Use of Wavelet Transform For Detection of Rotor Broken Bar and Vibration Faults Detection

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Abstract— **In industrial based applications, the machines can be improved through equipment monitoring. This reduces the risks of unexpected failures and resultant plant outages. Since all failure modes can cause an increase in machine vibrations, monitoring this area is the major and most widely used method to determine equipment condition, and to predict failures. In the proposed system, we detect two types of induction motor faults such as broken rotor bar faults and vibration faults. For the detection of broken rotor bar faults, Motor Current Signature Analysis technique is used. For broken rotor faults we measure current through transformer and for vibration faults we use ADXL 335 vibration sensor is used. From the current and vibration signal we extract characteristic frequencies and apply wavelet transform for detection of faults.**

Index Terms— **Motor current signature analysis, Rotor Broken bar, Vibration fault, Wavelet transform.**

I. Introduction

Induction motor has been used in 90 percentage of industries because of having low cost, Construction and maintenance. it is available in horse power to thousand horse power. If there is certain kind of fault occurs on induction motor all system will get collapse.

The faults on Induction motor are categorised as Electrical type, Mechanical Based and environmental based faults. The Electrical faults consists of unbalance supply voltage or current, single phasing, under or over voltage of current, reverse phase sequence, earth fault, overload, inter-turn short-circuit fault etc. The faults under mechanical are consist of broken rotor bar, mass unbalance, air gap eccentricity, bearing damage, rotor winding failure, and stator winding failure.

In rotor broken bar fault, if one bar breaks, the next bars carry currents greater than their design values, causing more damage if the broken bar condition is not quickly detected. So it is important to detect this fault at premature stage. It is experimental that for any of the bearing failures, normally friction increases which causes go up in temperature of the bearings and increase in trembling of the concerned machine.

A motor condition monitoring experiment is set up, and the motor's operational speed is controlled by an AC motor drive. The vibration of the motor is measured and monitored. The measured vibration data is analyzed using spectrum analysis software and a MATLAB program. The overall vibration level is monitored, the vibration severity is compared with the standard severity table and is used to determine the condition of the motor.[1]

The contribution of this investigation is the development of a condition monitoring strategy that can make reliable assessment of the presence of a specific fault condition in an induction motor with a single fault present through the analysis of sound signal. The proposed methodology is based on the combination of Intrinsic Mode Functions (IMFs) and the Fast Fourier Transform (FFT) methods. Results show that the proposed methodology can be applied to sound signal analysis; there this detection technique is suited for detection of fault frequencies in induction motors.[2]

while the increase of harmonic current distortion in order 3rd, 5th, 7th and acoustic noise, also in analyzed fault, harmonic and acoustic noise is the relationship, an effect to a high-temperature efficiency of the induction motor will high temperature efficiency of the induction motor will decreasing and energy consumption.[3]
In the projected method, broken bar detection is based on the disintegration of the stator currents, where wavelet coefficients of these signals have been extracted. Comparing these extracted coefficients is used for diagnosing the healthy machine from faulty machine. Experimental results are presented for healthy, and machines with two, three, four, and five broken bars in their rotor.[4]

Stator phase current was worn for wavelet analysis. Discrete wavelet transform (DWT) coefficients of stator current in a specific frequency band are derived and analyzed. Wavelets db8, db9, db10, sym7 and sym8 are employed to analyze broken bar distorted stator current. The sensitivities of these wavelets to fault signal are compared and assessed to select the most optimal one.[5]

