ABSTRACT

In every mechanical system, rolling element bearings are one of the most important and critical elements. Periodical health assessment of bearings is important not only for safe operation of machine but also to reduce the maintenance costs and to avoid breakdown. The vibration based signal analysis is one of the most important methods for condition monitoring and fault diagnostics of rolling element bearings since the vibration signal always carries dynamic information of the system. Even though several techniques have been reported in the literature for detection of faults in rolling element bearings, it is challenging to carry out fault diagnosis due to non-stationary nature of the vibration signal emitted by the bearing and noisy operating conditions depending on the service conditions. For example in machine tools cutting process itself generates and leaves the signature in the desired measured signal. The objective of this research is to apply wavelet transform as an advanced signal processing tool for more reliable bearing fault diagnostics. In the first phase of the research work, a dynamic model is developed for predicting the vibration behavior of a ball bearing under the influence of localized defects on the outer race and inner race. The pulse generated by the ball striking the defect on the races is modeled by using the blending functions of the cubic hermite spline as opposed to existing pulse forms such as rectangular, triangular, half-sine etc. The model demonstrates the influence of defect size, load, angular position of the defect, presence of multiple defects etc. on the vibration amplitude. In the second phase, an experimental set up is designed and developed towards diagnosis of defects in rolling element bearings. While processing a signal with wavelet transform, selection of appropriate mother wavelet is one of the key steps. Theoretically, the choice of the mother wavelet for various applications has remained ad hoc and arbitrary. The best mother wavelet for the situation results in perfect reconstruction and provides good localization in time and frequency. It is reported in earlier studies that quantitative wavelet selection criteria such as maximum energy, minimum Shannon entropy and the ratio of maximum energy to minimum Shannon entropy are decisive for selecting appropriate mother wavelet. However, every individual wavelet selection criteria results in altogether different mother wavelet complicating the decision making. To address this issue, in the current research work, in addition to energy and entropy based methods, denoising
performance attributes such as peak signal to noise ratio, mean square error and maximum error between the signal and the approximation i.e. all five wavelet selection criteria are integrated based on a methodology involving assigning of weights to every wavelet selection attribute and finding rank of each mother wavelet. The best mother wavelet is used for processing the vibration signals using multiresolution analysis (MRA). This newly developed strategy of mother wavelet selection is further extended to present couple of case studies. Firstly fault diagnosis of taper roller bearing of a pump is carried out using this method. Secondly, bearings on driving side of lathe machine tool are analyzed for vibration. The investigation results reveal that the newly developed mother wavelet selection strategy can be successfully used to enhance the reliability of the fault diagnostics.

**Keywords:**
Condition monitoring, Cubic hermite spline, Mother wavelet, Rolling element bearings, Vibration, Wavelet transform.