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QUALIFICATIONS

- CATIA V5R18 Part Design Specialist
- CATIA V5R18 Assembly Design Specialist
- Amateur Third-Class Radio Operator

EDUCATION

- Bachelor of Engineering, Nihon University, Tokyo(2015)
- Master of Engineering, Nihon University, Tokyo(2017)

RESEARCH OVERVIEW

Background

In recent years, space debris problem in low Earth orbit (LEO) is attracting a great deal of attention. Space debris includes fragments when launching the rocket, fragments of satellite destruction and non-functioning objects. These may be seriously damaged by colliding with satellites, rockets and satellites that are currently in operation. Furthermore, space debris would be an exponential increase with time by repeated collisions of satellites and debris (Kessler syndrome) (Fig.1) . It is necessary to active debris removal (ADR) in order to suppress and reduce this debris increase. Currently, as a method of positively removing debris and improving the orbit environment, tether net capture, electrodynamic tether and a high resistance device by membrane surface deployment are being studied.

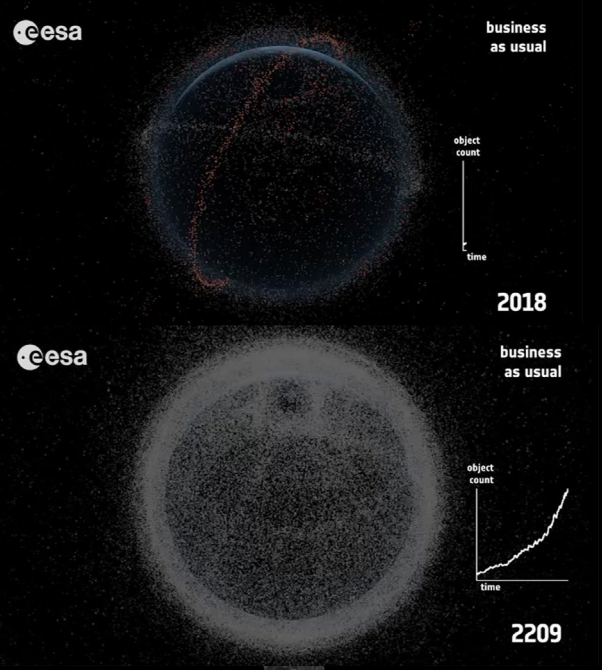

Fig.1 Kessler syndrome (image credit by ESA)

Purpose

- **We want to create a lightweight and simple debris capturing device for ADR.**

Target selection of debris

Fig.2 Constellation of satellites (image credit by one web)

Currently, target debris with a large product of collision probability and debris mass are selected. For this reason, the collision probability and debris mass greatly influence the future increase of debris. However, the total mass of debris with large mass is small, and conversely, the total mass of small and medium size debris is large. Furthermore, large-scale constellations of small and medium-sized satellites are proposed in the future. From the business point of view, it is considered suitable to take small to medium-sized satellites (100 to 500 kg), and the size of small to medium-sized satellites is assumed to be 1 to 10 m.

Target selection of debris

Three orbital regions in LEOs, where most catastrophic collisions are predicted to occur, have been identified as most critical (Fig.3). The altitude and orbit inclination are shown below.

i. Altitude: 1000 ± 100km, inclination: $82 \pm 1^\circ$
ii. Altitude: 800 ± 100km, inclination: $99 \pm 1^\circ$
iii. Altitude: 850 ± 100km, inclination: $71 \pm 1^\circ$

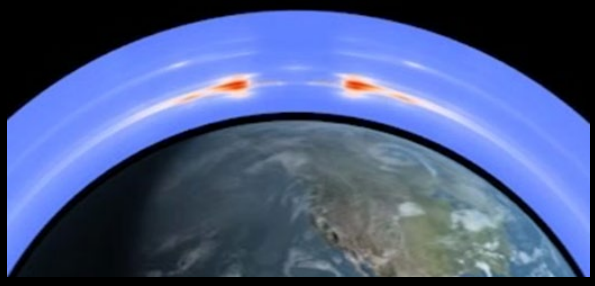

Fig.3 Hotspot of debris in LEOs (image credit by ESA)

It is targeted that Small satellites (100 to 500 kg), 1 to 10 m in size, and debris with an orbital inclination angle (i to iii).

