

IMPLEMENTATION OF PICCOLO DSP BASED FAULT MONITORING SYSTEM FOR SINGLE PHASE INDUCTION MOTOR

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ABSTRACT

Induction motors have been widely adopted, mainly because of their low price, ruggedness, simplicity of control, and reliability. The induction motor is considered as a robust and fault tolerant machine and is a popular choice in industrial drives. The purpose of this work is to demonstrate the importance of vibration measurements in fault detection and diagnosis of induction motors. MEMS based accelerometers are emerging as the alternate method of sensing the vibrations in a rotating machine. With the advent of MEMS technology there is a remarkable reduction in size, power consumption and cost of MEMS accelerometers compared to conventional accelerometer. The primary objective of the work is to detect and diagnose induction motor faults, caused due to electrical or mechanical origin by vibration analysis. Fault causes change in mechanical and electrical forces acting on the machine. This paper gives a justification for the change in machine vibration due to the excitation of voltage harmonics, this in turn will help in electrical fault detection in induction motor. Also, presents a method for detecting faults occurring due to mechanical origin such as mechanical looseness and misalignment in motor shaft coupled to brake drum with the help of MEMS accelerometer used as vibration sensor.

Keywords: Fault monitoring, Vibration analysis, MEMS Accelerometer, condition monitoring

1.INTRODUCTION

The condition checking and error analysis of induction motors are the important part of the industry. It can be much decrease the cost of protection and the hazard of unpredicted collapses by permitting the early on finding the possible tragic faults. In form based protection, one does not plan preservation or motor substitution based on the before records and statistical guess of machine collapse. somewhat, one relies on the in order to

collapses are the main reason for stator winding faults. The motor affected the reason of bearing failures, rotor faults, and various faults. The main faults of bearing stator winding faults provide a main section to the induction motor failures. However rotor faults show less momentous than the bearing faults, most of the bearing failures are produced by the shaft misalignment, rotor eccentricity, rotor related faults. The rotor faults can also end result in overload temperature, decreased usefulness, reduced longer life of motor, and iron core spoil. So the finding of mechanical and electrical faults are similarly important in motors.

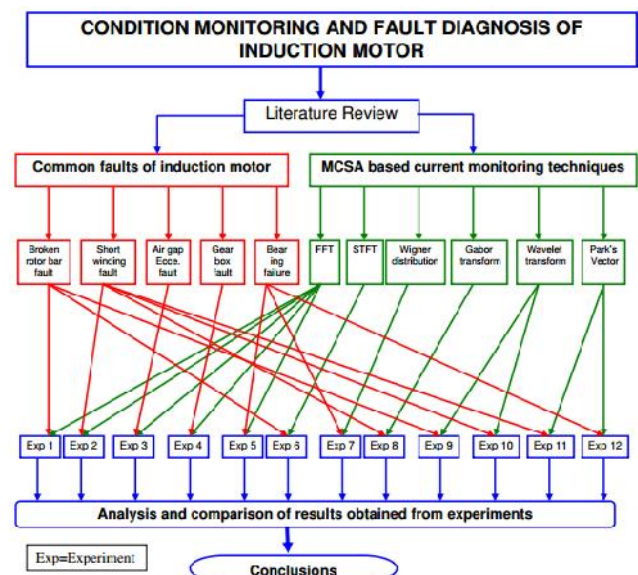


Fig:1.1 Diffent Methods Of Analysis

2.SINGLE PHASE INDUCTION MOTOR USING WINDING CONFIGURATION

All the single phase induction motors having two types of windings. One is considered as to present the main drive and it is also acknowledged as the run winding .And the other is used to describe the direction which the motor runs and it is generally acknowledged as the starting winding. Most of the motors having a capacitor that is related to the start winding an automatic is switch inside the motor. which changes their configuration when the motor gets up to speed generally to disconnect the starting winding.This switch able to be typically heard to operate the motor slows down. First followed by the slight friction noise at shaft speed. This is often referred to the centrifugal switch.

