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故障容错光交叉通道数据链路的可靠性

王新华, 甄子洋, 龚华军, 杨一栋

南京航空航天大学 自动化学院, 江苏 南京 210016

Reliability of a Fault Tolerant Optical Cross-channel Data Link

WANG Xinhua, ZHEN Ziyang, GONG Huajun, YANG Yidong

College of Automation Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing 210016, China

摘要	参考文献	相关文章
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摘要 光交叉通道数据链路(OCCDL)是光传飞行控制系统余度计算机之间进行数据交换的重要途径。为了提高OCCDL系统的可靠性,提出一种新的具有多链路故障容错能力的OCCDL系统。给出了该OCCDL系统的结构配置,分析了系统正常工作和故障工作情况下的工作流程,设计了系统光开关故障、光链路等关键部分的故障容错逻辑,建立了基于马尔可夫链的OCCDL系统可靠性模型,分析了光链路、光开关、现场可编程门阵列(FPGA)和双口随机存取存储器(RAM)等组成部分的故障概率计算问题。数值仿真结果表明,与传统数据链路系统相比,该OCCDL系统的可靠性和稳定度均得到了显著提高,并且具有良好的实时性和工程实用性等特点。

关键词: 光传操纵 光交叉通道数据链路 可靠性 马尔可夫过程 故障容错

Abstract: Optical cross-channel data link (OCCDL) is an important part for data exchange among the fly-by-light redundancy flight control computers. In order to improve the reliability of OCCDL system, a new OCCDL system with multi-link fault tolerant capability is designed. The structure of the OCCDL is given and the workflows of the OCCDL system under the conditions of normal operation and fault operation are analyzed. The fault-tolerant logical algorithms of its main component parts such as optical switch and optical link are designed. A Markov chain-based stability model of OCCDL system is established, and the fault probability calculations of optical link, optical switch, field programmable gate array(FPGA) and double-ports random access memory(RAM) are analyzed. The numerical simulation results show that the reliability and stability of OCCDL system are significantly improved. Moreover, the OCCDL system has the traits of real-time and practicality.

Keywords: fly-by-light optical cross-channel data link reliability Markov processes fault tolerant

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Corresponding Authors: 王新华,Tel.: 025-84892301-5051 E-mail: xhwang@nuaa.edu.cn Email: xhwang@nuaa.edu.cn

About author: 王新华(1977-) 男,博士研究生,讲师。主要研究方向:先进飞行控制技术。 Tel: 025-84892301-5051 E-mail: xhwang@nuaa.edu.cn

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