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基于支持向量经验模态分解的故障率时间序列预测

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Failure Rate Time Series Prediction Based on Support Vector Empirical Mode Decomposition

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摘要 针对故障率时间序列的非线性与非平稳特性,提出一种基于支持向量经验模态分解(SVEMD)的预测方法。首先,将故障率时间序列分解为多个固有模态函数(IMF)与一个余量(RF),利用最小二乘支持向量机(LSSVM)预测时间序列两端的局部极值点,以抑制传统经验模态分解(EMD)的边缘效应;同时以LSSVM回归方式形成包络线,以取代传统EMD中的三次样条插值;然后,建立各IMF与RF的预测模型;最终,将各IMF与RF的预测结果相加以获得故障率时间序列的预测结果。仿真结果表明,该方法的预测精度较传统基于EMD的预测方法与单一预测方法有显著提高,可实现对故障率的准确预测。

关键词: 经验模态分解 最小二乘支持向量机 时间序列预测 时间序列分析 故障率预测

Abstract: A prediction method based on support vector empirical mode decomposition (SVEMD) is proposed to deal with the non-linearity and non-stationarity of failure rate data. First, the failure rate data is decomposed into a series of intrinsic mode functions (IMFs) and a residual function (RF) by using empirical mode decomposition (EMD), and then a least squares support vector machine (LSSVM) is used to predict the local extremal points of the failure rate data and solve the end effect problem of the EMD. The upper and lower envelopes are constructed by using LSSVM regression instead of spline interpolation in EMD. Machine-learning-based prediction models are trained to predict the IMFs and RF. Finally, the prediction results of the failure rate data are obtained by integrating the prediction results of the IMFs and RF. Experiments on a plane failure rate prediction indicate that the proposed SVEMD-based prediction method can predict failure rate data accurately and has better performance in prediction accuracy than the traditional EMD-based prediction methods.

Keywords: empirical mode decomposition least squares support vector machine time series prediction time series analysis failure rate prediction

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