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COMO1#5 - Data-driven Interpretable Optimized Weights Derived from A Sparsity Measure Framework and Their Applications in Machine Condition Monitoring

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Machine condition monitoring aims to acquire information about machine's health status and prevent pending machine failures, by analyzing collected sensor data. Since most machine fault signatures will introduce repetitive impulsive transients into collected signals (e.g., vibration signals), sparsity measures that can effectively detect such signatures receive much research attention and are eagerly studied. A sum of weighted normalized square envelope spectrum (SWNSES) is a new framework for generalization of the sparsity measures, and optimized weights derived from this framework have been mathematically proved to be fully interpretable and demonstrate eminent properties for machine condition monitoring. What's more, by extending the SWNSES to a sum of weighted normalized Fourier spectrum (SWNFS), the corresponding optimized weights are capable of identifying fault frequency components and healthy frequency components, respectively. This paper intends to present several optimized-weights-based new technologies and their applications in machine condition monitoring. If square envelope spectrum in fast kurtogram is replaced by SWNSES-based optimized weights, a more robust OSESgram is obtained to locate informative bands; based signal processing methods such as variational mode decomposition and wavelet packet transform, a new indicator could be obtained to precisely quantify and extract machine fault components. Moreover, by introducing a new threshold approach, a new signal decomposition method named difference mode decomposition (DMD) could be designed to decompose a mixed signal into reference signals and concerned signals. Both simulation and real-world experimental vibration signals validated the effectiveness and superiority of the proposed optimized-weights-based new technologies, and the optimized weights are useful in boosting the development of machine condition monitoring.

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