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An novel approach for the condition monitoring of rotating machinery

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Abstract
The paper deals with detection of fault conditions based on measurements of vibration made on rotary machines in various industries. Detection of sources of vibration will be made based on the amplitude spectra and phase relationships of vibrations of individual machine parts, using the envelope of technology in detecting recurring events with low levels of the measured signal and processing of high-frequency signal in the range of acoustic emission. Because the display of a set of symptoms to the space of fault conditions for these methods is not simple, it is advisable to use a multi-parameter approach which means that important decisions are made on the basis of different types of measurements, for example, with using techniques of modal analysis and operational modal analysis. The paper presented the results of various measurements on the machinery.

Keywords: machinery, high frequency, symptoms

Introduction

In nowadays world, the number of electrical machines and their responsible tasks is continuously growing. This means that their reliability has to be a priority for all the producers and users of electrical machines. There are a vast number of different faults that can pose danger for the reliability of electrical machines. Most of those faults start as a small declination from the normal operating conditions. The problem with those faults is that if they are not treated at an early stage, they can grow to catastrophic measures. One possible solution for the early detection of faults in electrical machines is condition monitoring. Condition Monitoring (CM) is a process of acquiring equipment health status and predicting the operational ability of a system in a given environment: the health of the system is evaluated during itsoperation, and possible failures associated with it are recognized at an early stage. Motivations for condition monitoring (CM) in industrial automation include reductions in downtime, maintenance activity and related faults, and increases in energy efficiency, yield, and quality. Predictive diagnostics based on CM permit a well-informed plant maintenance activity. Condition based maintenance (CBM) using the equipment condition assessment has several benefits as compared to scheduled cyclic or reactive plant maintenance, mainly in terms of reduced downtime and replacement cost [1]. The methods used in system health assessment depend on plant infrastructure, operational criticality, process work flow, and ease of repair and service. A cost effective CBM can in some cases be achieved even with low cost condition monitoring equipment, for example by statistical treatment to reduce false positives and negatives in spite of the uncertainty of measurements or fault-trigger thresholds [2]. The success of CBM depends on the overall cost of the condition monitoring system in a plant, its arrangement, and on the relative benefits compared to the operation and maintenance costs over the life of the plant. Condition based maintenance (CBM) in industrial automation has evolved to achieve reduction of maintenance effort and time. The challenges are the optimization of maintenance work flow, information system, timely maintenance, and equipment service. Various elements within the maintenance process are shown in Figure 2. The process optimization includes minimizing the activities associated with managing the measurement system, information system and maintenance work flow. It is also necessary to reduce time between a maintenance trigger and equipment service or repair or replacement, which is efficient enough to justify the condition monitoring investments [15]. From this point of view, research has been carried out in the last years for the development of various methods for the condition monitoring of rotating machinery. These methods can be classified into the time domain, frequency domain, time-frequency domain, higher order spectral analysis, neural network and model-based techniques [9, 10, 11]. In this work, an approach for a VCM system is performed to acquires and analyzes vibrations that are caused by faulty bearings in a test rig of rotating machinery. The test rig consists of an AC induction motor, a pulley-belt system and a shaft-rotor system that were assembled. To measuring vibrations of the test rig is used MEMS-based accelerometers. The measured vibrations are acquired in the time domain and are analyzed in the frequency domain by using a virtual instrument based on LabVIEW. Here, the measured vibrations in the time domain are transformed into the frequency domain for investigating the vibrations due to using faulty bearings.

Experimental deign

In the current paper, a VCM system for condition monitoring of a test rig of rotating machinery presented in Fig. 1. The VCM system consists a virtual instrument based on LabVIEW in Personal Computer (PC), Arduino UNO, and two MEMS-based accelerometers. Fig.