Most of the single phase induction motors can be reversed by changing the connections to start the winding with respect to their run winding.Though not all motors have adequate connections is not done. But in others the connections are eternally made surrounded by the windings and will need expert consideration to overturn them. The single phase induction motor it is necessary to ensure that it also rotates in the correct direction for our application or it is readily reversible.

3.STATOR FAULT PROTECTION

A typical design of a unit connection with the elements generator, The two types of transformers are in induction motor. one is step-up transformer and another one is supplementary transformer. It is depending on their plant arrangement, and the generator circuit breaker may be moreover available. The potential location of an earth blame is noticeable by the circle. Transient over voltages implicated with isolation mature lead to the earth. The mechanical harms can also basis isolation injure and an earth fault arises out of that. The fault location can be occur in anywhere in the stator winding, To minimize the harm of the stator core and winding the fault current is usually partial from 10 A and in worst case situations up to 20 A .

In praxis there exist two ways of calculating the necessary load resistance RL. In li argumentation starts with the option of transient over voltages during irregular earth faults at isolated generator star points. A grounding of the star point only provides for limiting transient voltages, but a compromise must be found between the permitted fault current and the acceptable transient overvoltage.

The limits the transient over voltage in the healthy phases to a maximum of 2.5 times of the phase to earth voltage.Another argumentation in highlights the danger of an over function by the stator earth fault protection due to an earth fault on the high voltage side of the step up transformer. The displacement voltage on HV-side can lead to a trouble voltage on generator side via the capacitive voltage divider.

4. EXISTING SYSTEM

Here,The Acoustic emission (AE) sensors are used to describe put on in machine tools and monitoring the bearing fault and equipment problems in centrifugal pumps. First they developed the Non-Destructive Testing (NDT) system for sense the cracks. These sensors are used to identify the acoustic productions created by the discharge of vibration waves in a crystalline lattice due to the plastic deformation. An AE sensor is very useful to detect subsurface breaks before emerge on the surface causing additional spoil. Recently, MEMS acoustic sensors are developed, that is the advantage of one system able to be capture the multiple transducers on single substrate. which identify the each sound emission energy at different frequencies. This helps to differentiate false acoustic emissions arising from crash and friction, And it from the those arising from artificial bend. When compared to the characteristic of piezoelectric sensors having lower sensitivities and fail to detect some acoustic emissions. In addition, The acoustic emission signal undergo harsh reduction is crosses the a choice of interfaces, such as a gearbox or bearing coverings. In this test consisting of gear and an related bearing a 44dB reduction was flanked by an Acoustic emission sensors are placed directly on the trap to one placed on the bearing casing, and in some cases in-between losses of the signal were observed.

5. CASE STUDIES

The online stator resistance estimation employed adjusts precisely the stator resistance value relatively to the evolution of the stator current estimation error gradient to avoid the drive instability and ensure the tracking of the actual value of the stator resistance. The multi-resolution wavelet PI controller implemented for the three level wavelet decomposition is computationally far simpler as compared to the multi-resolution technique with separate computations for high and low pass filtering at each level of decomposition. Also it is prominent

by less number of tuning constants and less tuning effort as compared to a standard multi-resolution wavelet controller. The simulation results show that the proposed method can reduce the torque ripple and current ripple, superior to track the actual value of the stator resistance for different operating conditions[16].

A sensor less drive technique for brushless machines based on wavelet theory that provides the advantages of separating low-frequency and commutation effects. The approach adopts two methods of position prediction. The first method employs self-inductance variation, as established with finite element analysis. The second is based on induced voltage and zero-crossing point estimation.

