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TECHNICAL ANALYSIS OF ARTIFICIAL INTELLIGENCE ASSISTED SWARM CUBESATS FOR ACTIVE DEBRIS REMOVAL IN LEO

Abstract

The enormous growth in the number of space programs has led to an exponential increase in the number of small satellite missions in Low Earth Orbit (LEO). Space junk is not only a huge risk to the success of future space missions but also proves to be hazardous for the active satellites and spacecrafts. This urges an essential necessity of having an affordable and adaptive solution to address the problem.

This research paper analyses an active debris removal method utilizing a swarm of CubeSats to autonomously rendezvous with space debris in LEO, capture and remove it. Assisted by artificial intelligence, the CubeSats assess the removal strategy for a given debris based on the geometry and dimensions of the target. The swarm will autonomously maneuver around the debris to form a constellation around it, before closing in and hereby securing it. This "LEO model" varies individually for each space debris object targeted.

The paper assesses the technical aspects of the active debris removal approach including the mathematical representation of the artificial intelligence model deployed in the space system. The economic viability of the concept has been identified and is studied with a focus on the "LEO model" formation. The research shows that utilizing swarm CubeSats and artificial intelligence for target acquisition, efficient orbit maneuvering, target capture and deorbiting provides a reliable architecture for future active debris removal missions in LEO.

Keywords: CubeSat, swarm robots, LEO, space debris, active debris removal, artificial intelligence, mission autonomy