Paper ID: 53285
oral
student

17th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Orbit Determination and Propagation (9)

Author: Mr. Sergi López-Jiménez
GMV Aerospace & Defence SAU, Spain, serlopez@gmv.com

Mr. Alejandro Pastor-Rodríguez
GMV Aerospace & Defence SAU, Spain, apastor@gmv.com
Mr. Srinivas J. Setty
Germany, harsha.shresty@gmail.com
Dr. Diego Escobar Antón
GMV Aerospace & Defence SAU, Spain, descobar@gmv.com
Dr. Ernst Schrama
Delft University of Technology (TU Delft), The Netherlands, e.j.o.schrama@tudelft.nl
Mr. Alberto Águeda Maté
GMV Aerospace & Defence SAU, Spain, aagueda@gmv.com

TOWARDS COVARIANCE REALISM IN BATCH LEAST-SQUARES ORBIT DETERMINATION

Abstract

The problem of characterising the uncertainty in the estimated state of resident space objects (RSOs) is of major importance in the framework of Space Surveillance and Tracking (SST) activities and particularly for product provision (i.e. high-risk collisions, upcoming re-entries, fragmentations). Most of these SST products rely not only on the estimated orbits but also on their associated **uncertainty**, which are initially estimated during the catalogue build-up and updated through maintenance as more measurements are available. Assuming Gaussian processes, the uncertainty in the state of the objects can be represented by their **covariance**, which can be directly obtained via classical orbit determination.

Nevertheless, a common problem of orbit determination algorithms is that the **uncertainty of the dynamical models**, used to describe the motion of the objects, is not properly considered or even not considered at all. This leads to an optimistic (too small) estimation of the uncertainty that in many cases requires the application of non-physical scaling factors to artificially increase the uncertainty, acting as a safety factor. As a matter of fact, the uncertainty in the solar and geomagnetic indexes should be captured, since its effect on the atmospheric density is very important when dealing with low Earth orbit (LEO) objects.

This work aims at **improving the covariance realism** of orbit determination algorithms based on the **consider parameters theory**. The proposed method extends this classical theory to find the proper value of the consider parameters with which the resulting covariance is best fitted to the so-called observed covariance. Therefore, the contribution of each consider parameter is optimised via a fitting process so that the obtained estimated covariance adjusts to the observed one. The influence of the main sources of dynamic model uncertainty (atmospheric modelling, object geometry, geomagnetic and solar radiation indexes prediction, sensor calibration parameters, among others) have been investigated by evaluating the resulting covariance correction for each uncertainty source.

The methodology has been applied to a simulated realistic scenario of measurements and objects to evaluate the consistency of the corrected covariance via Monte Carlo analysis. Furthermore, an interesting use case involving real measurements from radars is analysed and validated through comparisons against precise orbit determination (POD) orbits.