II. Methodology:

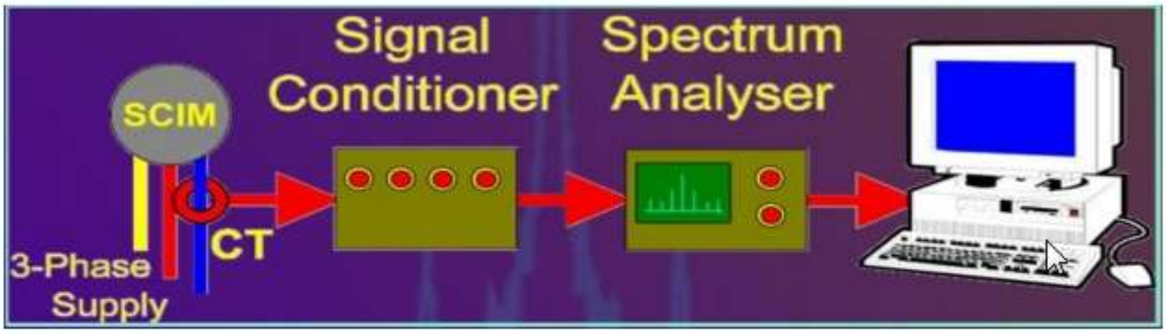
There are several common motor faults that can be identified using vibration analysis such as imbalance, mechanical looseness, and bearing faults. Each fault condition's severity and type can be assessed based on the amplitudes of the corresponding peaks as well as their respective locations on the frequency spectrum.
There are so many techniques are used for the surveillance and diagnosis of the rotating machinery.
Detection of the rotor bearing system using amplitude deviation Curve technique. the analysis of dynamic behaviour of a cracked rotor. vibration signature analysis of a rotor with a rotor stator rub, transverse fatigue crack and unbalance.
For detection of rotor broken bar Current signal analysis is used. The motor current signal analysis is used for the detection of broken rotor bars in induction motor. The analysis is done by using two methods that are FFT and wavelet transform.

The FFT transform has some restrictions and to get a better result analysis Wavelet transform is used. The Wavelet and Vibration analysis is used for the Protection of motor through that two faults are get detected that are Rotor broken bars and Vibration faults which is mostly related to bearing failure.

III. TOPOLOGY OF PROJECT:

- Motor Current Signature Analysis Basics

Motor current signature analysis can detect faults such as abnormal air gap eccentricity broken rotor bars, shorted turns in low voltage stator windings, and certain mechanical problems/drive train characteristics. Motor current signature analysis is the technique of online analysis of current to detect faults in a three-phase induction motor drive when it is in working and in service mode as shown in Figure.

