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AN INNOVATIVE METHOD FOR SIMULATING MICROGRAVITY EFFECTS THROUGH COMBINING ELECTROMAGNETIC FORCE AND BUOYANCY

Abstract

An experiment under microgravity is one of the essential steps for verifying the space operating technologies on the ground. To test and demonstrate the complex space operations, it is required that the ground test system can provide a long-time, large-space, controllable and accurate microgravity test environment to simulate the space motions of six degree-of-freedom or more. Currently, there are two types of simulation methods. The first is the environment simulation method, including the Zero-G airplane, the probe rocket and the drop tower, which can't meet the long-time requirement during the test and also with high cost. The other is achieved by simulating the zero gravity effects that maintains the apparent gravity of the test body continually to be zero, including the sling suspension system, the air-bearing suspension system and the neutral buoyancy system. But the sling suspension system has the complex structure and mechanism, and with which the simulating accuracy is relatively insufficient; the air-bearing suspension system can only simulate the motion in the horizontal plane, not have the degree-of-freedom in the vertical direction; the neutral buoyancy system seems to be qualified if it could be controlled well. An innovative method for simulating space microgravity is proposed in this paper. The new approach combines the neutral buoyancy and the electromagnetic force on the test body to balance the gravity and simulate the microgravity effects. The current experiments show that this method is feasible, and it has the following advantages. First, it retains the advantage of neutral buoyancy system, while the balancing process is much easier and the fidelity of the simulating is even higher. Second, the electromagnetic force can be real-time online controlled at the microgravity levels to meet the specific requirements of the experiment. Based on this method, an experimental system has just been built in our laboratory and used in the Chinese manned-space engineering. In the paper, we represent the detailed elements of the magnetic-fluid hybrid suspension microgravity simulating system, the components and functions of the facilities, and the implementation methods. Some key techniques that have been solved so far will be described in particular, including the calculation and design of the equivalent force field, homogenization design of the electromagnetic force field, equivalence principle of the motion of the test body, and compensation method of the water resistance force. And also, we'll give some experiment data and results with our innovative microgravity simulating system.