New time-frequency representations based on the morphological pattern spectrum for bearing fault diagnosis

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Abstract

Bearing failures have great impact on industry and economy. The bearing is a machinery component that plays a very important role, since it dominates the machine performance. Then, it is important to detect the bearing fault timely and reduce the operational and maintenance costs. Time-frequency analysis has been of great interest in the field of bearing fault detection over the past few decades. However, only a few studies have investigated how to automatically classify time-frequency representations (TFRs). A key element of this procedure is extracting informative features from the TFRs. In this paper, we propose a new TFR characterization scheme that uses the morphological pattern spectrum (MPS), which has been successfully implemented in image analysis areas, to classify bearing faults. In this paper, five different time-frequency transforms, short time Fourier transform, Wigner-Ville distribution, Choi-Williams distribution, Wavelet transform and S transform, are selected to generate the TFRs of bearing vibration signals. Then, the MPS of the TFRs are calculated and used as the input feature vectors of the classifiers to identify the bearing states. The method was applied to a set of experimental signals obtaining in the test bench and the results verified the proposed feature extraction scheme to be an effective approach to accurately classify not only the bearing fault types but also the degree of the fault severity. And the method could be used in the other fault detection fields, such as engine, suspension device and vehicle structure.

Keywords: Mathematical morphology; Morphological pattern spectrum; Time-frequency representation; Fault diagnosis.