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Facilities and Operations of Microgravity Experiments (5)

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A NEW CONCEPT OF FREE-FLOATING PLATFORM FOR MICROGRIVATY VIBRATION ISOLATION

Abstract

In order to provide the better microgravity environment for space scientific experiments, space stations and satellites are often equipped with active vibration isolation systems such as STABLE, ARIS, MIM, g-LIMIT and MVIS. China is also developing a MAVIS system recently. Those systems are reported to be able to alleviate the on-orbit vibration level to 10μg to 1mg level at 0.01-100Hz. For improving the vibration isolation technology further, we propose a novel strategy for microgravity science experiments, called the in-cabin free-floating technology. Experiment payloads are fixed in a box with rechargeable batteries and released by astronauts inside the spacecraft cabin. Because it is not affected by any on-orbit disturbances or vibrations, the payload can work in a very good microgravity environment. As long as its initial velocity is not very large, it can work for tens of minutes before it collides with the cabin wall. In addition, if it is equipped with reaction micro-thrusters to avoid collision, the working time may be prolonged to several hours. This platform is made up with a spherical structure, rechargeable batteries, accelerometers, position detectors, data handling systems and an alternative micro-thruster control module. Initially, the platform is placed on a docking room which provides battery charging interface and data channel. When running, the platform is released with little initial velocity and free floats in the spacecraft cabin like a micro-satellite. When it moves slowly towards the wall, the control system automatically detects position changes and if possible, generates a reaction force by electric micro-thrusters. After batteries are exhausted, the platform is retrieved by astronauts and sent back to the docking room. We carefully simulate the fluid flow field in cabin and investigate the level of air flow forces and thruster forces on different shapes of floating objects. The simulation results show that it is feasible to control the total force to less than mN, which means the acceleration level of ug on ordinary payloads. Such a platform is expected to achieve the better microgravity environment (at least one order of magnitude than traditional vibration active isolation systems). Moreover, such a platform may be used as an in-cabin small satellite or an assistant robot to help astronauts. We believe that it is an innovative and promising technology for microgravity science and other space utilization.