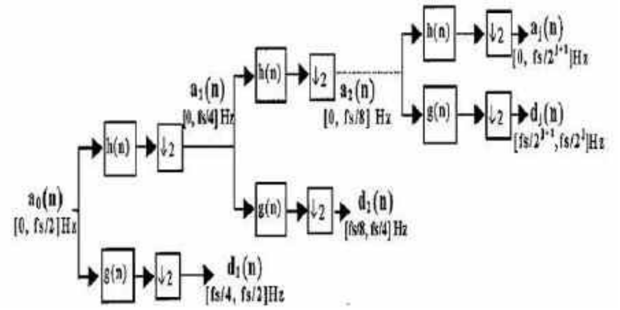

Figure 4: Multi resolution signal decomposition

2.4 Charting the Data Using Real Time Graph

Figure 5 displaying the run chart that is used for plotting the data values. The data that we obtain after reduction in noise it is charted to run for real time operation.

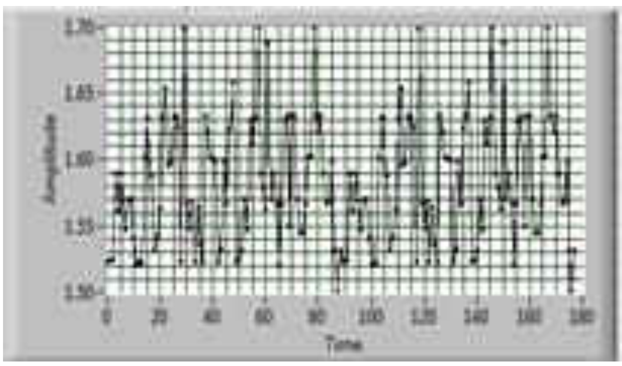

Figure 5: run chart for plotting data

The graph will plotted for time VS frequency. In this chart the signals will be obtained with noise. The severity of the noise signal increases as the load in the motor increases. This chart where the original signals of the motor occurs.

2.5 Setting Limits for Waveform and Run Chart

Figure 6 indicates the waveform chart, where the signals from the run chart is de-noised using wavelets and the purified signals are displayed here. In this method the two channels A and B will be set for upper and lower limits. The standard limits for motors will be ranging from 1.0V to 1.5V.
This section is used to evaluate the data that obtained is suitable for result analysis. In this the waveform is plotted for amplitude VS time.

After obtaining the data the waveforms will be obtained on the waveform chart if there is any abnormal condition in the system the voltage and vibration switches turn ON indicating that the data has crossed the nominal range and the switch turns red showing that motor is in fault condition.

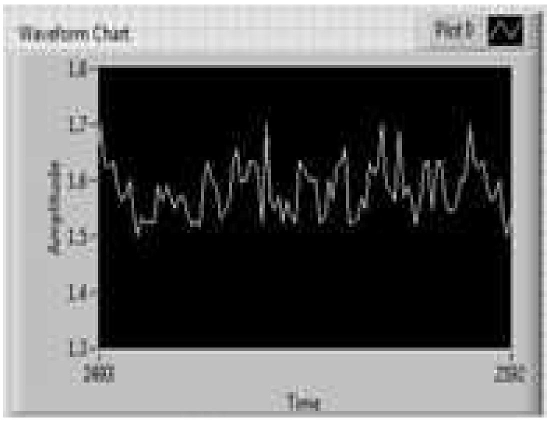

Figure 6: waveform chart for setting up the limits

2.6 Flow chart for the proposed methodology

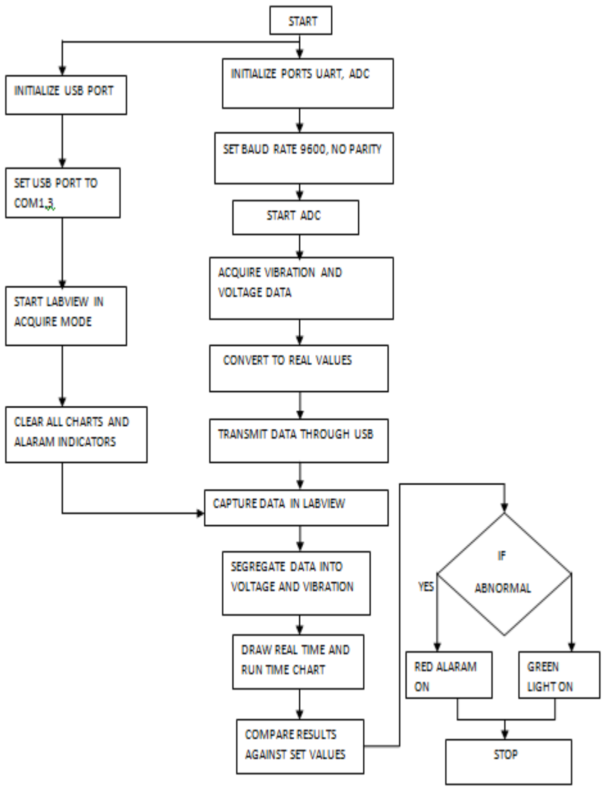

Figure 7: Flow chart of the fault extraction process

III. Results

The data values recorded for different motor operating conditions shown below

1. NO LOAD condition:

Table I: Data recorded for the no load condition of the motor

Channel A	**Channel B**
1.4178	**184**
1.4369	**183**
1.4569	**183**
1.4895	**182**
1.4215	**184**
1.4365	**183**
1.4569	**183**
1.4567	**182**
1.4556	**182**
1.4475	**184**
1.4258	**181**
1.4546	**183**
1.4258	**183**
1.4569	**182**
1.4879	**180**

Channel A represents vibration fault data in (V), channel B represents voltage data in (V).

