IJDACR
ISSN: 2319-4863

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 12, Issue 11, June 2024)

Enhanced Fault Detection in Rolling Element Bearings Using Kurtogram-Driven Spectral Kurtosis for Optimal Band Selection

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Abstract – **This paper introduces a robust methodology aimed at improving the detection and diagnosis of rolling element bearing faults, particularly in settings where other machinery components create masking signals that complicate fault identification. The proposed approach integrates advanced signal processing techniques with a straightforward classification method to achieve precise fault diagnosis. The methodology involves signal preprocessing, which includes wavelet transform-based denoising and normalization to enhance the signal-to-noise ratio and standardize signal amplitude. Subsequent Kurtogram analysis visualizes and quantifies transient features within the signal across various frequency bands using Short-Time Fourier Transform (STFT), highlighting impulsive and non-Gaussian characteristics indicative of faults. Spectral Kurtosis further isolates frequency bands with significant fault-related transients by identifying deviations from Gaussian behavior. Optimal frequency bands are selected based on a combined assessment of kurtosis and spectral kurtosis, followed by band-pass filtering to isolate these bands. Fault detection is performed using Envelope Spectrum Analysis to extract fault-specific frequencies from the filtered signal. A rule-based classifier, utilizing the log ratio of BPFI to BPFO amplitudes, is introduced for fault classification. Validation with test data shows consistent distributions and perfect accuracy, demonstrating the approach's effectiveness. Implemented and simulated in MATLAB, this integrated methodology enhances fault detection accuracy and lays the groundwork for future research involving advanced classification algorithms and additional diagnostic features.**

Keywords – **BPFI, BPFO, Kurtogram, Spectral Kurtosis, STFT, etc.**