Paper ID: 69558
oral
student

20th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Post Mission Disposal and Space Debris Removal 2 - SEM (6)

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AN END-OF-LIFE COLD GAS CONTROL SYSTEM FOR SMALL SATELLITES

Abstract

Worldwide, we depend on satellites in Low Earth Orbit (LEO) for communication, navigation, climate monitoring and various other services. As a result, the number of satellites in LEO has been exponentially growing over the last decade. CubeSats have been a part of this trend, with 705 planned launches in 2022 alone. Eventually, LEO could be so densely populated that a single impact event could result in a cascading collision event, a scenario known as Kessler syndrome, rendering some orbits unusable for generations.

As the risk of collision grows, the space community recommends that a spacecraft deorbit or maneuver into an orbit that will decay within 25 years or less after completing its mission. However, small spacecraft are not always equipped with thrusters, and rely on atmospheric drag for deorbit.

This paper discusses the development of a control system for a modular CubeSat Self-Contained Orbit Termination Tool (SCOTT). SCOTT is designed to operate on any 6U CubeSat and fit within a 2U module. The module is equipped with thrusters, sun sensors, a magnetometer, and a gyroscope. The control system observes the sun sensor and magnetometer measurements over multiple orbits and uses the observation in an artificial neural network to determine the orbital parameters. The orbital parameters are needed to determine the retrograde direction. The control system uses cold gas to reorient the spacecraft in the retrograde direction and maintains that orientation for the duration of a low-thrust spiral deorbit trajectory. Results show that SCOTT is able to change a CubeSat's trajectory from an initial altitude of up to 700 km to an orbit where the atmospheric drag causes deorbit within 25 years.