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A SPACE DEBRIS REMOVAL STRATEGY USING A COLLISION WITH SMALL RELATIVE VELOCITY

Abstract

Capture and re-entry is a representative strategy for space debris removal. Difficulties of capture mechanism and control of space debris are well-known among researchers. In addition, as deceleration of debris requires large amount of propellant, it is usually recognized impossible to remove many debris by a single mission.

About eighty percent of space debris whose orbit are precisely observed are staying in the LEO. It is possible to reduce the orbit lifetime of these debris by rather small deceleration. For example, a deceleration about 0.2km/s is sufficient to transfer space debris, originally on a circular orbit with an altitude of 850km, into an orbit with the orbit lifetime below 0.1year. Generally, the relative velocity between a pair of objects in LEO becomes larger than 14km/s in a head-on collision case, and about 7km/s in a case of lateral collision. In contrast, it is considered possible that a collision between a pair of objects flying into the same direction occur with a small relative velocity. In this case, by controlling an artificial object to orbit a little slowly in front of target debris, it becomes possible to occur collisions with small relative velocities to result in small decelerations of the debris to reduce their orbit lifetime largely. As it is unnecessary to capture debris in this strategy, it is considered possible to remove small debris that are impossible to capture by robotics. Furthermore, propellant consumption is neither necessary for the deceleration of debris. The damage of the material caused by collisions with small relative velocity is expected small enough to repeat collisions with debris. Therefore, it is expected that a single mission is able to remove many debris in this strategy.

In this study, the authors propose a new strategy for space debris removal, where a “plate satellite” is controlled on an LEO so that space debris catch up with the plate satellite to occur collisions with small relative velocities. Its feasibility is investigated through the orbital mechanics and material of the plate satellite, and orbital analysis of debris in both pre and post collision. The authors have already carried out preliminary analyses using debris TLE data provided by Space-Track.org and SGP4 for orbital analysis. It has been clarified that a plate satellite is able to decelerate about ten debris pieces within one month. The authors carry out more detailed analysis to present at the conference.