An Intelligent Detection System Development for Local Faults in a Ball Bearing

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Local faults can be produced in ball bearings during their manufacturing process. An efficient, fast and accurate local fault detection method can help improve the quality of ball bearings. To overcome this problem, an intelligent detection system for a ball bearing with local faults is developed based on the NI LabVIEW software. This system includes the determination of bearing fault parameters, signal acquisition, envelope analysis, time-domain parameter analysis and bearing fault status modules. In this system, the frequency-domain feature method is based on the envelope demodulation analysis, the effective statistical indexes, and the Pearson correlation coefficient. The frequency-domain feature method is used to determine the threshold range for each fault level in the system. This system can in turn be used to determine the fault location and sizes for the ball bearings. A case study for the calculation and analysis for the frequency and time-domain acceleration is presented to predict the location and size of the local faults in a ball bearing. The test data from the Case Western Reserve University Bearing Data Center is used to verify the developed intelligent detection system for local faults in the ball bearing. The results show that the proposed detection system can be used to detect the local fault in the ball bearings.

1. INTRODUCTION

Ball bearings are the key components of rotating machinery systems. Ball bearings can ensure the stable operation conditions of the system. However, different faults, including local and distribution faults, may be produced during the manufacturing process. Thus, an accurate and efficient detection method is very useful for detecting the faults in the ball bearings. This work is given to present an intelligent detection system for detecting the local faults in the ball bearings.

Many works were reported to study different detection methods for the local faults in rolling element bearings. Song et al., Cui et al., Guo et al., Liu et al., Dong et al., and Moosavian et al. proposed the frequency-domain and time-domain features to determine the operational status of the bearing systems. Song et al., Wang et al., and Cui et al. proposed some useful methods for diagnosing and analyzing the local faults in the bearing systems. Zhao et al. proposed some new methods for predicting the location and sizes of the weak faults in the bearing systems. Liu et al. proposed some new dynamic modelling methods for the vibration analysis of bearing systems with localized faults. Mishta et al. used the envelope analysis and threshold wavelet denoising methods to detect the faults of rolling bearings. This method can extract fault-related symptoms for the low speed conditions. Ali et al. presented the artificial Neural Network bearing defects system based on the health index to classify the bearing defects. Hoang et al. developed the automatic bearing fault detect system combining with convolutional Neural Network and vibration image. This method did not require any feature extraction techniques. Fan, Xie, and He used LabVIEW, MATLAB and VC++ to develop the detection systems for the local faults in the ball bearings. The systems developed by Fan, Xie, and He are based on frequency and time-domain vibration features. This detection system includes data collection, signal analysis, signal transmission, and fault detection modules. Although the above system can detect fault generation, they cannot detect the fault size range. In practice, both the generation and size range should be detected in order to classify the different faults that are generated in the bearing system. The purpose of this work is to introduce a system that can detect both the generation and size range of the local faults.

In this paper, an intelligent detection system for a ball bearing with local faults is developed based on the NI LabVIEW software. The LabVIEW software includes bearing fault parameter determination, signal acquisition, envelope analysis, time-domain parameter analysis and bearing fault status modules. The frequency-domain feature method is based on the envelope demodulation analysis, the effective statistical indexes, and the Pearson correlation coefficient. The frequency-domain feature is used to determine the threshold range for each fault.