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控制科学与工程

基于可变遗忘因子的改进RPCA方法及其在自适应故障监测中的应用

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摘要:

针对现有监测方法对时变过程易产生误警且对微弱故障的检测能力不足等问题,提出一种基于可变遗忘因子的改进递归主元分析(recursive principal component analysis,RPCA)方法用于自适应故障监测。在主元模型的在线更新中引入一种可变遗忘因子,并为不同的模型参数设置不同的遗忘因子;在相关矩阵的递归分解中引入部分奇异值分解的思想,递归计算负荷矩阵和特征值对角矩阵;提出一种控制限递归更新方法,实现控制限的自适应更新。对某型雷达发射机工作过程的监测结果表明,改进的RPCA方法能自适应地跟踪过程的时变,有效地减少了对正常工况调整的误警和对微弱故障的漏报。

关键词: 递归主元分析 自适应故障监测 可变遗忘因子 部分奇异值分解 时变过程

Improved RPCA method based on variable forgetting factor and its application in adaptive fault monitoring

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Abstract:

In order to avoid false alarms for time-varying process and missed alarms for weak fault, an improved recursive principal component analysis (RPCA) method based on variable forgetting factor was proposed for adaptive fault monitoring. A new variable forgetting factor style was introduced for online update of the principal component model, and different forgetting factors were set for different parameters. The loading matrix and eigenvalue matrix were updated by applying partial singular value decomposition (PSVD) method to the recursive decomposition of correlation matrix. In addition, a recursive updating method of control limit was proposed to update control limit adaptively. Monitoring results of the working process of a radar transmitter demonstrate that the improved RPCA method could capture the variation of process adaptively to detect fault, and could reduce both false alarms for normal working condition adjustment and missed alarms for weak fault.

Keywords: recursive principal component analysis adaptive fault monitoring variable forgetting factor partial singular value decomposition time-varying process

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