The problem of starting is resolved by sensing inductance for the first method and by providing a look-up table for each direction of rotation for the second method. Both proportional-integral-derivative and fuzzy control algorithms are developed, and simulated current and speed-controlled performance predictions are obtained. Daubechies discrete wavelet analyses of experimental and simulated waveforms are obtained, with emphasis on commutation intervals. An algorithm is developed to predict commutation instants from wavelet results. The simulation model and its wavelet analysis match the experiments.[18]

Electric machines are frequently exposed to non-ideal or even detrimental operating environmental conditions. These circumstances include overload insufficient lubrication, frequent motor start/stops, inadequate cooling..under these condition the induction motor is subjected to undesirable stresses, which put motor under fault of failures. The common faults and their statistical occurrences are listed.

Table:5.1

Types of faults	Number of faults/failures				
	Induc motor	Syn. motor	Wound rotor motor	Dc motor	All motor
Bearing	152	2	10	2	166
Winding	75	16	6	-	97
Rotor	8	1	4	-	13
Shaft	19	-	-	-	19
Brushes	-	6	8	2	16
E.Device	40	7	1	-	18
Others	10	9	-	2	51

6. PROPOSED SYSTEM

In the proposed system The signals of vibration are obtained using the MEMS Acceleration sensor diagnostic model based methods are competent monitoring systems for providing caution and expecting certain faults. That caused due to the overload on the devices in their early stages .The fault diagnostics of system, It is hard to develop an logical model that depicts the presentation of a gear under all its operation positions. It is complicated for a human expert to differentiate faults from the healthy operation. while diagnostic based methods are effective classification method, Here the fault analysis measurement is motor vibration. The MEMS accelerometer having the three axis for measurement. It is fixed top on the motor for measuring the vibrations . Furthermore the predictable methods cannot be applied efficiently for vibration signal analysis. The MEMS accelerometer measure the signals correctly data oriented models are used to categorize faults in induction motor system.

6.1 VIBRATION SIGNALS

The induction motor faults are mostly rising from the mechanical and electrical defects. The reason for mechanical faults will creating by the reason of overloads, and certain or unpredicted load changes, which can create the bearing faults and rotor bar fault. The electrical failure are usually related with their power supply.

The Induction motors can be eager from the constant frequency sinusoidal power supplies or variable speed of alternative current drives. still, The induction motors are more vulnerable to fault when complete by the alternative current drives. This is due to the extra voltage pressure on the stator windings, The high frequency stator current components, and the tempted bearing currents, caused by the alternative current drives. The motor's over voltages be able to transpire. Because the length of cable connections between a motor and an alternative current drive. The consequence is caused by the reflected wave transient voltages .Such as electrical pressures may produce the stator winding short circuits and result in a complete motor failure

6.2. SIGNAL ANALYSIS

Each sequence of X/Y values is considered to be a "signal" (audio signal, spectrum, etc.).Consequently, each sequence has its sampling rate, even if it was not actually created by digitally sampling some analog signal. Sampling rate of an

FFT is simply number of its values (bins) in one Hz. Following this logic, it is possible to perform, for example, FFT analysis on a FFT result. Even if it seems like it does not make sense, it can sometimes be interesting to see the results. Figure(6.2.1) shows the wave signal of vibration measurement signal.

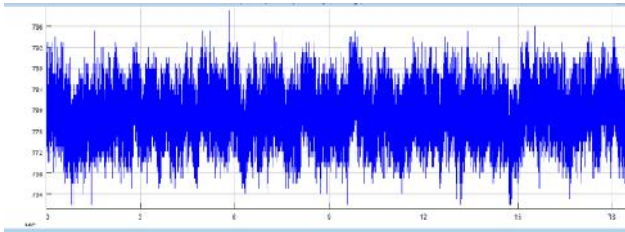


Fig 6.2.1 Wave signal.

The wave signal noises are removed by using the FFT Transformation. Figure (6.2.2) shows the denosing filtered wave signal

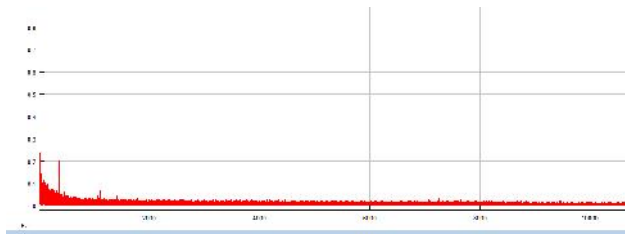


Fig 6.2.2 FFT Wave signal.

