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APPLICATION OF A MULTIPLE HYPOTHESIS FILTER TO NEAR GEO HIGH AREA-TO-MASS RATIO SPACE OBJECTS STATE ESTIMATION

Abstract

Optical surveys have identified a class of high area-to-mass ratio (HAMR) objects in the vicinity of the Geostationary Earth Orbit (GEO) regime . The nature of these objects is not well known, though their proximity to the GEO belt implies origins from resident space objects (RSOs) near GEO. These HAMR objects pose a collision hazard as they transit through the vicinity of active GEO satellites. Due to their high area-to-mass ratios (AMRs), ranging from 0.1-20 m2/kg and higher, the effective solar radiation pressure perturbs their orbits significantly. Improvements in detection sensitivity will result in large numbers of uncorrelated tracks from surveys. A multiple hypothesis filter (MHF) approach to the initial state estimation and track association provides a potentially automated and efficient approach to the processing of multiple un-correlated tracks.

The availability of long-term optical angles data collect for a set of near GEO HAMR objects provides the means for testing candidate estimation processes such as the MHF. A baseline orbit determination process uses an Extended Kalman Filter/Smoother to manually estimate the 6 orbital elements, plus the area-to-mass ratio (AMR) which dictates the solar radiation pressure perturbations on the orbital trajectories. In addition to allowing the characterization of the long-term behavior of the AMR, this process establishes a pseudo-truth trajectory to which can be compared to subsequent MHF analysis. An Unscented Kalman Filter (UKF) is applied in the MHF estimation process to estimate the 6 orbital elements and AMR, with no a priori state assumptions, and the results compared to the pseudo-truth results for validation.

The work to be presented summarizes the UKF/MHF process, assesses state estimation performance based on selected data for selected near GEO HAMR objects having a range of AMR value and variations. The prediction accuracy is also assessed by comparing predictions derived from filter updates to segments of the pseudo-truth trajectory determined from data not included in the updates.