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Transient modeling and parameter identification based on wavelet and correlation filtering for rotating machine fault diagnosis

Shibin Wang, Weiguo Huang, Z.K. Zhu *

School of Urban Rail Transportation, Soochow University, Suzhou 215006, China

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ABSTRACT

At constant rotating speed, localized faults in rotating machine tend to result in periodic shocks and thus arouse periodic transients in the vibration signal. The transient feature analysis has always been a crucial problem for localized fault detection, and the key aim for transient feature analysis is to identify the model and its parameters (frequency, damping ratio and time index) of the transient, and the time interval, i.e. period, between transients. Based on wavelet and correlation filtering, a technique incorporating transient modeling and parameter identification is proposed for rotating machine fault feature detection. With the proposed method, both parameters of a single transient and the period between transients can be identified from the vibration signal, and localized faults can be detected based on the parameters, especially the period. First, a simulation signal is used to test the performance of the proposed method. Then the method is applied to the vibration signals of different types of bearings with localized faults in the outer race, the inner race and the rolling element, respectively, and all the results show that the period between transients, representing the localized fault characteristic, is successfully detected. The method is also utilized in gearbox fault diagnosis and the effectiveness is verified through identifying the parameters of the transient model and the period. Moreover, it can be drawn that for bearing fault detection, the single-side wavelet model is more suitable than double-side one, while the double-side model for gearbox fault detection. This research proposed an effective method of localized fault detection for rotating machine fault diagnosis through transient modeling and parameter detection.

1. Introduction

Rotating machinery covers a broad range of mechanical equipments and plays an important role in many industrial applications, such as aircraft engines, transmission systems, power plants, etc. Most of the machinery was operated by means of bearings, gearboxes and other rotating components, which may develop faults. These faults may cause the machine to break down, resulting in significant economic loss and even catastrophic personal casualties. The study of rotating machine fault diagnosis has thus attracted attention over the past decades.

The transients or transient signals, characterized by a short period of time and span within a wide frequency range, contain important information about system dynamics being studied [1,2]. For example, the transients in the vibration signals generated on a gearbox usually correspond to the localized fault of bearing or gear teeth, such as flaking, crack, breakage and fracture. For machine fault diagnostics, therefore, it is useful representing the characteristics of the machine health by analyzing the transients in the vibration signal [3,4].

* Corresponding author.
E-mail address: zkzhu@ustc.edu (Z.K. Zhu).

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