Analysis of Motor Faults Based on the Vibration Signal and Virtual Instrument Technology

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***Abstract*— Motor is one of important equipment's to convert electrical energy to mechanical energy in the modern production and it plays an important role in modern industrial plants. In this work virtual instrumentation and vibration analysis are applied to motor to monitor and detect various failures. This paper is based on virtual instrument system which is composed of piezoelectric type acceleration transducer, USB data acquisition and a notebook computer. In addition, LABVIEW is selected as the software developing platform and vibration signals of motor is analyzed by power spectrum method.**

Machine vibration analysis and motor current spectrum analysis have recently been widely used for the purpose of condition monitoring and detection of mechanical faults in induction machines. Although the current is as good as the vibration in indicating the presence of a fault and the plot of the components of interest in the current versus load does not necessarily look like a plot of the components of interest in the vibration versus load. This is due to several reasons but most important is that the vibration sensor measures the absolute movement of the motor while the current reflects a relative movement.

***Keywords*—**Virtual Instrumentation, Vibration signal analysis, Power spectrum and LabVIEW, Induction Motor.

I. Introduction

The risk of motor fault can remarkably induce a serious danger to the normal life and productive activities of the people. It may reduce costly expensive downtime if signs of failure can be distinguished availably. Vibration is one of the key indicators of quality of motor, when they are steady work; the vibration spectrum has certain characteristics, if there is an internal failure, then the corresponding vibration spectrum or other parameters will also change. In addition, the motor vibration waveform is not a single sine wave, but composed of many different frequencies waveforms. Therefore, the vibration spectrum of motor need to be analyzed to preventing malfunction and resolving in a timely manner.

Over the past 20 years, the virtual instrument technology has made considerable development and been widely used in areas such as engineering test. Compared with traditional instruments, virtual instrumentation technology has several advantages, for example, high-performance, excellent expands ability and so on.[1]

Motors are uses everywhere nowadays, but less invention to detect the fault of motor. Fault can be detected by temperature, current, vibration analysis method etc. Vibration is one of the indicators to detect the fault of motor. It is based on frequency domain analysis. Comparison between old and new graphical representation of vibration signal is uses to detect the fault. Power cestrum analysis is also helpful to detect the fault.

II. conditional monitoring

Maintenance is required in regular interval of time. There are various types of maintenance techniques of a machine through which the fault can be detected. In break down maintenance, regular servicing of machine is not done until the machine breaks down. In preventive maintenance, machine requires regular maintenance after stipulated time period whether the machine runs or not. At that particular period, the work of machine has been stopped. It is costly method of maintenance because production has been stopped at that period. In predictive maintenance, the performance & relative data of machinery have been collected. This helps for planning the maintenance of machinery in advance that results less maintenance cost. Due to smooth efficiency and productivity, the operating cost can be reduced. It is called on line condition monitoring of the system. Predictive maintenance technique includes vibration monitoring system [2].

Vibration occurs when a machine runs. It is an important technique in which internal faults of the machine can be easily detected. There are various causes for which vibration occurs. These are repeating force, looseness, resonance etc. By vibration monitoring, the preventive action can be taken on the machine. Control action can be done on the machine in advance. Vibration signal processing and monitoring are performed by two processes. One is time domain signal processing. This signal analysis gives the real time signal and extracts the signal characteristics like value of amplitude, time & phase characteristics. Another one is frequency domain analysis. The various information like amplitude, phase, power spectrum, Fast Fourier transforms (FFT), a windowing action, filtering are obtained by this signal analysis [3]. This analysis gives more information about the signal and

signal system through which it is generated. It is good as compared to time domain analysis.

III. virtual instrument technique

Lab VIEW includes libraries of functions and development tools designed specifically for instrument control. For Windows, Macintosh, and Sun, Lab VIEW also contains libraries of functions and development tools for data acquisition. Lab VIEW programs are called virtual instruments (VIs) because their appearance and operation imitate actual instruments. However, they are analogous to functions from conventional language programs. VIs has both an interactive user interface and a source code equivalent, and accepts parameters from higher-level virtual instrument (VIs).