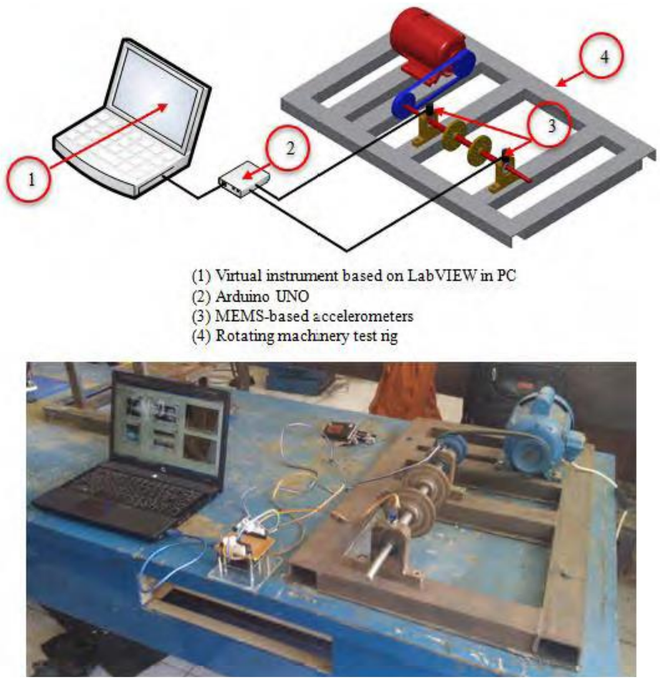

Fig 1

Block Diagram and Front Panels of the developed virtual instrument in this work are shown in Fig. 2. There are two Front Panels i.e. Front Panel of The Acquired Signals and Front Panel of The FFT Analyser.

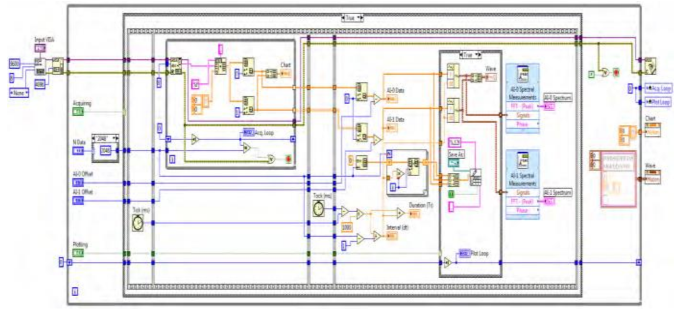

Fig 2

Vibrations of the test rig are measured by using two micro-electro-mechanical system (MEMS)-based accelerometers. These MEMS-based accelerometers are laid on both left and right supports of shaft-rotor system as shown in Fig. 3. MEMS-based accelerometers are used to measure vibrations of the test rig due to test bearings. There are four 6302-2RS PTM test bearings that are used in this experiment. All of the test bearings are ball bearings and have a number of balls, n = 7. MEMS-based accelerometers and Arduino UNO are connected to the virtual instrument. This experiment is conducted by varying the placement of test bearings

Result and discussion

Vibrations of a test rig of rotating machinery that are measured at the left support of shaft-rotor system are shown in Fig. 4 and vibrations that are measured at the right support of shaft-rotor system are shown in Fig. 5.

