固体力学与飞行器总体设计

多重故障并发下单部件系统视情维修建模与优化

葛恩顺, 李庆民, 彭英武, 王慎

海军工程大学 兵器工程系, 湖北 武汉 430033

Condition-based Maintenance Modeling and Optimization for Single-unit System with Multiple Competing Processes

GE Enshun, LI Qingmin, PENG Yingwu, WANG Shen

Department of Weaponry Engineering, Naval University of Engineering, Wuhan 430033, China

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摘要

实际装备使用工程中,系统性能随工作时间延长而缓慢劣化并最终导致劣化故障发生而需进行更换,这一过程往往伴随着各种随机冲击,系统因故障的突然发生而失效,即多重故障并发。从维修工程的实际问题出发,考虑劣化故障与冲击故障并发以及多重故障之间存在相关性的情况,建立了序贯检测条件下基于多级控制限的单部件系统视情维修模型,给出了在预定维修策略下系统维修费用率的数学表达式,并以长期运行费用率最低为约束条件对系统维修阈值进行优化。通过实例与基于定期检测的维修策略进行对比,验证了模型的合理性和有效性。

关键词： 多重故障并发   多级控制限   维修   长期运行费用率   优化

Abstract：

In most practical situations of equipment work, the system does not only degrade with use and age, but is also subject to traumatic events or shocks which lead to a sudden failure; that is, system failure is due to both deterioration and shock events. Focusing on the actual problem of maintenance engineering, a new condition-based maintenance model is established based on the sequential inspection policy and multi-level control-limit rule for a single-unit system which is subject to both the deterioration process and shock process. The competing and dependent failures due to deterioration and shock are considered. A mathematical model for the deteriorating system cost is derived under a pre-selected maintenance policy, and the long-run cost rate can be minimized by a joint optimization of the maintenance structure thresholds. Through a numerical example, the proposed model is compared with the maintenance model using periodically inspection policy, and the validity and superiority of the model are proved.

Keywords： multiple competing processes   multi-level control-limit   maintenance   long-run cost rate   optimization

Corresponding Authors: 李庆民,Tel.: 027-83442947 E-mail: licheng0001@hotmail.com   Email: licheng0001@hotmail.com

About author: 葛恩顺 男, 博士研究生。主要研究方向: 装备视情维修决策。 Tel: 027-83442753-7402 E-mail: geenshun@yahoo.com.cn;李庆民 男, 教授, 博士生导师。主要研究方向: 武器系统仿真、 装备综合保障等。 Tel: 027-83442947 E-mail: licheng0001@hotmail.com

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