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ORBIT DETERMINATION FROM SPACE-BASED OPTICAL OBSERVATION

Abstract

This study, that regards the space based optical observation of the space debris in LEO orbits, was developed in the framework of Thales Alenia Space with the partnership of the Space Systems laboratory of University of Rome “La Sapienza”. Particularly in this work the orbit estimation problem of a space object from a set of Space-based optical measurements is analysed. The studied configuration involves two space objects, the observer satellite, on which the optical sensor is mounted, and the target object. The state of the observer satellite is known and we want to estimate the orbit of the target object after a synodic period. The first step of this study has involved the evaluation of the sensor bore-sight considering the Sun phase angle problem. After this analysis we have simulated the measures obtained from the optical sensor, that as known are the celestial coordinates of a space object. Using these measures and considering a dynamics model that include the J Gravitational Harmonic we have implemented four different solutions for the estimate problem. The first two solutions involve the sequential estimator approach, using the EKF and the UKF, while the other analysed solutions involve the batch estimator approach. The algorithms that have been used for the solution of least squares problem are the Levemberg-Marquardt and Powell’s dog-leg algorithm. In the first step of the orbit determination study we have been used a field of view of 180 degrees in order to compare the different algorithms in ideal condition and in an independent way respect to the visibility. Instead in a second time we have compared the different solution obtained with these estimators and we have observed that the Powell’s dog-leg algorithm is the best choice for the analysed case. Once we have chosen the algorithm, we have evaluate its robustness simulating non modelled perturbation effect and the results confirm that this algorithm, within the simulation time, is not too sensible to non modelled forces. At the last time, after the algorithm choice and validation, we have analysed the effects of the optical sensor resolution on the orbit determination and we have determined the minimum sensor field of view that is necessary for an accurate orbit estimate for a set of typical debris orbit. The developed analyses have shown that the used solution for the algorithm provides a high accuracy and robust estimate of the space debris state.