ABSTRACT

Vibration signal has been widely used for fault detection in rotating machineries. However, it often carries structure borne noise and its associated signal conditioning equipment are also very costly. In this research, rotational speed signal from a rotary encoder is used for fault detection in rotating machineries, which is both cost effective and less noisy. The rotational speed signal is termed as instantaneous angular speed (IAS) and which is estimated from encoder pulse signal by different signal estimation techniques. Moreover, a comparative study has been made among different signal estimation techniques for proper estimation of IAS.

For experimental investigations, two test rigs have been used. The first test rig consists of a multistage helical automobile gearbox with artificially seeded faults which is driven by an induction motor. The output shaft of the gearbox is coupled with a DC generator which is connected to a load resistor bank for loading purpose. An incremental optical rotary encoder is used to measure the IAS of the output generator shaft. The gearbox has three gear ratios and hence, it has three gear meshing frequencies (GMFs). The measured IAS signal from gearbox is analyzed by various signal processing techniques such as fast Fourier transform (FFT), cepstrum, demodulation, wavelet packet decomposition, complete ensemble empirical mode decomposition techniques. Amplitude demodulation and cepstrum analysis are found better for detection of fault in gearbox. Moreover, the IAS signal contains periodic signal and random noise over a revolution of the shaft. Hence, time synchronous averaging (TSA) based algorithm is developed to extract those periodic signals followed by fast Fourier transform (FFT) to detect the fault efficiently.

Another test rig consists of a four stroke, single cylinder gasoline engine and a computerized control panel. An eddy current dynamometer is connected to the engine through cardan shaft to apply varying load on the engine. The IAS from encoder signal from the test rig is analyzed by short time Fourier transform (STFT) to detect the engine firing frequency. However, the firing detection deteriorates due to frequencies other than firing frequency. Therefore, complementary ensemble empirical mode decomposition (CEEMD) followed by STFT is used to detect the engine firing efficiently. The encoder signals can thus be used as a cheap and effective method to monitor the condition of rotating machines.