Combining the high-performance modular hardware with the efficient and flexible software, the virtual instrument can complete all kinds of tasks, such as test, measurement and automation applications. The software of virtual instruments integrates all the functions including acquisition, control, data analysis, results output and user interface features, which has a lot of advantages such as high performance, strong expansibility, less development time, seamless integration of several measuring devices and so on. Lab VIEW is a kind of graphical programming language, which provides plenty of computing functions, advanced acquisition and signal analysis module, perfect simulation debugging tools, dynamic and continuous tracking mode. Through the interactive graphical front panel system and the functions, user can control the system, display the result and write programs with block diagram to complete required tasks. Lab VIEW is widely used in embedded application systems such as simulations, data acquisitions; instrument control, measurement analysis and data display. There are many new advantages in Lab VIEW, such as more easily integrating with almost any hardware device or deployment target, supporting muti-kind developing mode, adding more new specific function libraries, better connecting with internet and so on. Owing to integrate new high performance hardware, including the new multi-core Compact RIO, portable data acquisition module based on USB, internet and wireless, developing efficiency is increased greatly. Using scan mode programming features of Lab VIEW Real-Time Module, user either can read or write to Compact RIO I/O module directly or program in real-time FPGA module through FPGA programming, which brings more flexibility for operation. These features make the graphical system design, user-defined analog and digital control, data acquisition and high-speed signal processing more convenient, saving developing time and improving the developing efficiency.

IV. components of vibration monitoring

Vibration monitoring and Analysis system consists of following components which is shown in figure 1. The components are sensor system, vibration signal acquisition, vibration signal analysis, vibration signal processing, vibration signal display and recording [4]

.In vibration monitoring system, different components like accelerometer transducer, amplifier, data acquisition card, and computer are required. For controlling of machine, motor control unit is required. Machine condition monitoring and analysis is an important role in the plant. Because any damage in machine causes a great loss. In vibration analysis, vibration transducer is mounted with machine. Accelerometer transducer is used as a vibration transducer. When vibration occurs in machine three parameters are changed. These are displacement, velocity and acceleration of machine. Accelerometer transducer is directly proportional to the velocity, displacement, acceleration and frequency of signal. By above factors, the machinery condition can be accurately diagnosed. Charge amplifier gives the moderate voltage output that satisfies to data acquisition card. The hardware module 9234 is used as a data acquisition card. Data acquisition card must have high acquisition rate, because if the vibration of the machine increases, consequently velocity of the machine also increases. The acquisition rate must also be increased to prevent aliasing effect of the wave form and to calculate the component frequency of the displacement.

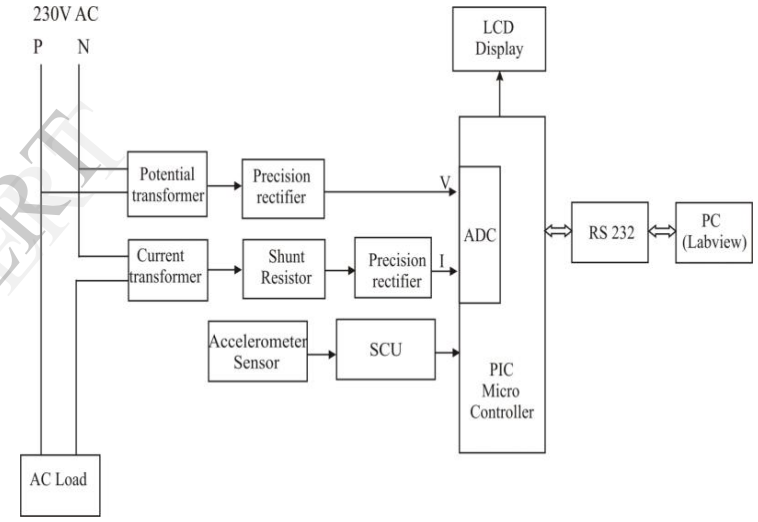

Fig 1: Component of vibration monitoring system

V. HARDWARE IMPLEMENTATION AND EXPERIMENTAL RESULTS

The hardware implementation set up of motor fault analysis is given in figure 2. In this hardware implementation the triaxial accelerometers measure the vibration in three axes X, Y and Z. They have three crystals positioned so that each one reacts to vibration in a different axis. The output has three signals, each representing the vibration for one of the three axes. The microcontroller that has been used for this hardware implementation is from PIC series. PIC microcontroller is the first RISC based microcontroller fabricated in CMOS that uses separate bus for instruction and data allowing simultaneous access of program and data memory. In telecommunications, RS-232 is a standard for serial binary data interconnection between a DTE and a DCE. It is commonly used in computer serial ports.

