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Author: Dr. Simone Varanese
Sapienza University of Rome, Italy, simone.varanese@uniroma1.it

Dr. Lorenzo Mariani
Sapienza University of Rome, Italy, lorenzo.mariani@uniroma1.it
Dr. Gaetano Zarcone
University of Rome "La Sapienza", Italy, gaetano.zarcone@uniroma1.it
Ms. Mascia Bucciarelli
University of Rome "La Sapienza", Italy, bucciarelli.1792406@studenti.uniroma1.it
Mr. Lorenzo Cimino
Sapienza University of Rome, Italy, cimino.1785896@studenti.uniroma1.it
Mr. Matteo Rossetti
Sapienza University of Rome, Italy, rossetti.1821458@studenti.uniroma1.it
Dr. Thomas Kelecy
Aerospace Corporation, United States, tom.m.kelecy@aero.org

GEO OPTICAL MEASUREMENT CORRELATION AND ANGLES-ONLY ORBIT DETERMINATION

Abstract

Given the raising number of active satellites and space debris in the Geostationary Earth Orbit (GEO) ring, a continuous and accurate monitoring of these objects is strictly necessary and increasingly important. By accurately determining their orbits, Space Surveillance and Tracking (SST) services play a critical role in ensuring the safety and sustainability of space operations in the GEO region. Optical measurements are a key source of data for the Orbit Determination (OD) of GEO objects. In this paper, the research team from Sapienza Space Systems and Space Surveillance Laboratory (S5Lab) suggests a method for the correlation of optical measurements and a precise angles-only OD technique that can be used to compute an accurate orbit of observed space objects. S5Lab owns a network of telescopes and observations systems for both Space Situational Awareness (SSA) activities and Space Traffic Management (STM), among which two persistent monitoring wide field-of-view observation systems for monitoring the GEO ring: SURGE (located in Italy) and Mini-SURGE (located in Australia). The optical data used in the context of this paper was gathered using these two observations systems. Every night tens of thousands of uncorrelated optical measurements, in terms of Right Ascension (RA) and Declination (Dec), are acquired. Processing this amount of data is a challenging task that involves identifying and matching optical measurements of an object over time. One approach to correlation of optical measurements is to use catalogue-based methods. This involves comparing the observed position of an object to a catalogue of known objects in the field of view. When catalogue-based methods are unsuccessful, another approach is provided that can be used in place of or in addition to them. This might be the case of newly detected objects that have not been included in public catalogues. Uncorrelated measurements are cross-referenced with a list of potential correlatable measurements. These potential candidates are skimmed using multiple correlation conditions until a positive correlation is found. Finally, a nonlinear least squares differential-correction technique is used to compute an accurate orbit of each observed space object. The correlation process and the OD procedure are both validated by comparing the results with reference satellites having known high accuracy ephemerides.