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Application of Complete Ensemble Empirical Mode Decomposition with Adaptive Noise and Multipoint Optimal Minimum Entropy Deconvolution in Railway Bearings Fault Diagnosis

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Abstract : Although the measured vibration signal contains rich information on machine health conditions, the white noise interferences and the discrete harmonic coming from blade, shaft and mash make the fault diagnosis of rolling element bearings difficult. In order to overcome the interferences of useless signals, a new fault diagnosis method combining Complete Ensemble Empirical Mode Decomposition with adaptive noise (CEEMDAN) and Multipoint Optimal Minimum Entropy Deconvolution (MOMED) is proposed for the fault diagnosis of high-speed train bearings. Firstly, the CEEMDAN technique is applied to adaptively decompose the raw vibration signal into a series of finite intrinsic mode functions (IMFs) and a residue. Compared with Ensemble Empirical Mode Decomposition (EEMD), the CEEMDAN can provide an exact reconstruction of the original signal and a better spectral separation of the modes, which improves the accuracy of fault diagnosis. An effective sensitivity index based on the Pearson's correlation coefficients between IMFs and raw signal is adopted to select sensitive IMFs that contain bearing fault information. The composite signal of the sensitive IMFs is applied to further analysis of fault identification. Next, for propose of identifying the fault information precisely, the MOMED is utilized to enhance the periodic impulses in composite signal. As a non-iterative method, the MOMED has better deconvolution performance than the classical deconvolution methods such Minimum Entropy Deconvolution (MED) and Maximum Correlated Kurtosis Deconvolution (MCKD). Third, the envelope spectrum analysis is applied to detect the existence of bearing fault. The simulated bearing fault signals with white noise and discrete harmonic interferences are used to validate the effectiveness of the proposed method. Finally, the superiorities of the proposed method are further demonstrated by high-speed train bearing fault datasets measured from test rig. The analysis results indicate that the proposed method has strong practicability.

Keywords : bearing, complete ensemble empirical mode decomposition with adaptive noise, fault diagnosis, multipoint optimal minimum entropy deconvolution
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