The distance between data points will increase logarithmically from left to the right side of the displayed part of the signal. By using this view on an FFT result, lower frequency components will take more space, and the higher frequencies will be shown “compressed” at the right side of the graphics. Showing logarithmic Y-axis is not possible in general. If we need to show our spectrum values on a dB(log) scale. The fault frequency easily able to be analyzed using FFT.

$$X(K) = \frac{1}{N} \sum_{n=0}^{N-1} x(n) e^{-j \frac{2\pi kn}{N}} \quad K=0,1\dots n$$

X(K) is the fourier transform of the signal. K is the frequency index. N is total length of the signal. n time index.

6.3 IMPLEMENTATION

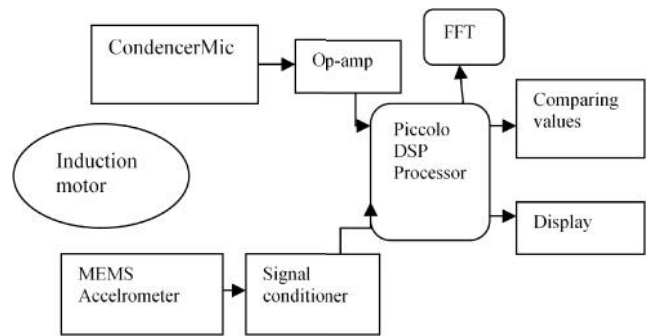


Fig 6.3.1 Block diagram

The Block diagram shown in the figure(6.3.1).The MEMS Accelerometer is fixed top on the induction motor. it measured vibrations from the induction motor. and then the next step is the signal conditioner will analyzing the signals and by using FFT the noise will removed from the wave signal.

6.4 TIME DOMAIN SIGNAL

The time domain signals is unprocessed format. When we design time-domain signals, we will get a time amplitude illustration of the signal. This demonstration is not for all time the best illustration of the signal for most signal processing associated applications. In this time domain signal shows the input signal ranges. Figure(6.4.1).shows the input signal of the time frequency with that signal amplitude.

The frequency spectrums of a signal is essentially the frequency component of the signal.STFT also used to identify the time and frequency domain.The unique signal is divided into the small segments

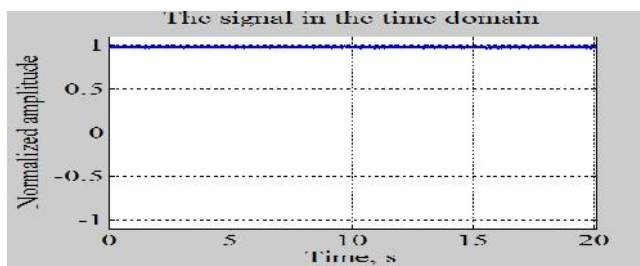


Fig 6.4.1 Time domain signal

$$X(\tau, \omega) = \int_{-\infty}^{+\infty} i(t) W(t - \tau) e^{-j\omega t} dt$$

Here, $X(\tau, \omega)$ is the short time fourier transform. and the $W(t-\tau)$ is the window function of the signal. t is denoted by the time domain signal. and then τ is the delay parameter of the signal.

6.5 SPECTROGRAM OF THE SIGNAL

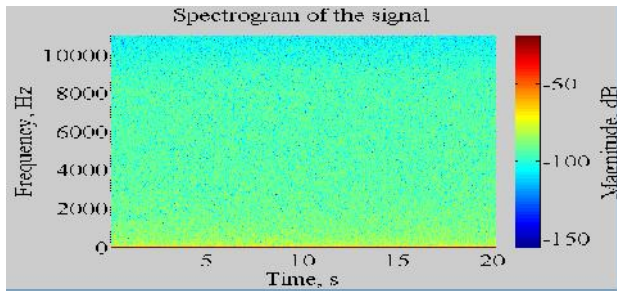


Fig 6.5.1 Spectrogram of the signal

Spectrograms are color-based visualizations of the development of the power spectrum of a audio signal as this signal through time. Spectrograms use the periodogram power spectrum evaluation technique and are widely used.

