SPACE DEBRIS SYMPOSIUM (A6)
Space Debris Removal Concepts (7)

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ACTIVE DEBRIS REMOVAL BY A SMALL SATELLITE

Abstract

Debris environment remediation, that is, active debris removal is necessary in order to reduce the burden of collision avoidance maneuver operation and debris protection design, and unavoidable debris collision damage risk in the future. The targets of the removal are large intact debris objects (defunct satellites or rocket bodies) in the crowded regions, because they are the source of numerous smaller debris that pose direct risks. In order to remove large debris objects, a robotic spacecraft that rendezvous with debris for de-orbiting is the most possible measure since other methods such as a laser or a sweeper cannot remove them with current technology within realistic cost. JAXA is investigating an active removal system that can rendezvous with and capture non-cooperative debris objects in crowded orbits for de-orbiting them. This paper describes the required technologies and scenario for realizing debris removal with low cost. A flight demonstration using a small satellite to remove one Japanese H-IIA rocket upper stage is investigated. Non-cooperative rendezvous can be achieved using optical cameras, after the removal satellite gets close to the target object using GPS sensor and TLE data. The distance between a target object and a removal satellite can be estimated using only direction information obtained by the camera image, by comparing the change in the direction before and after the thrust for adapting their orbits. The attitude of Japanese rocket body is expected to be almost stable because of the gravity gradient torque, based on the observation data obtained from the ground. After the removal satellite approaches the target object, the end of the tether is attached to the target object using a harpoon or a device attached to payload attachment fitting of the rocket upper stage. And then the tether is deployed from the debris to deorbit until the target object re-enters the atmosphere. The propellant requirements of conventional propulsion systems make them infeasible for transferring multiple objects, but electrodynamic tether (EDT) is considered to be the most promising propulsion system for cost effective de-orbiting.