

Rotor Fault Detection of Induction Motor with the help of Signal Processing

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Abstract—Due to reliable and low cost the Induction motors are widely used. The early detection of upcoming fault removal is very necessary for the prevention of failure of the induction motors, reducing repairs costs and total motor outage time. In this paper current signals are processed and results can be analyzed. DSP based detection of rotor fault allows machine monitoring to be carried out on-line with a consequent increase in the system. The fault detection for induction motor based on Signal Processing is done in this paper.

Keywords-DSP processor, Induction motor, Rotor fault, Squirrel cage Induction Motor.

I. INTRODUCTION

Though induction motors are more robust but It may damage and hence early detection of failure is needed before they affect the whole operational performance. This kind of early fault diagnosis can increase machine availability and performance, reduce sequential damage and breakdown cost. To avoid the unwanted shutdown and increases the serviceable life of equipment, one must go for predictive maintenance instead of the conventional time based maintenance. This process reduces the possibility of motor failure during operation. By using this predictive maintenance one can get the higher reliability and low substantial cost. Therefore fault diagnosis and protection is very important as machine themselves. There are a number of techniques available for detection of nature and degree of faults in an Induction motor.

The various types of faults in induction motor are single line to ground fault, double line to ground fault, line to line fault, single phase fault, under and over voltage fault etc. this proposed method is applied to an induction motor using DSP processor kit to identify the single phase fault online based on the stator current and the measured data get analyzed. Research has picked up a fervent place in the area of fault diagnosis of electrical machine. The manufacturers and users of electrical machine initially relied on the simple protection such as over current, over voltage, earth fault etc .to ensure safe and reliable operation. There are many condition monitoring methods including vibration monitoring, thermal monitoring, chemical monitoring, acoustic emission monitoring, but all these monitoring methods require expensive sensors specialized tools , whereas current monitoring out of all does not required additional sensors . this is because the basic electrical quantities associated with electromechanical plant such current and voltage are readily measured by tapping into existing the current and voltage transformer that are always installed as a part of protection system . So the stator current is used for monitoring and fault detection of induction motor to DSP.

Digital Signal Processors (DSPs) are microprocessors with the following advantages(a) Real-time digital signal processing capabilities. DSPs typically have to process data in real time, i.e., the correctness of the operation depends heavily on the time when the data processing is completed.

- b) High throughput. DSPs can sustain processing of high-speed streaming data, such as audio and multimedia data processing.
- (c) Deterministic operation. The execution time of DSP programs can be foreseen accurately, thus guaranteeing a repeatable, desired performance.
- (d) Re-programmability by software. Different system behavior might be obtained by re-coding the algorithm executed by the DSP instead of by hardware modifications.

DSPs appeared on the market in the early 1980s. Over the years they have been the key enabling technology for many electronics products in fields such as communication systems, multimedia, automotive, instrumentation and military.

II. BROKEN ROTOR BAR AND END RING FAULT

Induction motor rotor faults are mainly broken rotor bars because of pulsating load and direct on line starting. It results into fluctuation of speed, torque pulsation, vibration, overheating, arcing in the rotor and damaged rotor laminations. The broken rotor bars problem belongs obviously to the rotor related faults. This can be a serious problem with certain induction machines submitted to start-stop constraints. Although broken rotor bars do not initially cause an induction machine to fail and to stop definitively, they can lead to serious secondary effects. The fault mechanism can result in broken parts of the bar hitting the end windings at high velocity, this can cause serious mechanical damage to the insulation and consequently a winding failure may occur resulting in a costly repair and a lost of production. In hazardous environments, sparking at the fault site during the degradation process can be a potential safety hazard. The reasons for rotor bar and end-ring breakage are numerous and they can be a consequence of thermal stresses due to the overload on the shaft, imbalance in the power supply, hot spots, excessive losses, magnetic stresses caused by electromagnetic forces, imbalanced magnetic pull, electromagnetic noise or vibration, dynamic stresses arising from shaft torque or bearing failure. Various methods for rotor fault detection have been reported in the literature. Motor current signature analysis (MCSA) can diagnose problems such as broken rotor bars, shorted turns in low voltage (LV) stator winding and air gap eccentricity in three-phase induction motor drives. Induction machine stator voltages and currents are measured, recorded and used for computation of the partial and total input powers and the estimated torque. The different waveforms for the stator current, partial input power, total input power and estimated torque are subsequently analyzed using the fast Fourier transform (FFT). The reasons for rotor bar and end ring breakage are several.

