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MONITERING AND DIAGNOSIS OF STATOR INTER TURN FAULTS AND SUPPLY UNBALANCE IN THREE PHASE INDUCTION MOTOR

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Abstract - *Induction motors are one of the commonly used electrical machines in industry because of various technical and economical reasons. Three-phase induction motors are the "workhorses" of industry and are the most widely used electrical machines. In an industrialized nation, they can typically consume between 40 to 50% of all the generated capacity of that country. Stator fault is one of the most commonly occurring faults in ac machines. Early detection of faults in stator winding of induction motor is crucial for reliable and economical operation of induction motor in industries i.e condition monitoring of machine is more important.This paper proposes a Motor Current Signature Analysis technique to diagnose the stator inter turn fault and supply unbalance fault in induction motor using complex wavelet transform . The current signals are captured by using power network analyzer DIP8000(UNIPOWER) with sampling frequency 6.6kHz .This data is then processed and analyzed using Wavelet transform.*

***Key Words*:**
Induction motors, Inter turn faults , supply unbalance, Motor current signature analysis (MCSA),Wavelet transform.

1.INTRODUCTION

Induction motors are widely used in industrial applications since they are highly reliable, require low maintenance and have high reliability but they are susceptible to many types of faults. If a motor failure is not detected at an early stage, it may become catastrophic and damage the motor. This will in turn cause production shutdown. In [1], industrial case histories are presented. One of them is a case where a broken rotor bar had lifted in the slot and it resulted in damage of high voltage stator winding.

Generally, stator winding insulation thermal stresses are categorized into three types: aging, overloading and cycling [2]. The lead time between the start of the fault and the complete failure of the machine depends on several factors, namely the initial number of shorted turns, winding configuration, ratedpower, ratedvoltage, environmental condition etc [3]. Wavelet techniques for fault monitoring and diagnosis of induction motor are increasing because these techniques allow performing stator current signal analysis during transients [4]. It is thus a powerful tool for condition monitoring and fault diagnosis. Inter turn fault and supply unbalance is detected with the help of absolute peaks of standard deviations of the coefficients of all three phases in which the fault occurs.These fault phase coefficients are compared with the healthy phase coefficients. Almost 90% of induction motors are provided with squirrel cage motor because of its very simple, robust and almost inscrutable construction.

1. WAVELET TRANSFORM

1.1 INTRODUCTION TO WAVELETS

Wavelets are mathematical functions that cut up data into different frequency components, and then study each component with a resolution matched to its scale. They have advantages over traditional Fourier methods in analyzing physical situations where the signal contains discontinuities and sharp spikes. Wavelets were developed independently in the fields of mathematics, quantum physics, electrical engineering, and seismic geology.

"A wavelet is a waveform of effectively limited duration that has an average value of zero"

1.2 WAVELET TRANSFORM

Wavelet transform (WT) is an efficient means of analyzing transient current and voltages. Wavelet analysis represents the next logical step: a windowing technique with variable-sized regions. Wavelet analysis allows the use of long time intervals where we want more precise low-frequency information, and shorter regions where we want high-frequency information.

Fig 1 Wavelet analysis of given signal

The complex wavelet transform (CWT) is a complex-valued extensiontothestandard discretewaveletransform (DWT). It is a two-dimensional wavelet transform which provides multiresolution, sparse representation, and useful characterization of the structure of an image or signal. Wavelet Transforms are used to compress the fingerprint pictures for storage in their data bank. Data compression can be achieved by discarding these low amplitudes.

2. Experimental set up

Currently electrical motors are amongst the most useful equipment in the industry. For an experimental purpose 3H.P, 3 phase, 4 pole, 415 volts, 50 Hz,15A squirrel cage induction motor is considered for the analysis of stator inter-turn faults. Experimental setup of the three phase Induction motor is shown in Fig 1.2. Dip 8000 is used to capture the three phase stator currents Stator currents and are used to analyze the various inter turn faults with the help of Wavelet Transforms.

Fig 2: Experimental set up of 10-HP three phase Induction motor Stator inter turn fault detection.

A. Interfacing Device-DIP 8000(Power network analyzer):

DIP 8000(UNIPOWER) is specially designed for power distributors, utilities, industries, consultants, hospitals and many other user categories in need of advanced measuring equipment in the power network environment.

2.1Faulty phase detection by using Wavelet analysis based on the standard deviations of the current signals.

