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”COMO2#3 - Optimal filter design for rotating machinery fault detection under time-varying speed conditions”

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Critical assets found in the mining and power generation industries need to operate reliably. The harsh operating environments can lead to accelerated degradation of the components, which can lead to unexpected failures and long downtimes that impede production. Vibration-based condition monitoring methods are used to detect changes in the condition of critical components, and to identify and potentially trend the damaged components and potential damage modes. This information can support maintenance decisions. Damage often manifests as weak components in the vibration signals and is masked by dominant signal components attributed to gear mesh excitations and the operating environment. Furthermore, rotating machinery found in the power generation industry (e.g., wind turbines) and mining industry (e.g., bucket wheel excavators) operate under time-varying operating conditions. The speed and load variations add additional modulation to the signals that impede fault detection. Hence, methods are required to enhance damage components for early fault detection and improved fault characterisation under time-varying operating conditions. Blind deconvolution methods are used to recover the sources that are convolved with the impulse response function of the system and are corrupted by other extraneous sources from the raw vibration signal. Optimal filtering methods are implemented by identifying a measure that is maximised by the source of interest, e.g. if the source is non-Gaussian, then a feature that measures the deviation from Gaussianity can be maximised. Features such as kurtosis, correlated kurtosis, ICS2, Hoyer index, L2/L1, and negentropy have been used with great success under constant-speed operating conditions, but their application under varying operating conditions is still rather limited. In general, the optimal filtering problem is solved by formulating an optimisation problem by defining relevant loss and constraint functions. Various frameworks are available to solve the optimization problem, including classical gradient-based methods when gradients are readily available. The optimisation problem provides flexibility in the form of the loss and constraint functions to identify novel features with which to perform optimal filtering. In this study, optimal filtering using these features is performed on gearbox data that were generated under time-varying speed conditions.

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