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CAPTURE AND REMOVAL OF SMALL SPACE DEBRIS USING ORIGAMI INSPIRED NET IN SSO

Abstract

The potential threat to operational satellites orbiting Earth from space debris is ever increasing. Various state-of-art methods, such as tentacles, robotic arms, tether, net, have been proposed to mitigate this problem. One of the greatest challenges of these methods is to reliably capture and remove a non-cooperative target while avoiding the generation of more space debris. These methods gave little attention on small (¡1cm) and medium (¡10cm) space debris. The small debris accounts for 129,000,000 or 98% of total debris, and also, they cannot be traced and hence, cannot be avoided from being hit by them. These collisions happen at 7-15kmps when debris change their orbits or when they collide with launch vehicles and re-entry vehicles.

Abstract In this paper, the proposed idea stems from the use of the net to capture small fishes. Just like small space debris, the density or distribution of small fish in the ocean is not known before casting the net. Unlike the use of tethers and robotic arms, we have proposed the use of origami-inspired solid net/sheet to capture small space debris in large quantity in Sun-Synchronous Orbit (SSO) while maintaining a slower orbital velocity. The slower orbital velocity increases the relative velocity from zero to 1-2m/s between the operational satellite and the debris in orbit. Due to this, the debris eventually gets collected in the net. The net needs to have enough material strength to absorb the momentum transfer when it captures the debris. Deployment of the net of this size and material strength requires clever folding and unfolding mechanism so that it can be launched in space. Two main problems are presented in this project: folding and unfolding the origami net and the thrust control for low orbital speed flight. Robust optimal control is implemented to work against the uncertainties during the mission and to conserve fuel. A debris field with atmospheric drag around Earth in SSO is simulated in Matlab to validate the proposed method. Variable mass and inertia analysis is carried out, and it is observed that the net is able to capture countable debris without damaging its structural strength.