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”COMO2#5 - Combined bearing faults detection using the Multiple Improved Envelope Spectra via Feature Optimization gram (MIESFO-gram) in complex systems”

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Bearing diagnostics is a growing field of study, with a focus on complex machinery that includes a variety of bearing and gear components operating under varying conditions (e.g. speed and load). Meanwhile, some components with weak signatures may remain hidden while others with intensive defects are detected. Therefore, the ability to detect combined faults in the machinery, having different cyclic frequencies is critical. Envelope Analysis is a popular method for bearing diagnostics, in which a filter is typically applied around an excited frequency band and the signal is enveloped, yielding the Squared Envelope Spectrum. However, as several damaged bearings may excite not only different but also several frequency bands simultaneously, band-pass filtering around only one frequency band may not be sufficient to detect all bearing faults in the machine. This will be more challenging when an operational condition like speed is changing over time which causes the fault-related cyclic frequencies to be smeared and/or hidden. Furthermore, different carrier frequencies may be excited under different speed conditions. Recently, IESFOgram has been proposed utilizing Targeted and Blind features. The method has been essentially developed based on either the Cyclic Spectral Correlation or the Cyclic Spectral Coherence, in order to select the optimal frequency band and extract the corresponding Improved Envelope Spectrum. In the IESFOgram with the Targeted features, the possible existing fault frequencies are fed into the algorithm as inputs. However, the IESFOgram with Blind features aims to find the most-occupied frequency band with the cyclic frequencies. On the other hand, when there are more than one bearing faults exciting different natural frequencies, selecting only the single most dominant carrier may prove insufficient to detect other damages present in the signals. In this paper, an extension of the Blind IESFOgram is introduced with the aim of finding all possible unique frequency bands occupied by cyclic frequencies. The method is applied and evaluated on simulated and experimental data with different types of faults under steady and varying speed conditions in a complex system. Finally, the results are compared with the conventional Targeted and Blind IESFOgram.

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