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REFLECTOR-BASED ATTITUDE DETECTION SYSTEM

Abstract

In recent years the number of launched satellites rapidly increased. In 2022, more than 1,200 satellites were brought to orbit mainly by commercial operators pushing the objects tracked by space surveillance networks to more than 30,000. Defunct or uncontrolled satellites pose a threat to active satellite missions and can start to rotate due to external or internal torques acting on the satellites. A better understanding of the attitude behavior of such satellites would provide assistance to future active debris removal missions. Space debris laser ranging allows to perform range measurements to space objects without corner cube retro reflectors (CCR) sized approximately one meter. Due to the diffuse reflection on the whole body and the statistical distribution of returns in the single photon regime, information on the size of the object and potential rotation behavior is contained in the data. However, the quality of the attitude reconstruction can be improved if the satellite in question is also equipped with CCRs.

The future ESA Copernicus satellites are already embarking Design for Removal technologies, including the implementation of several CCRs distributed over the satellite's surface to allow attitude determination from ground. Within the framework of the ESA study Reflector-Based Attitude Detection System (RADS) the optimal placement of CCRs on multiple faces of Earth observation satellites is assessed. A modular simulation tool allows to simulate arbitrarily rotating space objects on different orbits and calculate laser ranging observed-minus-calculated residuals for those objects. Within this simulation, multiple parameters, such as the pattern of the CCRs on the satellite, the rotation axis, the spin rate, or the station's coordinates can be varied. The tool provides means to design an optimal distribution of CCRs on the spacecraft surfaces and generates simulated input data for the development of attitude analysis

algorithms based on laser ranging data.