Correlation techniques for catalogue build-up and maintenance with radar and optical survey measurements

Alejandro Pastor\(^{(1)}\), Diego Escobar\(^{(1)}\), Manuel Sanjurjo\(^{(2)}\), and Alberto Águeda\(^{(1)}\)

\(^{(1)}\)GMV, Calle Isaac Newton 11, Tres Cantos, 28670, Spain  
\(^{(2)}\)Universidad Carlos III de Madrid, Madrid, Spain

ABSTRACT

The number of resident space objects (RSOs) is increasing year after year and therefore the sensing capabilities. Space Surveillance and Tracking (SST) systems are composed by sensors and on-ground processing infrastructure devoted to generating a catalogue of RSOs: a robust automated database that contains information of every detected object. The catalogue build-up process consists in detecting new objects to include them in the catalogue without any previous information, while maintenance entails the update of existing objects information.

Since 2007 GMV has developed and used methods to identify, track and catalogue RSOs. The SST Cataloguing Simulator (catsim) is GMV’s software capable of receiving SST measurements from a sensor network and performing the build-up and maintenance of a catalogue of RSOs.

This paper focuses on the correlation techniques for both radar and optical measurements implemented in GMV’s cataloguing solution and their performances in terms of clear correlation metrics, such as true positives, false positives and false negatives. The cataloguing chain, in charge of performing both build-up and maintenance of the catalogue, takes into account the main sources of potential new objects detection, by order of decreasing frequency: operational satellites maneuvers, satellites launches and break-up events. Techniques involved entail track-to-orbit correlation: correlation of uncorrelated tracks (UCTs) with already catalogued objects, track-to-track correlation: association of UCTs among them in order to identify new objects not previously catalogued and orbit-to-orbit correlation: correlation of objects of the catalogue with those from external catalogues, as well as cross-correlation for validation. They rely on initial orbit determination and orbit determination methods, both batch and sequential estimations.

The experience on these subjects gained by GMV with its own software solution for catalogue build-up and maintenance will also be described in the paper, using data from real sensors: more than 30 telescopes, radars and SLRs in five continents, covering all SST telescopes in Spain (OAM, TFRM, TJO, IAC, IAA), Airbus’s GEoTracker telescopes, SpaceInsight telescopes, AIUB telescopes in Switzerland, ESA’s OGS, Russian ISON telescopes network, Numerica and ExoAnalytic Solutions telescopes in USA, and radars such as TIRA in Germany, Chilbolton in UK, ESA’s MSSR, LeoLabs in USA and the Spanish Navy SLR station, among others.