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Application of an improved kurtogram method for fault diagnosis of rolling element bearings

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ABSTRACT

Kurtogram, due to the superiority of detecting and characterizing transients in a signal, has been proved to be a very powerful and practical tool in machinery fault diagnosis. Kurtogram, based on the short time Fourier transform (STFT) or FIR filters, however, limits the accuracy improvement of kurtogram in extracting transient characteristics from a noisy signal and identifying machinery fault. Therefore, more precise filters need to be developed and incorporated into the kurtogram method to overcome its shortcomings and to further enhance its accuracy in discovering characteristics and detecting faults. The filter based on wavelet packet transform (WPT) can filter out noise and precisely match the fault characteristics of noisy signals. By introducing WPT into kurtogram, this paper proposes an improved kurtogram method adopting WPT as the filter of kurtogram to overcome the shortcomings of the original kurtogram. The vibration signals collected from rolling element bearings are used to demonstrate the improved performance of the proposed method compared with the original kurtogram. The results verify the effectiveness of the method in extracting fault characteristics and diagnosing faults of rolling element bearings.

1. Introduction

Rolling element bearings are widely used in modern machinery, and faults occurring in the bearings may lead to fatal breakdown of machines. Therefore, it is significant to be able to accurately detect and diagnose the existence of the faults occurring in the bearings. Vibration signals collected from bearings carry rich information on machine health conditions. Therefore, the vibration-based methods have received intensive study during the past decades. It is possible to obtain vital characteristic information from the vibration signals through the use of signal processing techniques [1].

In order to effectively diagnose faults occurring in rolling element bearings, researchers have extensively investigated different signal processing techniques to accurately extract fault characteristics from vibration signals. Since the envelope analysis focuses on the low-amplitude high-frequency broadband signals characterizing bearing conditions and may minimize the effects of interfering signals within the selected frequency band, it has been widely applied in detecting faults of rolling element bearings [2]. Spectral kurtosis (SK), as an envelope analysis technique, was originally presented by Dwyer [3] to complement the classical power spectral density in detecting and characterizing transients in a signal. The basic idea of this technique is to exploit the possibility of using the kurtosis at each frequency line as a measure to discover the presence of non-Gaussian components and to indicate in which frequency bands these occur. Such non-Gaussian

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