The current signals are captured by using power network analyzer (DIP8000) with a sampling frequency of 6.6 KHz. These signals are analyzed by using 'cgau'mother wavelet to obtain the 5th level and 2^6 sclale coefficients. The detection of faulty phase can be analyzed by comparing the standard deviations of 5th level scale of 2^6 coefficients of three phase stator currents are compared with a threshold to identify the faulty phase.Now let us consider fault in B-phase .

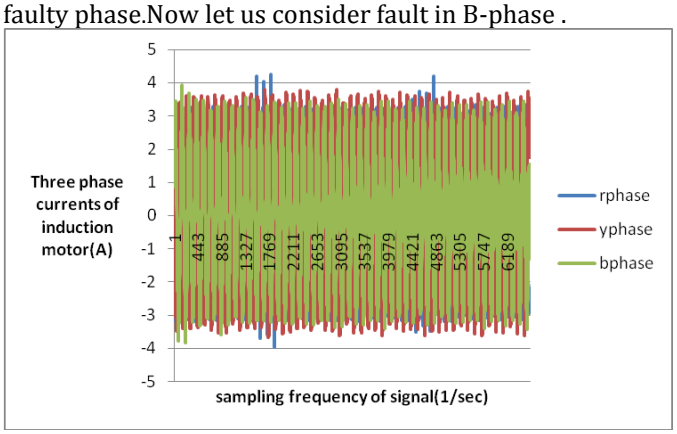

Fig 3: Healthy 3-phase currents of induction motor

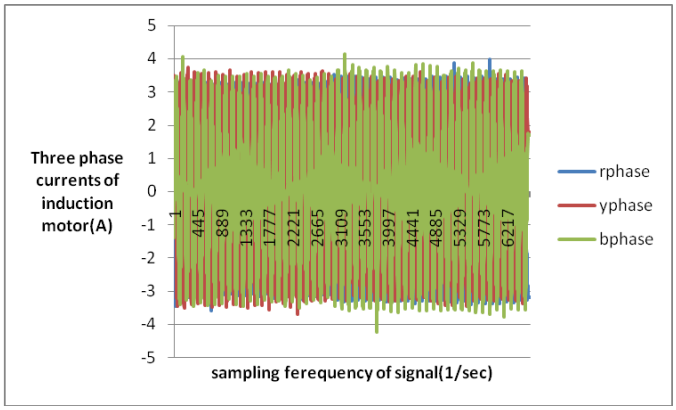

Fig 4 : Two turn fault in B-phase of induction motor

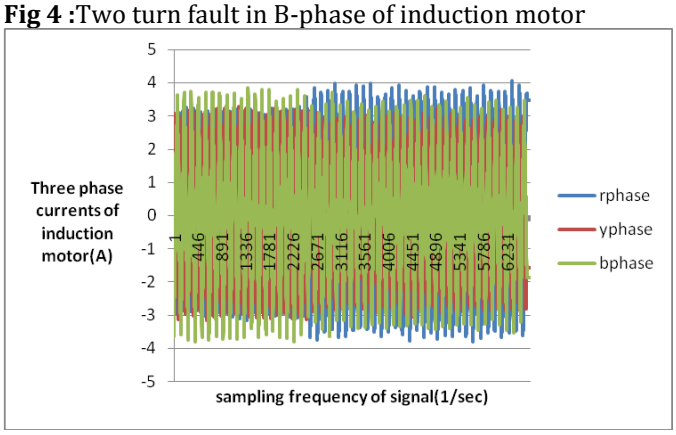

Fig 5: 1v drop in voltage of B-phase of induction motor

The current signals are now analysed by the cgau 5th level and scale is 2^6.This scale coeffients are now analysed by taking one cycle each of all points.And standard deviations are taken for all points.By taking the healthy values as threshold we can write a algorithm .Like this for all R-phase,Y-phase having 2-turn, 4-turn,6-turn,8-turn and for all voltage dips below 5% we can apply the same algorithm and get the good results by detecting fault.

