# A modified rolling bearing fault diagnosis approach based on improved multiscale permutation entropy and generalized hidden Markov model

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## Abstract

Safety and stability of rolling bearings is related to productivity of rotating machine process and products quality. Developing an effective fault diagnosis approach for the rolling bearings is the key to identify working condition. In this paper, a modified rolling bearing fault diagnosis approach based on improved multiscale permutation entropy and generalized hidden Markov model is proposed, where reduced interval valued features efficiently recognizes and classifies machine states of the rolling bearings. In the proposed approach, raw vibration signals in different conditions are preprocessed and decomposed into multiple modes using variational mode decomposition. In form of generalized intervals, the balancing parameters give a concise representation for aleatory and epistemic uncertainty, which helps to improve identification robustness. Improved multiscale permutation entropy technique is used to extract inherent features from the decomposed signals. Neighborhood component analysis is adopted to reduce feature dimensionality and computational cost. With the reduced features, a generalized interval probability-based hidden Markov model is applied to recognize and classify machine states of the rolling bearings. Finally, the experimental results verify effectiveness of the proposed approach in recognizing and classifying fault types and fault severity levels of rolling bearings. This diagnosis method helps to efficiently quantify the two uncertainty components.

Keywords: **Generalized interval, Uncertainty Quantification, Fault diagnostics, Signal decomposition, Feature extraction and reduction, State recognition and classification.**

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