Fig.2. Hardware Implementation set up of Motor fault analysis

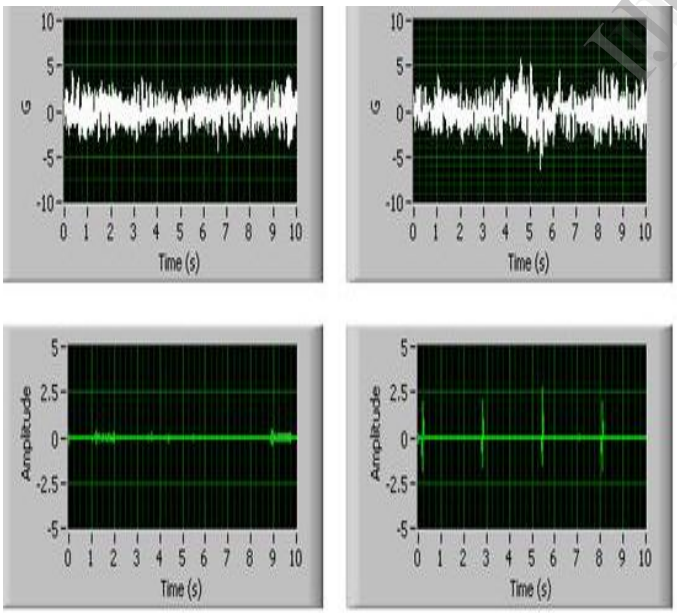

Fig.3. Time Domain waveform of Good Motor and Faulty Motor

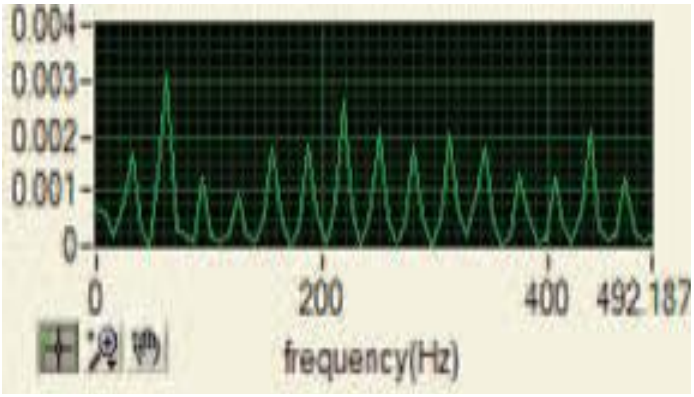

Fig.4. Spectrum of vibration signal

This above front panel from figure 3 shows that maximum displacement exceeds the limit. In the time domain the good motor is indistinguishable from the faulty motor, but using wavelet analysis the faults readily become apparent. For avoiding the difficulties in time domain analysis, frequency domain analysis is performed. Velocity which is in time domain is converted to frequency domain using FFT algorithm. The frequency domain of vibration signal is presented in power spectrum in figure 4.

Power spectrum has a spike graph. From this the exact frequency component of fault location is obtained. It is easy to find the component of a machine in which fault has occurred. So that replacement of component is done immediately. It is much better analysis compared to time domain analysis.

VI. CONCLUSIONS

This paper presents analysis and monitoring of vibration signal in terms of time domain and frequency domain. This hardware setup proposed in this paper substitutes the conventional test method based on separate test equipment and realizes signal analysis and displays through software. The fault of vibration signal is not clearly obtained from displacement graph which is in time domain. So, frequency domain or power spectrum analysis of vibration signal is performed and the fault type and fault region are easily detected by spectrum analysis. By comparing the results shown in figure 3 and figure 4 i.e. time domain and frequency domain analysis, it is conclude that the frequency domain or spectrum analysis gives more information about the type of vibration signal, type of signal fault and fault region. In time domain analysis, it is difficult to find the fault type and fault region.

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