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Two Stage Helical Gearbox Fault Detection and Diagnosis based on Continuous Wavelet Transformation of Time Synchronous Averaged Vibration Signals

ABSTRACT
To find reliable symptoms of a fault in a multistage gearbox.
Explores the use of time synchronous average (TSA) to suppress the noise and Continuous Wavelet Transformation (CWT).
The results obtained in diagnosis an incipient gear breakage show that fault diagnosis results can be improved by using an appropriate wavelet.

THEORETICAL BACKGROUND

Continuous Wavelet Transform:
Continuous Wavelet transform is to perform the Following equation:
\[ \text{CWT} \{ x(t); a, b \} = \int x(t) \psi_{a,b}^*(t) dt \]

Time Synchronous Averaging:
Assuming a signal \( x(t) \) consists of a periodic signal \( x_T(t) \) and a noisy component \( n(t) \), the period of \( x_T(t) \) is \( T_o \) whose corresponding frequency is \( f_o \). The synchronous average of the signal \( x(t) \) by using TSA can be expressed as:
\[ y(t) = \frac{1}{M} \sum_{i=0}^{M-1} x(t + iT_o) \]

RESULTS

CWT has been shown to be an effective tool for rotating machinery fault detection and diagnosis.
TSA allows the noisy components to be removed significantly and hence highlights the fault related impulse components which paves the basis for accurate feature extraction.
Three types of wavelets: db1, sym2 and coif3 were explored to find the optimal wavelet for separating the small fault.
The results have shown that wavelet db1 produces the best fault separation whereas the coif3 wavelet fails to do the separation.

FUTURE WORK
Drive a mathematical model for vibration signal characterisation under healthy and faulty gear condition
Validate the modelling results and hence the developed algorithms based upon the experiments data.