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SPACE DEBRIS SYMPOSIUM (A6)
Space Debris Removal Concepts (6)

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PHOTON-PRESSURE COLLISION AVOIDANCE: EFFICIENCY ASSESSMENT ON AN ENTIRE CATALOGUE OF SPACE DEBRIS

Abstract

In the past, the potential of using ground-based lasers to perturb an orbit using photon pressure was shown. Possible applications would be protecting space assets from impacts with debris and stabilizing the orbital debris environment. Focusing on collision avoidance rather than de-orbiting, the scheme avoids some of the security and liability implications of active debris removal, and requires less sophisticated hardware than laser ablation. Earlier research concluded that one ground based system consisting of a 10 kW class laser, directed by a 1.5 m telescope with adaptive optics, could avoid a significant fraction of debris-debris collisions in low Earth orbit. The earlier research used a displacement threshold to quantify the fraction of objects that could be diverted from collisions and restricted itself to a limited number of objects. As orbit prediction error is dependent on debris object properties, a static threshold for displacement is not the best measure to assess the efficiency of this scheme. In this paper we present the results of an approach using collision probability. Using a least-squares fitting method, we improve the quality of the original TLE catalogue in terms of state and co-state accuracy. We then calculate collision probabilities for all the objects in the catalogue. The conjunctions with the highest risk of collision are then engaged by a simulated network of laser ground stations. After those engagements, the perturbed orbits are used to re-assess the collision probability in a 24h window around the original conjunction. If that probability falls below a certain threshold, the collision avoidance maneuver is counted as a success. Using the described success criteria, we then assess the number of base-line ground stations needed to mitigate a significant number of high probability conjunctions. Cloud cover and duty cycles of the laser are taken into account for this assessment. Finally, we also give an assessment to which extent a laser ground station can be used for both orbit deflection and debris tracking during the same pass.