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Author: Mr. Fanyu Zhao
School of Aerospace Engineering, Beijing Institute of Technology, China, zfybit@bit.edu.cn

Dr. Rui Xu
Beijing Institute of Technology, China, xurui@bit.edu.cn
Prof. Pingyuan Cui
School of Aerospace Engineering, Beijing Institute of Technology, China, cuipy@bit.edu.cn
Mr. Dexiang Chen
School of Aerospace Engineering, Beijing Institute of Technology, China, chendexiangbit@163.com

DYNAMIC RECONFIGURABLE ON-BOARD REAL-TIME OPERATING SYSTEM DESIGN BASED ON FPGA FOR DEEP SPACE EXPLORER

Abstract

Due to the limited hardware resource and the requirement of low cost space missions, the deep space explorer needs on-board automation and the ability of reconfiguration to fulfill long-term operating safely without the support of the ground. Otherwise, the outer space environment can lead to the single event upset (SEU) and radiation effects. It can cause not only degradation, but also failure of the electronic and electrical systems in deep space explorer. The on-board system reconfiguration can improve the dependability which is vital to ensuring the safety of deep space explorer. Therefore, architecture of dynamic reconfigurable on-board real-time operating system is put forward based on embedded microprocessor and Field Programmable Gate Arrays (FPGA) in this paper. Various tasks and functions can be realized with the resource of FPGA through dynamic reconfiguration. With these properties, the deep space explorer can adapt itself to multiple tasks and failure situation flexibly. When fault occurs in certain node, the architecture can enable fault recovery or isolate the fault through partial reconfiguration. In this paper we also proposed a reconfiguration method together with VxWorks real-time operating system and on-board automated planning to fulfill the task scheduling and on-board software for deep space mission. Using the dynamic reconfiguration ability of on-board autonomous system, it can simplify the on-orbit hardware update process, realize the fast switch of different operating modes, support the fault-tolerant strategy for system level and improve the performance, flexibility and expandability of on-board computer system. This method can also enhance the ability to cope with the impact or damage of deep space environment. The experiment results show that the real-time operating system based on reconfigurable on-board computer can well meet the real-time demand of deep space exploration.