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”FDP2#2 - Orthogonal nonnegative matrix factorization as informative frequency band selector”

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One of the most common representations of acquired vibration signals from a faulty machine is the time-frequency representation in the form of a spectrogram matrix. Because the magnitude part of the spectrogram matrix consists only of non-negative elements, it can be decomposed using non-negative matrix factorization (NMF) into a base matrix and weight matrix, which represent the frequency and time content of the signal, respectively. The frequency features of the base matrix can be used as filters to detect local damage in bearings by filtering the original signal with these filters. However, classical NMF provides filters that cover all frequency bands with different amplitudes. Unfortunately, such filters cover both informative and non-informative frequency bands, second ones corresponds to the noise. To solve this problem, the NMF can be enhanced by using orthogonal non-negative matrix factorization (ONMF), which imposes orthogonality constraints onto the NMF model. The orthogonality constrained applied to NMF improves the quality of clustering properties of NMF, which corresponds to better detecting of informative frequency bands. Additionally, the orthogonality constraints make the decomposition more sparse, which translates into zero amplitude at the non-informative frequency band related to the noise. Hence, using ONMF we can obtain a more selective filter which filters out only the most relevant information from the signal. The ONMF works for both signals with Gaussian and non-Gaussian noises. The analyzed signals come from a test rig with faulty bearings (Gaussian noise) and belt conveyor (non-Gaussian noise).

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