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Abstract
In this paper, a linear least squares analysis method is applied in the high frequency resonance technique and lowest vibration mode of mechanical system, respectively to detect the envelope signal. The envelope detection based on the resonant frequency in the single vibration mode of mechanical system to estimate the coefficients of sinusoidal function basic. First, according to the vibration spectrum, the resonant frequency in the lowest vibration mode is designated. The vibration signal could be decomposed into a sinusoidal function basis at the resonant frequency. Thus, the envelope signal could be retrieved by estimating the coefficients of the function basis with the linear least squares analysis. In the past, the high frequency resonance technique is usually applied in the envelope detection for a vibration signal with amplitude modulation. When applying the Hilbert transform in the high frequency resonance technique for the envelope detection of vibration signals, the computing burden is very high. On the other hand, when applying the linear least squares analysis method, the computing burden is lower. When applying the envelope detection in the lowest vibration mode, an accelerometer with the low-pass filtering cutoff frequency at 4kHz should be choose.

The envelope detection method could theoretically retrieve an envelope signal corresponding to the lowest mode vibration and the envelope signal is less distortion. If the envelope signal were detected according to the resonant frequency in the lowest vibration mode, the envelope signal would automatically become a signal with low sampling rate. It would be helpful to reduce the computing burden in the spectrum estimation, it is easy in calculation to derive the envelope signal or even to reconstruct the vibration signal from the envelope signal. However, this method theoretically has a limitation that the sampling rate of the vibration signal must be at least 6 times higher than the resonant frequency. Fortunately, the resonant frequency in the lowest resonant vibration mode would be low. Thus, the computer performance is not required to be very high. According to the experimental study, the envelope detection method could be effectively applied in the signal processing for a defect bearing.
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