Fault Feature Identification Theory and Separation Method

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ABSTRACT:
Fault diagnosis, as a key technology for ensuring the safe operation of equipment, centers on fault feature extraction. Current research challenges include: difficulty in identifying fault and reference frequencies due to unclear fault mechanisms; difficulty in explaining the variation patterns of fault features due to unknown fault dynamic evolution laws; and difficulty in predicting fault feature evolution due to multi-factor coupling. To address these challenges, the applicant systematically elaborated on key issues such as the identification, localization, separation, novel design, and evolution patterns of fault features, focusing on cutting-edge scientific problems including the laws of fault and reference frequency identification, the correlation mechanism between fault feature variation patterns and degradation characteristics, and the data-model interaction mechanism between degradation features and prognostic models. This research has constructed a fundamental research system for fault feature extraction. This report specifically concentrates on the theories of fault feature identification and methods for separation: A common framework for fault features based on sparsity measures was proposed, an interpretable weight learning network was constructed to identify fault and reference frequencies through weight optimization, and difference mode decomposition was developed to overcome the limitations of bandpass filters, such as wavelet transform, empirical mode decomposition, variational mode decomposition, etc.