Rolling Bearing Fault Diagnosis Based on an Improved Denoising Method Using the Complete Ensemble Empirical Mode Decomposition and the Optimized Thresholding Operation

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Abstract*— Vibration signals are widely used in monitoring and diagnosing of rolling bearing faults. These signals are usually noisy and masked by other sources, which may therefore result in loss of information about the faults. This paper proposes an improved denoising method in order to enhance the sensitivity of kurtosis and the envelope spectrum for early detection of rolling bearing faults. The proposed method is based on a complete ensemble empirical mode decomposition with an adaptive noise (CEEMDAN) associated with an optimized thresholding operation. First, the CEEMDAN is applied to the vibration signals to obtain a series of functions called the intrinsic mode functions (IMFs). Second, an approach based on the energy content of each mode and the white noise characteristic is proposed to determine the trip point in order to select the relevant modes. By comparing the average energy of all the unselected IMFs with the energy of each selected IMFs, the singular IMFs are selected. Third, an optimized thresholding operation is applied to the singular IMFs. Finally, the kurtosis and the envelope spectrum are used to test the effectiveness of the proposed method. Different experimental data of the Case Western Reserve University Bearing Data Center are used to validate the effectiveness of the proposed method. The obtained experimental results illustrate well the merits of the proposed method for the diagnosis and detection of rolling bearing faults compared to those of the conventional method.

Index Terms*— Vibration analysis, bearing fault diagnosis, CEEMDAN, denoising, thresholding operation, envelope, kurtosis.