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THE LASERS MISSION CONCEPT FOR ACTIVE DEBRIS REMOVAL USING LASER ABLATION
BY A SWARM OF CUBESATS

Abstract

The exponential increase of space debris poses significant challenges and threats to the safety of space operations and activities. However, for active debris removal, most of the efforts are put in the Low Earth Orbit (LEO) region using concepts like robotic arms, nets, or laser ablation onboard a single spacecraft. Little attention has been put on the Geostationary Orbit (GEO) region which hosts many defunct telecommunication satellites and other types of debris.

To address GEO debris removal, we propose the LASERS (LAsER-based Space dEbris Removal with a cubesat Swarm) mission to touchlessly dispose of an example defunct satellite in GEO by moving it into a graveyard orbit using laser ablation, provided by a swarm of CubeSats. Laser ablation works by ablating the surface of the debris and creating an expanding plume of material that induces a thrust acting on the body. The laser ablation approach is selected due to its advantage of reduced operational risks compared to other physical attachment concepts. The three main advantages of using a swarm instead of a single spacecraft for active debris removal using laser ablation include 1) the lower power requirement of a set of smaller lasers compared to a single larger one; 2) the possibility of having duty cycles of individual sets of CubeSat; 3) the increased robustness of the mission due to the distributed system design. Taking the defunct ATS-3 (Application Technology Satellite-3) of NASA in GEO as the example mission target, the LASERS mission could transfer ATS-3 from GEO to a graveyard orbit in 200 days by providing a total delta-V of 10 m/s with the swarm consisting of 27 laser CubeSats and one chief CubeSat.

Besides the main aim of debris removal, LASERS will also be a technology demonstration mission to test an on-board laser system and the autonomous coordination of the distributed swarm system. Moreover, the LASERS mission demonstrates promising commercialization potential due to its high technology readiness level and the big market potential in GEO region. Last but not least, it also demonstrates the potential applications in MEO and LEO regions.