The spectrogram signal is used to develop a visual kind of the frequency for an audio signal. Figure(6.5.1). Shows the power spectrum estimation of the spectrogram visual result. It is also shows the harmonic levels of the visible signal. These signals are according to their audio frequency range. Time and frequency also shown in this spectrogram.

6.6 AMPLITUDE SPECTRUM OF THE SIGNAL

The amplitude of the spectrum signal. Figure(6.6.1) shows the visualization of the signal based frequency parameters. It used to analyzed the signal and detect the faults in induction motor.

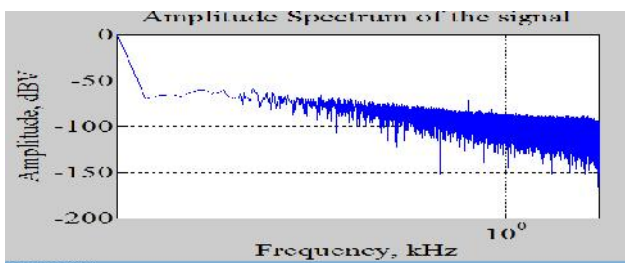


Fig 6.6.1 Amplitude spectrum of the signal

6.7 DYNAMIC FACTOR

The dynamic factor of the signal is analysis for the fault analysis of the signals. it is used for which type of fault form the observed vibration signal. Figure(6.7.1) shows the analysis of the fault in induction motor.

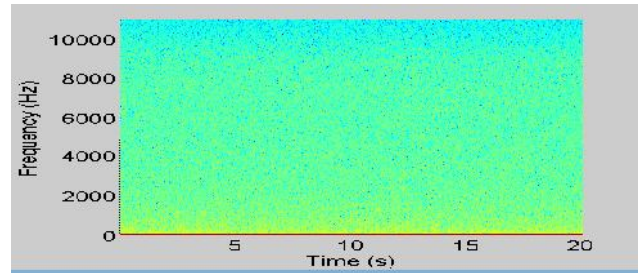


Fig 6.7.1 Dynamic factor

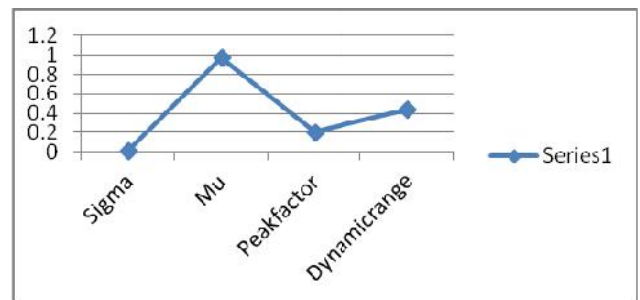


Fig6.7.2 Simulation output of the signal graph

Here, Figure(6.7.2) shows the comparison of values of sigma of time domain signal, Mu of amplitude spectrum of the signal, peak factor of amplitude of the signal and then the dynamic factor of the signal.

These four values of the signals analyzed the range of fault frequency.

6.8 WAVELET TRANSFORMATION

Wavelet transform is competent of given that the time and frequency information at the same time, Therefore charitable a time frequency representation of the signal.

The time domain signal for a variety of filters in high pass and low pass filters. which filters out either high frequency or low frequency sections of the signal. All time some section of the signal analogous to some frequencies removed. Figure(6.8.1) shows the wavelet transformation of the signal. the spectral element exist at any specified time instant. This is a problem of resolution. STFT is a fixed resolution at all times.

