Paper ID: 61448
oral
student

48th STUDENT CONFERENCE (E2)
Student Team Competition (3-GTS.4)

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MISSION ORCA: ORBIT REFINEMENT FOR COLLISION AVOIDANCE

Abstract

With new launches every year, and the use of ‘mega-constellations’ becoming commonplace, there is an increasing number of active satellites and other resident space objects (RSOs) in low Earth orbit. However, a collision between objects could be disastrous, having wide-ranging impacts on the collision orbit and all the satellites users within it. Collision forecasting currently has large degrees of uncertainty,

causing satellite operators to often ignore collision warnings. It is therefore critical that a system becomes operational to track RSOs and determine the likelihood of collisions with greater accuracy than is currently available.

The proposed solution uses a constellation of 28 spacecraft (plus in-orbit spares) in Sun Synchronous Orbits. CubeSats will be used to reduce the cost and the time required for the constellation to become operational. Each satellite uses an optical payload to track target RSOs, with the satellite's position precisely determined. Multiple pictures of the RSO are taken, and the spacecraft attitude used to calculate the target's position relative to the spacecraft. The target's orbit is then determined from the movement of the target through the field of view over time. The system outputs orbit state vectors of the tracked object, allowing precise orbit characterisation and collision forecasting to be delivered. The constellation's design allows high temporal resolution, so reliable information can be supplied to end-users.

The paper shows the results of the system design of a demonstration mission meant to verify the feasibility of the concept, performed by a team of students of Cranfield University. The exercise addresses all the aspects of the preliminary design, including the definition of the mission and system requirements, the selection of the overall mission architecture, operations, and mission phases. A cap on the overall cost allows for the realisation of the platform within a university budget. The outline of the design includes not only the selection and sizing of all the subsystems and payload, but also suggests a new strategy for deploying the constellation if the demonstration mission is successful. The utilisation of high TRL and COTS components, as well as mass, power, and link budgets, demonstrate the feasibility of the overall mission concept.