MICROGRAVITY SCIENCES AND PROCESSES (A2)
Facilities and Operations of Microgravity Experiments (5)

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ELECTRONIC DESIGN FOR CHINESE MICROGRAVITY ACTIVE VIBRATION ISOLATION SYSTEM

Abstract

Microgravity environment in outer space is a unique resource that human can utilize and make great discovery. However the gravity level on satellites or spacecrafts could not satisfy many science experiments due to orbital disturbances and astronaut action. For achieving the better microgravity level, several microgravity vibration isolation systems have been flight tested in orbit, including STABLE, ARIS, MIM, g-Limit and MVIS. China also started the study of the Microgravity active vibration isolation system (MAVIS) since 2006, prepared for the future Space Lab Plan. MAVIS is made up with a stator, a floater, accelerometers, position sensors, Lorentz actuators and a controller. This paper focuses on the electronic design and how we integrate and simplify the control system. The electronics system consists of power module, control module, signal conditioning module, accelerometer monitor, actuator driver and data communication module. The power module converts the 28V bus voltage to 5V and 15V DC for each electronics unit. The accelerometer monitors measures the stator and floater's acceleration by I-F conversion. The signal conditioning module measures the position change through the PSD sensor. All information is sent to the control board, which analyzes the data and determine how to drive the actuator based on optimized control algorithms. The data communication module provides the data channel between the payload on the floater and the outer devices. This electronic design has two distinct features. Firstly, infrared communication is used between the stator and the floater. With the wireless channel, the number of cables is reduced to 2 or 4, so it greatly weakens the mechanical link between the stator and the floater and simplifies the control model. The infrared channel is able to support the speed of maximum 16 Mbps based on new IrDA protocol from 2001, which is sufficient to transmit real-time data and videos from the floater payload. Secondly, a highly-integrated control board is designed, which consists of high-performance DSP and FPGA, as well as digital and analog circuits. This board functions as controller and monitor, and also used for fault monitor and data interface. This highly-integrated "brain" is mounted on the front of the stator and is interchangeable by astronauts, enhancing the flexibility of the device. The ground experiments demonstrated that the preliminary design is very successful and the control system achieves expected results.