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Author: Mr. Takuma Nagata
Chukyo University, Japan

Mr. Hiroki Nagai
Chukyo University, Japan
Dr. Kazuma Ueno
Chukyo University, Japan
Dr. Takanobu MURANAKA
Chukyo University, Japan

PRELIMINARY STUDY ON DEORBIT OF LARGE DEBRIS USING A CHARGED SAIL IN LOW EARTH ORBIT

Abstract

Increasing of space utilization activities increase large debris like an upper stage of the rocket in congested orbit of altitude 700-1000 km. This debris collides with others and a lot of small debris and which causes further collisions with other spacecraft. In addition, small satellites activities are in a similar situation. For these reasons, some low-cost debris removal systems are proposed and a part of fundamental technologies was already demonstrated by space agencies in space. The atmosphere in the altitude of 700-1000 km is composed of neutral particles He, H, O and ion particles O+, H+. One of the conventional deorbit system is a deployable sail capturing the neutral particles to produce a drag force. The drag force decrease spacecraft velocity and then the spacecraft dawn to the earth. This type of deorbit system is very simple, but a large-scale structure is needed to produce enough drag force. In this research, we focus on the ion particles and proposed a new concept of deorbit system utilize an ion sheath generated by a charged deployable thin film. A mechanism of the proposal deorbit system is as follows. At first, an onboard sail which made of a thin film is spread in the direction of travel. Second, the sail is charged to the negative potential and the back side of the spacecraft is charged to the positive potential balanced to the sail potential. Then, the ion sheath is generated in front of the sail by the negatively charged sail and the drag force by capturing ion particles with the ion sheath. In order to verify this system, the drag force is estimated theoretically and measured using a small scaling-model experimentally. A developed ground simulator consists the scale-model and RF ion source simulated as the orbit environment in the altitude of 700-1000 km. In the experiment, the scale-model is mounted on the thrust stand to measure the drag force and immersed into the plasma flow to simulate a spacecraft flight on orbit. This paper reports some preliminary results of this verification.