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基于组合优化相关向量机的航空发动机性能参数概率预测方法

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Probabilistic Prediction Method for Aeroengine Performance Parameters Based on Combined Optimum Relevance Vector Machine

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摘要 参考文献 相关文章

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摘要

针对航空发动机性能参数预测过程中存在的不确定因素,提出一种基于组合优化相关向量机(CORVM)的概率预测方法。首先,通过正交小波变换将性能参数序列分解为具有不同特征尺度的随机分量和趋势分量,并分别建立各分量的相关向量机(RVM)回归预测模型。然后,以留一交叉验证误差最小作为优化目标,采用量子粒子群优化(QPSO)算法实现RVM核参数和嵌入维数的自适应优化选择。最后,组合各RVM回归预测模型得到最终预测均值及方差,进而得到预测值的概率分布。通过航空发动机排气温度变化量和滑油金属含量预测实例验证了方法的有效性,实验结果表明:该方法能够有效避免传统点预测方法可能导致的不可靠结果,并具有比单一模型更高的预测精度。

关键词: 概率预测 航空发动机 性能参数 相关向量机 正交小波变换

Abstract:

To cope with the uncertainties in the prediction process of aeroengine performance parameters, a probabilistic prediction method is proposed based on a combined optimum relevance vector machine (CORVM). Firstly, the performance parameter sequence is decomposed into sub-sequences in different frequency bands by orthogonal wavelet transform, and the prediction models of these sub-sequences based on relevance vector machine (RVM) regression are established respectively. Secondly, the quantum-behaved particle swarm optimization (QPSO) algorithm is employed to optimize the kernel parameters and embedding dimensions, which uses the minimum leave-one-out cross-validation error as the optimization target. Finally, all the prediction models are combined to obtain the final prediction values and variances. Thus the probabilistic distributions of prediction values are obtained. The validity of the proposed method is proved by experiments on aero-engine delta exhaust gas temperature prediction and lubrication metal content prediction. The experimental results show that the proposed method can avoid unreliability results and has better performance in prediction accuracy than the single prediction model.

Keywords: probabilistic prediction aeroengine performance parameter relevance vector machine orthogonal wavelet transform

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