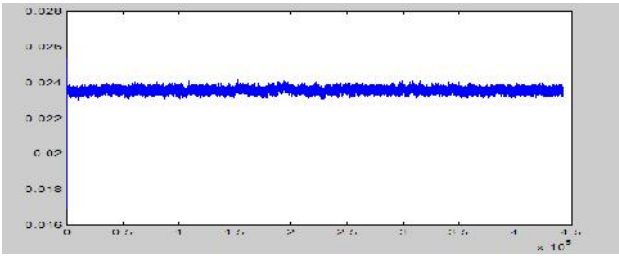


Fig 6.8.1 Wavelet transformation of the signal

$$WT(a,\tau) = \frac{1}{\sqrt{a}} \int_{-\infty}^{+\infty} i(t) \varphi_{a,\tau} * \left(\frac{t-\tau}{a}\right) dt$$

WT is the wavelet transformation of the current signal $i(t)$. τ and a is the translation and scaling. $*$ is the complex conjugate of the functions.

From the mother or scaling function and the coefficients we construct wavelet functions $\Psi(x)$

$$\Psi(x) = \sum_k (-1)^k c_{M-k} W(2x - k) \quad \text{compression or at other levels}$$

$$\Psi(2^{j-1}x) = \sum_k (-1)^k c_{M-k} W(2^j x - k) \quad \text{with generally}$$

$$\Psi_{jk} = \sum_k (-1)^k c_{M-k} W(2^j x - k)$$

6.9 DECOMPOSITION OF THE WAVELET TRANSFORMS

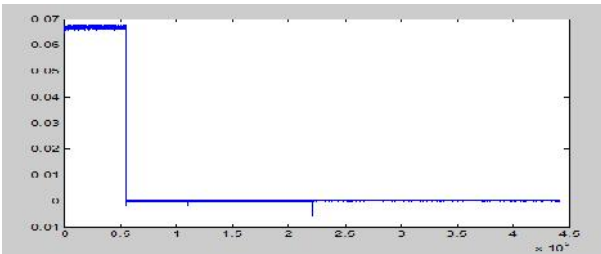


Fig 6.9.1 Decomposition of the wavelet signal

This is the shown in a figure(6.9.1)is the normal wave of the signal. The wavelet transforms and decomposition are also applied in this signal. The high frequencies are determined by time, and lower frequencies are determined by frequency. This means that, a certain high frequency element can be located better in time than a low frequency element. The low frequency element can be positioned in frequency compared to high frequency component.

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6.11 CONCLUSION AND FUTURE WORK

The most severe troubles in Industrial Motors are involving in mechanical failures, Particularly for rotating parts of the rotor gears and generators. Hence, Motor strength checking system is most important part of the industrial Motors. Additionally, The wireless sensor technology create likely to compute and manage the vibrations of the motor for the duration of process time.

This techniques of mechanical failure exposure through the vibration analysis and evaluated oriented on their capability to finding motor irregularities. MEMS accelerometer is very low cost, low weight, compact in size and low power consumption. These are the advantages of the MEMS accelerometer, a vibration detection technique is proposed in this dissertation.

Motor vibration analysis in time and frequency domain has been analyze and a harshness detection technique is also implemented. The implementation of mechanical fault monitoring system can be used to approximation the range of harshness levels. It is very useful for the condition based predictive maintenance.

The major charity of this future works are the piccolo DSP processor based fault monitoring system in induction motor. Development and implement a MEMS oriented wireless sensor network for a physical condition monitoring which will be competent to perceive the mechanical fault conditions based on the vibration signature. To reduce the downtime and manual procedures by continues monitoring of wind turbine operations.

Developing a new predictive monitoring system instead of protective system to ensure the Good condition of wind turbines. To develop a wireless monitoring system to overcome the drawbacks of wired networks. The overall cost of the monitoring system gets reduced due to no usage of wired conductors for signal transmission. The low cost microcontrollers and low power consumption equipments are used.

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