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Microgravity Sciences Onboard the International Space Station and Beyond - Part 1 (6)

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THE DESIGN OF STANDARD CONTROLLER FOR MICROGRAVITY SCIENCE EXPERIMENTS: GENERAL REQUIREMENT AND SOLUTION

Abstract

The orbital environment provides a unique opportunity for microgravity science experiments. As on-orbit science laboratories, satellites and space stations carry a number of experiment payloads, in disciplines such as life science, material science, fluid mechanics, combustion and fundamental physics. Most of those scientific payloads need automatic operation and control. The automatic function includes the detection of various physics quantity, the drive of various movement mechanism, automatic information transmission and power management. Generally, the payload control system is some complex and multifarious, therefore the development cycle may be very long and often postpone the launch of the scientific experiment and delay the important scientific discovery. As a conclusion, a general controller satisfying various scientist requirements and supporting rapid development is very imperative. By decades of experience on payload development, we focus on the standard computer special for payload control. Here a high-reliability computer conformed with open-VPX standard is developed. The computer includes a flexible high-strength structure with arbitrary number of slots which could plug into circuitry boards, such as central control board, power module board, A/D conversion board, interface board and so on. As examples, we introduce three projects using our standard computers, including the controller of an evaporation condensation experiment on Chinese first Cargo Ship, the controller on a boiling bubble experiment and a material transportation experiment on Practical Satellite 10, as well as some undergoing projects on Chinese Space Station. The control requirements of these experiments are listed and the framework design of the controller and its electronic system is introduced. Some critical control performance is also presented, for example the precision of temperature control, the high-precision motor control, the high-speed camera's connection and image processing. All products of those controllers are developed rapidly, and have been verified on orbit environment or by ground test. It is a good progress for scientists to realize their idea from imagine to practice. In the future, we expect standard controllers could support more kinds of microgravity experiments and benefit the space utilization.