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基于混合系统粒子滤波和二元估计的故障预测算法

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A Fault Prognostic Algorithm Based on Hybrid System Particle Filter and Dual Estimation

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摘要 针对一类故障预测问题提出了一种基于粒子滤波的故障预测算法。在算法的状态估计阶段，采用混合系统粒子滤波和二元估计算法同时估计对象系统故障演化模型混合状态和未知参数的后验分布。在算法的状态预测阶段，在一定的假设条件的前提下，将混合模型连续状态变量的预测问题转化为一个基本状态空间模型的状态预测问题。通过对连续状态变量当前时刻的后验分布进行迭代采样从而获得其未来时刻的先验分布。在算法的决策阶段，在获取的故障演化模型连续状态变量分布基础上，结合一定的故障判据近似计算出对象系统剩余寿命分布。故障预测仿真实验结果证明了算法的有效性。

关键词： 故障预测   随机系统   混合系统粒子滤波   二元估计   重要性采样重采样   剩余寿命分布

Abstract： To solve certain kinds of fault prognostic problems, an algorithm based on particle filter is presented. At the state estimation stage, the algorithm estimates the posterior distribution of the states and parameters of the system fault progression model based on hybrid system particle filter and dual estimation. At the state prediction stage, the algorithm converts the problem of predicting the continuous states of a hybrid system model to the problem of predicting the states of a basic state space model under certain predefined assumptions. By sampling iteratively the posterior distribution of current continuous states, the algorithm can use the sampled particles to form the state prior distribution for some future time. At the prognostic decision stage, based upon the above calculated continuous state distribution, combined with certain fault criteria, the distribution of system remaining useful lifetime can then be inferred. Simulation result demonstrates the validity and feasibility of the proposed algorithm.

Keywords： fault prognostics   stochastic systems   hybrid system particle filter   dual estimation   sampling importance resampling   distribution of remaining useful lifetime

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引用本文：

张磊;李行善;于劲松;廖灿星. 基于混合系统粒子滤波和二元估计的故障预测算法[J]. 航空学报, 2009, 30(7): 1277-1283.

Zhang Lei;Li Xingshan;Yu Jinsong;Liao Canxing. A Fault Prognostic Algorithm Based on Hybrid System Particle Filter and Dual Estimation[J]. Acta Aeronautica et Astronautica Sinica, 2009, 30(7): 1277-1283.