They can be

- (a) Thermal stresses due to thermal overload and unbalance, Hot spots or excessive losses, sparking (mainly fabricated Rotors),
- (b) Magnetic stresses caused by electromagnetic forces, Unbalanced magnetic pull, electromagnetic noise and

Vibration, (c) Residual stresses due to manufacturing problems, (d) Dynamic stresses arising from shaft torques, centrifugal Forces and cyclic stresses, (e) Environmental stresses caused , for example Contamination and abrasion of rotor material due to Chemicals or moisture, (f) Mechanical stresses due to lose laminations, fatigued Parts, bearing failure etc.

III. METHODOLOGY

The objective is to identify the fault in their incipient stage to avoid any unwanted shutdown and malfunctioning of motor. In online condition monitoring this objective can be achieve accurately and in very short time.

3.1 Problem Identification

Reliability of a motor operation is especially important where an unexpected shutdown might result in the interruption of critical services such as medical, transportation or military, industrial operations where failure potentially could lead to costly maintenance or loss of life. A motor failure that is not identified in an initial stage may become catastrophic and the induction motor may suffer severe damage. Thus, undetected motor faults may cascade into motor failure, which in turn may cause production shutdowns. Such shutdowns are costly in terms of lost production time, maintenance costs, and wasted raw materials. Therefore condition monitoring and fault detection is most important as machine itself. If we study about motor faults, we found that most of the research work have been carried in the area of stator fault. As the stator related faults are 40% so researchers concentrated on the stator faults. Rotor related faults are 10% though percentage of rotor failure is small, if rotor fails then it takes more time to repair, has more production cost. There is lot of work for rotor faults, broken rotor faults, end-ring bar faults. Condition monitoring and fault detection of induction motors is based on the signal processing techniques. The signal processing techniques have advantages that these are not computationally expensive and these are simple to implement. Therefore fault detection based on the signal processing techniques is suitable for an automated on-line condition monitoring system. Rotor faults in the stator current of induction motor operating at different load conditions. Most of the researchers it has been found that, stator current get affected due to various faults and maximum information can be extracted from stator current to diagnose various faults. For that purpose signal processing is done. Now a day's digital signal processor has been occupied important place

in many areas of engineering including condition monitoring. So, now a day's DSP is being widely used technique to analyze the motor signals to identify the faults at their incipient stage.

3.2 Assumptions

The following assumptions are made to model the three-phase IM

- (a) Space harmonics of the stator and rotor magnetic flux are negligible.
- (b) High permeable iron.
- (c) Stator and rotor windings are sinusoidal distributed in space and replaced by an equivalent concentrated winding.
- (d) Magnetic saturation, anisotropy effect, core loss and skin effect are negligible.
- (e) Windings resistance and reactance do not vary with the temperature.
- (f) Currents and voltages are sinusoidal terms.

The motor fault can occur due to various reasons as; stator insulation can fail due to several reasons. Primary among these are; high stator core or winding temperatures, slack

Core lamination, slot wedges, and joints, loose bracing for end winding, contamination due to oil, moisture, and dirt, electrical discharges. The reasons for rotor bar and endring

Breakage are several. They can be caused by the; thermal stresses due to thermal overload and unbalance, hot spots, or excessive losses, sparking (mainly fabricated rotors), magnetic stresses caused by electromagnetic forces, unbalanced magnetic pull, electromagnetic noise, and vibration, residual stresses due to manufacturing problems.