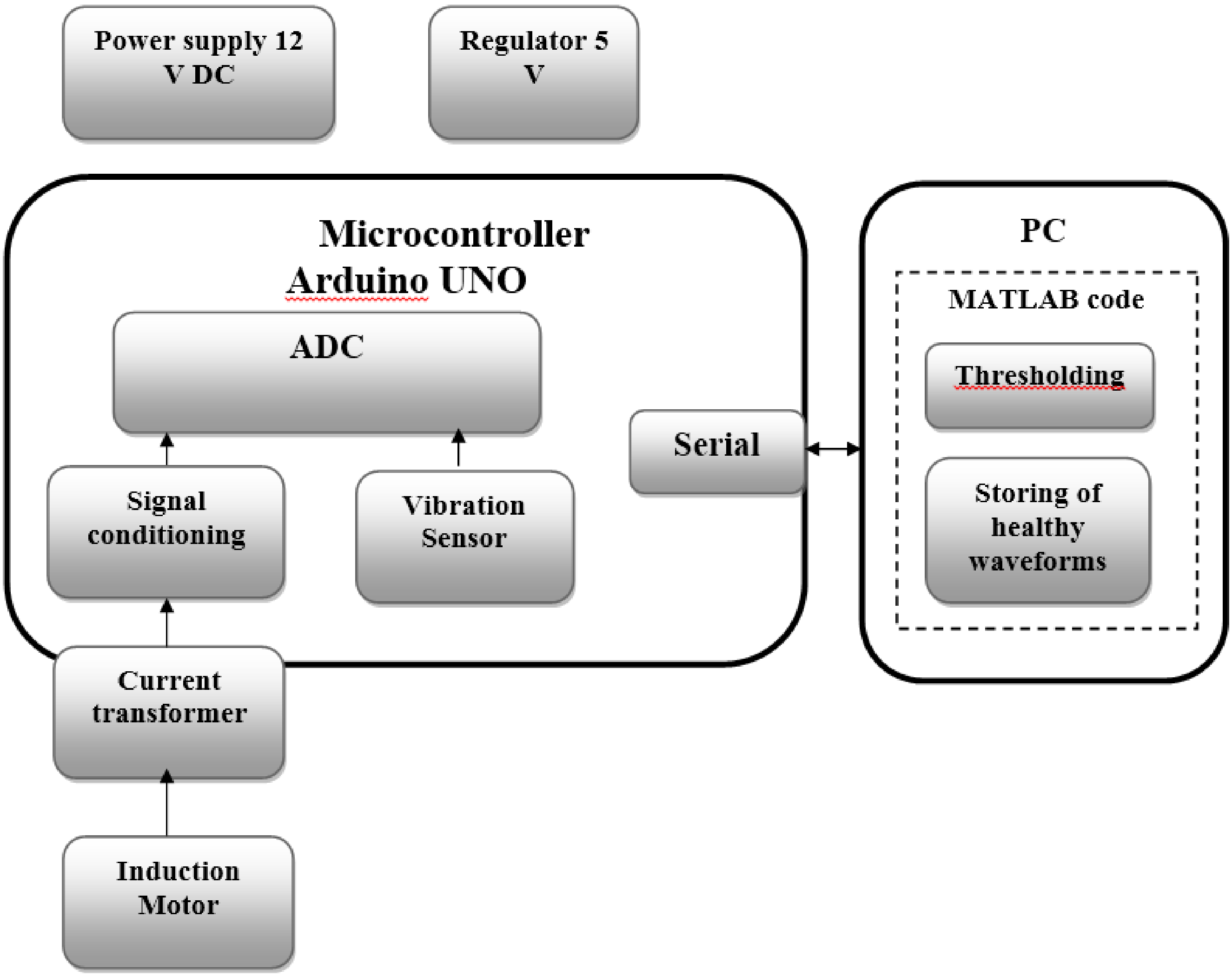


A basic MCSA instrumentation system consists of the following:

- A current transformer (CT) to sense the signal.
- A resistive shunt across the output of the CT- CTs is available with internal shunts.
- An MCSA instrument (spectrum analyzer) to produce the current spectrum or signature.

An idealized current spectrum is shown in Figure which represents the twice slip frequency sidebands due to broken rotor bars. Decibel (dB) versus frequency spectrum is used to give a wide dynamic range and to detect the unique current signature patterns that are characteristic of different faults.

The basis of fault detection or identification is the difference in normalized current RMS values of both healthy and faulty bearings. Broken rotor and eccentricity in the rotor and the stator of an induction motor result in side bands of electric supply line frequency. Prior knowledge of spatial position of fault and the load torque with respect to the rotor is necessary as the effects of load torque and faulty conditions are difficult to separate. Current signals can be analyzed in the time-domain or the frequency-domain. The former is also capable of analyzing systems during transients, such as during the initial or final operation of the system. MCSA requires amplitude information of the motor currents. The currents have imbedded information on the driven loads, with the information being available in the frequency domain or the time domain. To obtain rotor speed, frequency-domain analysis is chosen.



The project consists of microcontroller along with other peripherals. We will be using microcontroller Arduino Uno. Other peripherals include Induction motor, signal conditioning circuit, current transformer, serial communication circuit, USB to serial converter, PC and power supply. We will be monitoring two faults. 1st is broken rotor shaft and the other is vibration of motor. For broken rotor detection, we will have to measure current. The current of motor will be monitored through current transformer. Current should be effectively monitored to achieve improved condition monitoring and protection system for induction motor. Signal conditioning circuit will be used to measure current at microcontroller end. Signal conditioning is needed to make the current signal compatible to microcontroller to read. Current will be measured through internal ADC of microcontroller. The current data in the form of digital signal will be transmitted to PC end through serial communication circuit wand USB to serial converter. At the PC end, current data will be processed through various blocks wavelet transform of the data will be taken. Also, healthy waveforms will be stored in database. Also, 2nd fault, vibration of the motor will be measured using vibration sensor ADXL335. Output of this sensor is analog. We have to use another ADC channel to acquire the signal of vibration sensor. Similar to 1st fault, signal of vibration sensor is also sent to Matlab and get processed. Wavelet transform of the signals will be calculated and compared with the previously stored healthy waveform.

IV. Conclusion:

The proposed algorithm is applied to the rotor current of a healthy and faulty induction motor. The wavelet transform analysis is used to detect fault regarding Rotor broken bars and vibration sensor is used to detect the faults regarding vibration.

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