长论文

基于WSVR和FCM聚类的实时寿命预测方法

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摘要
针对产品的性能退化轨迹呈现为非线性特性，且个体的性能退化数据为小样本的情形，为了充分利用同类产品的性能退化数据进行特定个体的实时寿命预测，从研究退化轨迹相似性的角度出发，提出一类基于小波支持向量回归机 (Wavelet support vector regression, WSVR)和模糊C均值(Fuzzy c-means, FCM) 聚类的实时寿命预测方法. 该方法分为离线和实时两个阶段：离线阶段先采用WSVR对同类产品的性能退化数据进行规范化处理，接着对规范化数据进行FCM聚类，然后，基于WSVR建立各聚类中心的退化轨迹模型;在实时阶段，针对特定个体的历史测量数据是否规范化，分别提出两种实时退 化轨迹建模和寿命预测方法——隶属度加权法和误差加权法. 最后，通过两个实例分析验证了所提方法的有效性.

关键词　　性能退化　　小波支持向量回归机　　模糊C均值聚类　　实时寿命预测

分类号

Real-time Lifetime Prediction Method Based on Wavelet Support Vector Regression and Fuzzy c-means Clustering

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Abstract
For the case where the products have nonlinear performance degradation paths and there is little performance degradation data for each individual, in order to take full advantage of performance degradation data of the same kind of products in individual real-time lifetime prediction, as viewed from the comparability of degradation paths, a class of real-time lifetime prediction methods are proposed, on the basis of wavelet support vector regression (WSVR) and fuzzy c-means (FCM) clustering . The methods consist of two stages, called offline and real-time stages. In the offline stage, WSVR is employed to normalize performance degradation data, and FCM is used to classify the normalized data, then WSVR is adopted again to build the cluster centers' degradation path models. In the real-time stage, depending on whether the specific individual's historical data is normalized or not, two real-time model-building methods, named degree-of-membership-based weighted method and error-based weighted method, are proposed. And then, by combining with the specific individual's real-time measurement, its degradation path model is renewed, and its lifetime is predicted. Two example analyses are executed based on fatigue crack growth data and the CG36A transistor degradation data, and the experimental results validate the validity of the two proposed methods.

Key words　 Performance degradation　 wavelet support vector regression (WSVR) fuzzy c-means (FCM) clustering　 real-time lifetime prediction

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