Concept of Debris Capturing Device

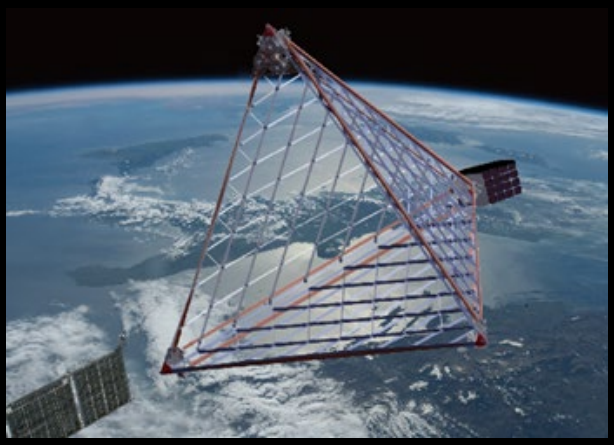

Fig.4 Concept of Debris Capturing Device

This capturing device (Fig.4) mainly consists of three-dimensional self-deployable truss (3DSDT) (fig.5).and nets.
3DSDT has the following characteristics

- 3DSDT stores the energy of the booms which are wound, and it releases this energy to deploy itself
- Lightweight structure
- High storage efficiency.
- High specific rigidity structure

We think that 3 DSDT is suitable for debris capturing device.

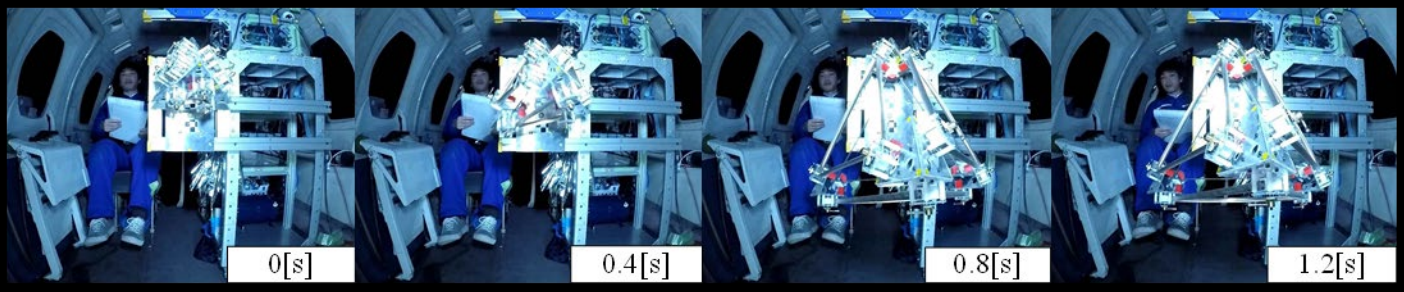

Fig.5 Time history of Deployment Test of 3DSDT in Micro-gravity Environment by Airplane

The mission sequence of ADR is shown in Fig.6. It consists of four phases.

⓪ Launch phase
① Chaser transfer orbit phase
② Rendezvous/Capturing phase
③ De-orbit/Re-entry phase

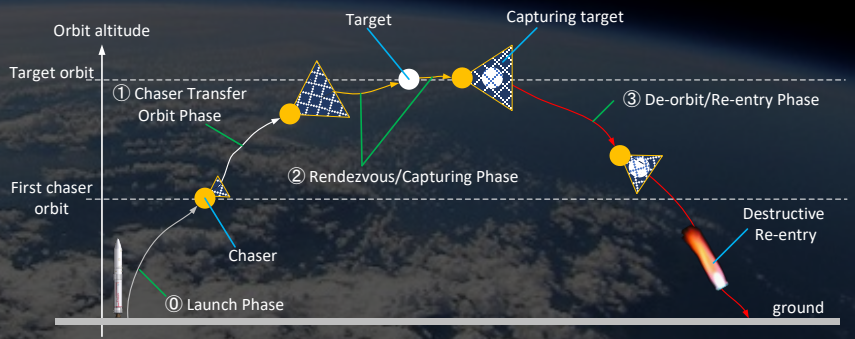

Fig.6 ADR mission sequence

April , 2019 Daishi Kawarabayashi