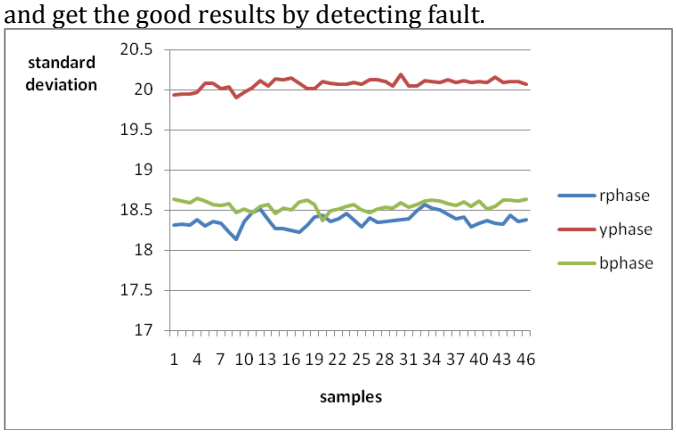

Fig 6: Standard deviations of healthy phases of induction motor.

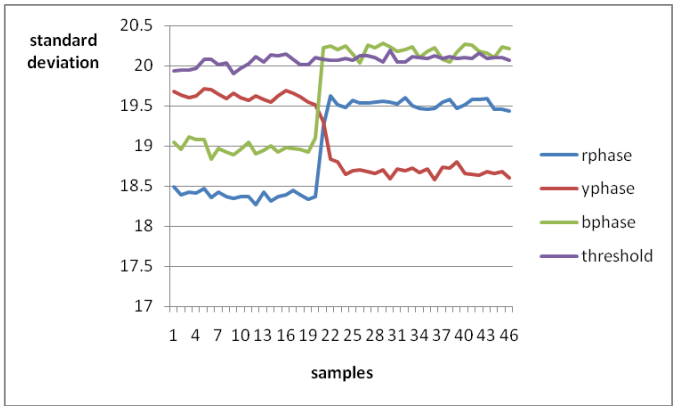

Fig 7: Standard deviation of two turn fault in B-phase

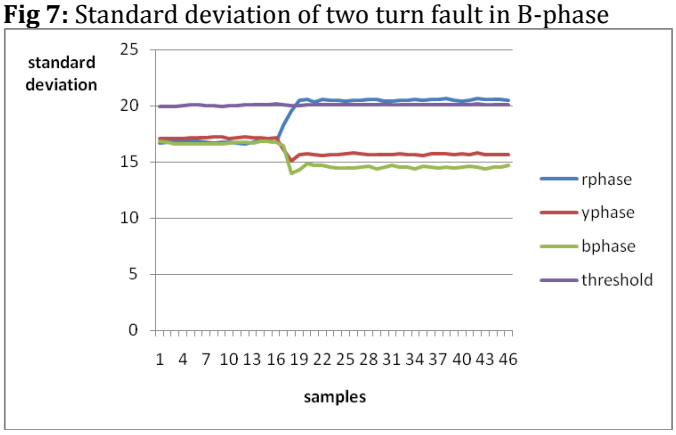

Fig 8 : Standard deviation of supply unbalance of 1v dip in B-phase

2.3ALGORITHM:

Decompose the three phase currents of induction motor upto 5th level with 2^6 coefficients of cgau mother wavelet.
Obtain the fault coefficients from 3-phase currents.
Take one cycle analysis of all the coefficients obtained .
The Standard deviations of healthy case values are calculated first.
The highest maximum point of the standard deviatons of all healthy phases is now treated as threshold value.
If the highest maximum points of atleast any two phases is above than threshold value then we can say that Inter turn faut occurs .
Else if
This highest maximum point will be there , that phase is the faulty phase.
End if
End if
Else
If the highest maximum points of atleast two phases is below than the threshold value than we can say that Supply Unbalance is occurs.
Else if
This lowest maximum point will be there ,that phase is the faulty phase.
End if
End if

CONCLUSION:

Complex Wavelet decomposition is a superior method of signal analysis in time varying situations due to spatial data retention. Analysis using Complex wavelets produces both frequency and spatial information providing a robust solution for motor fault detection. Damage of stator insulation is the most frequent failure in electrical motor. The current signals are captured by using DIP8000 and analyzed by usingComplex Wavelet analysis. This paper proposes an algorithm to detect the stator inter-turn fault supply unbalance ,identify the faulty phase by using Complex wavelet-based multi resolution analysis. The proposed algorithm gives better performance to detect the stator inter-turn fault,supply unbalance and identify the faulty phase because of the threshold.
We can apply this algorithm to different ratings of induction motors for fault detection.

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