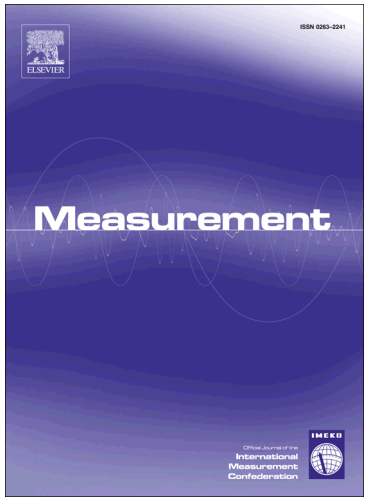

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Feature recognition of small amplitude hunting signals based on the MPE-LTSA in high-speed trains

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Abstract:

Hunting stability is an important factor for high-speed trains to achieve safe operation, which can be monitored by on-board instruments. When analysing measured online tracking data of high-speed trains, the authors have observed that small amplitude hunting tend to appear. When these signals show growth of lateral vibration to high enough amplitude, train derailment would happen. Research on the bifurcation evolution of small amplitude hunting of high-speed trains has been rarely reported so far. In this paper, chaotic features of the data are extracted and the results show that lateral acceleration signals from the bogie frame has strong nonlinear characteristics. Then a commonly used method based on frequency distribution characteristics of bogie vibration energy is first used to separate different states of hunting. However, the results are not satisfactory. So a feature extraction method based on Multiscale Permutation Entropy (MPE) and Local Tangent Space Alignment (LTSA) is proposed to distinguish the different states of complex signals. The proposed method is applied to extract features of the small amplitude hunting signals at high-speed of 320-350 km/h. The results show that the MPE-LTSA method can identify the bifurcation evolution of small amplitude hunting signals much more effectively than the method based on the MPE-ISOMAP (Isometric Feature Mapping) and MPE-PCA (Principle Component Analysis). The method can be used in other feature recognition for the complex chaotic signals.

Key words: high-speed trains; small amplitude hunting; Multiscale Permutation Entropy; Local Tangent Space Alignment.

1 Introduction