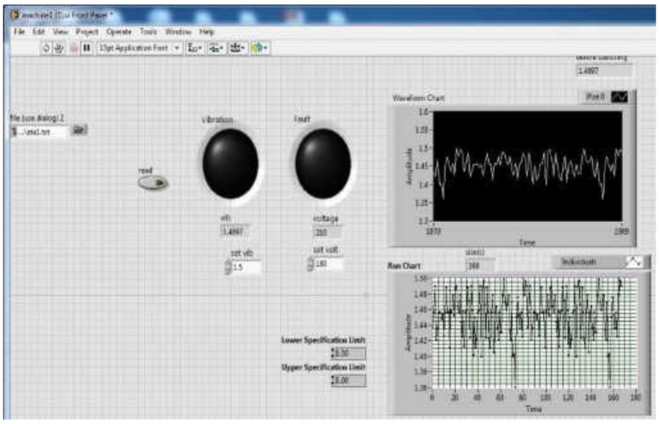

Figure 8: simulation result displaying no load condition

Here we are selecting two channels A AND B .Channel A represents vibration data values. Channel B represents voltage data values. Here we are setting up the voltage limits for channel A which ranges between 1 to 1.5. Similarly we are setting the set up voltage to channel B as 180V. In this section we are not getting any fault because the vibration of the motor is not exceeding the limit set by the programmer. In this case the motor is in healthy condition.

2. 30% LOAD condition:

Table II: Data recorded for 30% load condition of the motor.

Channel A	**Channel B**
1.5241	**177**
1.5236	**178**
1.5248	**179**
1.5247	**180**
1.5897	**179**
1.5623	**178**
1.5897	**178**
1.5693	**177**
1.5478	**178**
1.5698	**177**
1.5698	**177**
1.5412	**179**
1.5203	**178**
1.5236	**178**
1.5201	**179**
1.6021	**176**
1.6325	**175**
1.5997	**178**
1.5890	**177**

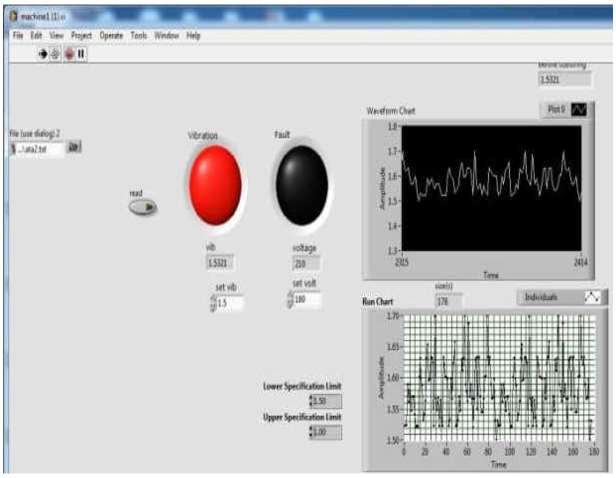

Figure 9: simulation waveform for 30% motor load

From the figure 9 we can observe that there is an fault in the vibration data as the voltage is increased from its set value due to slight loading of the motor. In this case the motor fault is not much affect able but leaving this for a long time will affect the motor by getting heat in the coils and cooling fan will get damaged. This can be monitored in the earlier stages from motor being damaged from the faults obtained.

3. 50% LOAD condition:

Table III: Represents Data recorded for 50% load of the motor

Channel A	Channel B
1.6998	175
1.6874	175
1.6995	174
1.6321	176
1.6325	177
1.6321	176
1.6548	175
1.6325	175
1.6332	176
1.6251	175
1.6390	175
1.6954	174
1.7012	173
1.7410	172
1.7013	172
1.7123	171
1.7456	170
1.7894	168
1.7456	169

From the figure 10 we can observe that the motor showing both vibration and voltage fault as the load in the motor increases. The voltage level has sliced down from the reference voltage because of the load in the motor increased. As the voltage increases the current in the coil, the flux in the magnetic field also increases which results in decrease in the efficiency. This should be identified in the initial stage in order to avoid the motor from getting damaged.

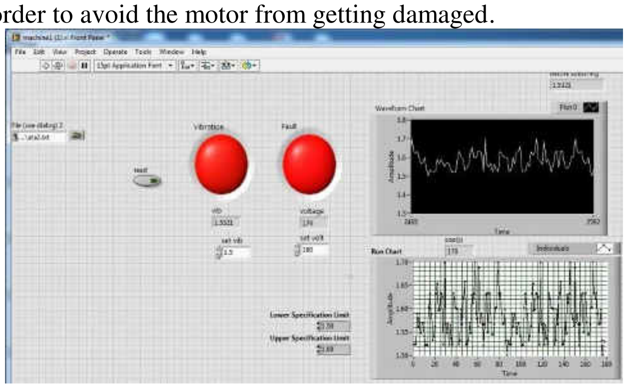

Figure 10: simulation waveform for 50% motor load

CONCLUSION

In the proposed model, fault extraction and de-noising of fault data using DB-02 acts as main mechanism for monitoring of faults. The performance and efficiency criteria have been evaluated under real time operating conditions.

In conclusion, I observed that the proposed system provides a much more awareness and predicting the induction motor faults in the earlier stages. From the two charts we can observe that the motor shows unhealthy readings as the load in the motor increases.
The application of analyzing the vibration faults in the motor is to provide an immense response in many industrial purposes such as small scale industries, power generation, and automation industries. An induction motor plays prominent role in agricultural purposes such as to provide the water to the crops, cultivation etc.

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