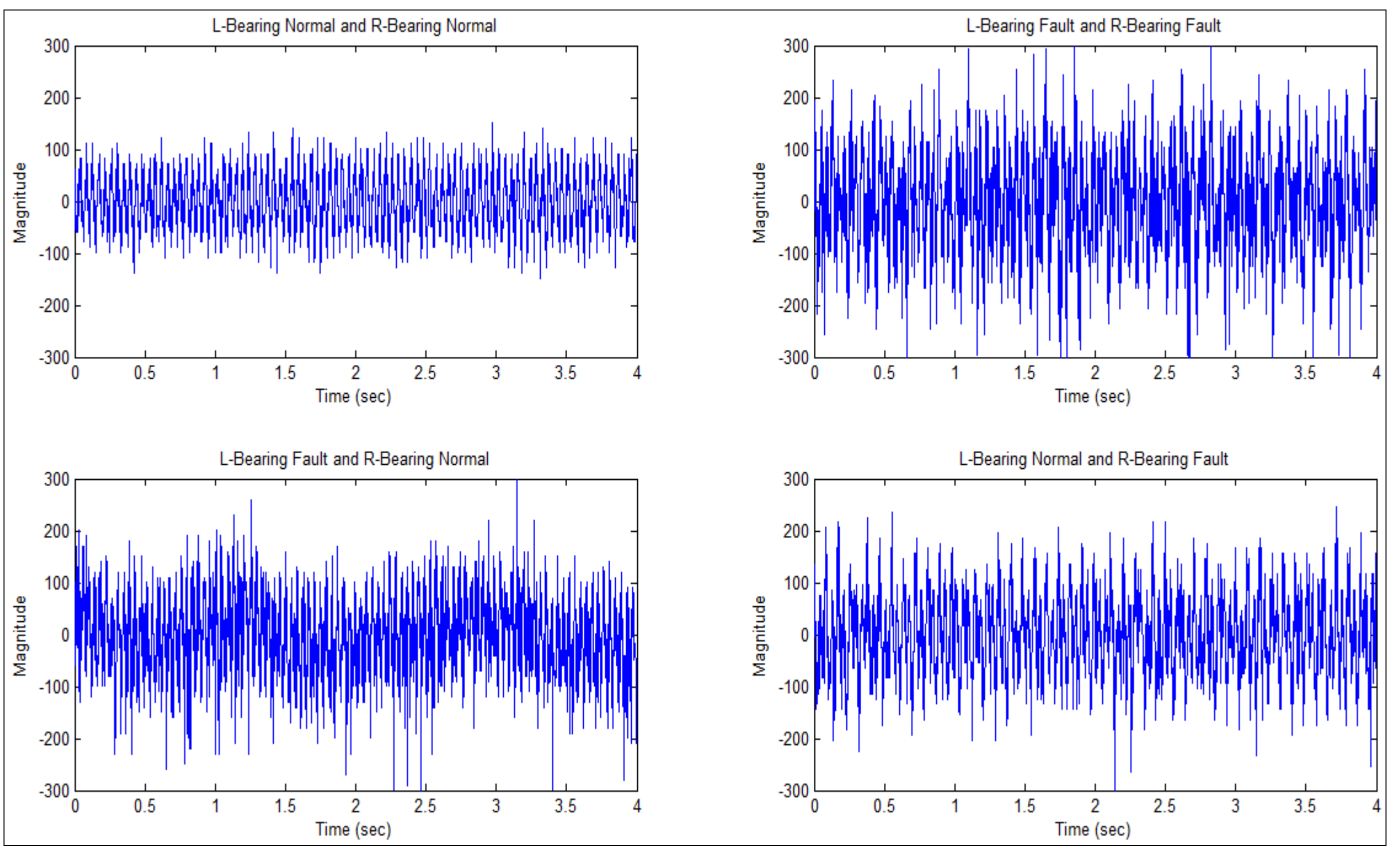

Fig 3

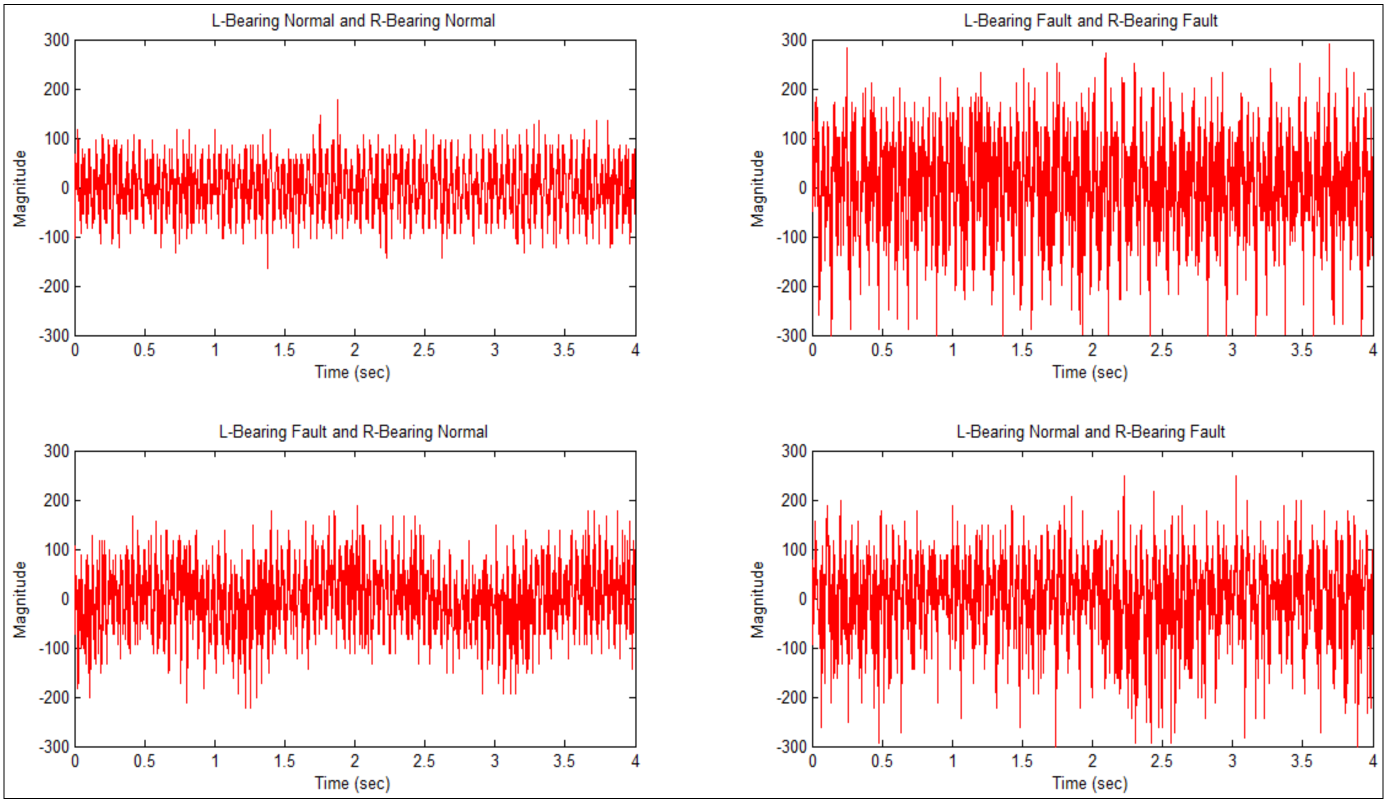

Fig 4

The deliberate vibrations in the time area are appeared in Front Panel of The Acquired Signals of the virtual instrument. The deliberate vibrations in the time area are changed into the recurrence space by utilizing the Fast Fourier Transform (FFT) work in Lab VIEW. The deliberate vibrations in the recurrence space at the left help of shaft-rotor framework is a measure of awkwardness mass in the test fix. Be that as it may, if the test fix utilizes broken direction in its backings, at that point critical crests in vibration ranges will show up at different frequencies. In this analysis, when the test fix utilize metal rollers that have n = 7 and its external ring shortcoming, alternate frequencies show up at around 7xRPM and 14xRPM (its harmonic).

Conclusion

An approach for condition monitoring of rotating machinery has been done in the research paper. In this work, vibrations of a test rig of rotating machinery are acquired and analyzed by using a virtual instrument based on Lab VIEW and are measured by using MEMS-based accelerometers. The virtual instrument is acquiring and analyzing the measured vibrations in the time domain and the frequency domain respectively to Predicts the vibration frequencies of the test rig. In general results of this experiment are shown that the developed virtual instrument was able to Predicts the vibration frequencies of the test rig. If the test rig uses normal bearings in its supports, then in vibration spectrums will appear one dominant frequency at shaft speed. But, if it uses faulty bearings in its supports, then significant peaks in vibration spectrums will appear at other frequencies.

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