There are several main reasons of rotor faults

- (a) During the brazing process in manufacturing the non-uniform metallurgical stresses

May be built into cage assembly and these can also lead to failure during operation.

- (b) A rotor bar may be unable to move longitudinally in the slot it occupies, when thermal stresses are imposed upon it during starting of machine.

- (c) Heavy end rings can result in large centrifugal forces which can cause dangerous stresses on the bars.

In online condition monitoring method, DSP is used for signal processing to detect the various faults very accurately and at incipient stage. for that purpose different algorithms are used in DSP processor like FFT, WT, etc. so by using the algorithm we can develop the program to monitor the status of online IM.

IV. FIGURES

Fig. Shows the experimental setup for rotor fault detection method by using DSP. It consists of induction motor, sensor, anti-aliasing filter and DSP controller. In the given fault detection method, the current signal is taken from rotor supply by current sensor. The AC current signal is fed to ADC of DSP through anti-aliasing filter. A sensor is a device that detects events or changes in quantities and provides a corresponding output, generally as an electrical or optical signal. An anti-aliasing filter is a filter used before a signal sampler, to restrict the bandwidth of a signal to approximately satisfy the sampling theorem. A realizable anti-aliasing filter will typically permit some aliasing to occur; the amount of aliasing that does occur depends on a design trade-off between reduction of aliasing and maintaining signal up to the Nyquist frequency and the frequency content of the input signal. The sensor is used to step down current signal. Then the dc signal is fed to ADC of DSP controller. The LCD display is used to monitor the status of three phase induction motor. For that purpose programming should developed for interfacing of DSP with LCD display. We have to also select the algorithm for programming in DSP. According to the programming of DSP. LCD will monitor the status of induction motor.

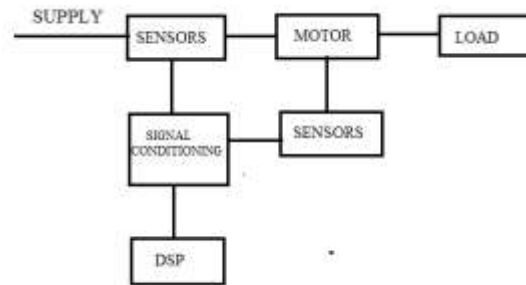


FIG. 1: Basic block diagram of induction motor for fault detection using DSP

V. SCOPE OF WORK

Problem is identified in the last Chapter and in this Chapter scope of the work is presented. Induction motors are widely used in the industrial drives because of rugged, reliable and economical. While operating induction motor various stresses in the motor i.e. thermal stress, electrostatic stress, electromagnetic stress, and mechanical stress therefore windings get affected. There is possibility to damage stator, rotor winding and bearing. To detect such motor faults are essential to reduce revenue loss and shutdown time. As per literature survey stator faults are 30%, rotor faults are 10%, bearing faults are 40%. The researchers are concentrated on stator and bearing related faults because they are comparatively frequent. Though rotor related faults are low in percentage very few work is done on rotor related faults. There are various traditional methods to monitor the rotor related faults such as MCSA, FFT and discrete wavelet transform. But there are some drawbacks of the above traditional methods. Such as it is difficult to distinguish broken rotor bar related frequency for measured data using on FFT algorithm. The objective of this seminar is to detect rotor fault using DSP. DSP has real-time digital signal processing capabilities. DSPs typically have to process data in real time, i.e., the correctness of the operation depends heavily on the time when the data processing is completed. A DSP based architecture for detection of rotor fault allows machine monitoring to be carried out on-line. Stator current of induction motor operating at different load conditions to achieve this the two types of fault broken rotor bar fault and unbalance rotor fault are replicated in laboratory and their effects on the spectrum of motor current studied. This helps in better understanding the behavior of rotor faults in induction motor.

VI. CONCLUSION

In this paper induction motor rotor faults are identified using signal processing analysis.

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