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Size Estimation for Naturally Occurring Bearing Faults Using Synchronous Averaging of Vibration Signals
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Abstract
One of the most critical categories of machine failure is rolling element bearing failure. Most bearing failures start from raceway fatigue spalls. From the initial formation of spalls, a bearing may still have 10-20% useful life remaining. This makes rolling element bearing an ideal candidate component for fault prognosis. The size estimation for bearing raceway spalls can provide crucial information for bearing fault prognosis. Vibration analysis has been used for bearing fault detection and diagnosis for many years. However, the estimation of bearing fault size using vibration analysis has been only found in dealing with simulated or notched ideal bearing faults. It is a significant challenge to estimate the size of naturally occurring bearing faults using vibration analysis. The objective of this research is to define some feasible vibration signal processing methodologies in dealing with size estimation for naturally generated and propagated faults in high-speed bearings. In this paper, we propose a scheme of estimating bearing spall size based on synchronous signal averaging (SSA) with respect to the bearing fault characteristic frequency, combined with envelope and wavelet analyses of the averaged signals. The averaged signal presents the vibration characteristics within one period of impacts produced by the bearing faults. When the fault size is smaller than the pitch spacing of the balls, the features associated with the balls entry into and exit from the spalled zone can be extracted by envelope and wavelet analyses, and then, the fault size can be estimated. The main novelty in this paper is the use of the tacho-less SSA method in size estimation of naturally occurring large spalls in high-speed rolling element bearings. The technique is validated using the vibration data from naturally spalled bearings in a high-speed bearing test rig. The results show that the technique is effective in revealing the entry and exit features needed for the size estimation of naturally occurring bearing faults. © 2016 by ASME.

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