17th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Space Debris Detection, Tracking and Characterization (1)

Author: Mr. Vincenzo Schiattarella
Sapienza University of Rome, Italy, vincenzo.schiattarella@uniroma1.it

Prof. Fabio Curti
Sapienza University of Rome, Italy, fabio.curti@uniroma1.it
Dr. Dario Spiller
Sapienza University of Rome, Italy, dario.spiller@uniroma1.it
Dr. Claudia Facchinetti
Italian Space Agency (ASI), Italy, claudia.facchinetti@asi.it
Dr. Luigi Ansalone
Italian Space Agency (ASI), Italy, luigi.ansalone@asi.it
Mr. Alberto Tuozzi
ASI - Italian Space Agency, Italy, alberto.tuozzi@asi.it

STAR SENSOR IMAGE PROCESSING FOR ORBITING OBJECTS DETECTION (SPOT): VISIBILITY ANALYSIS

Abstract

Over the last decades, the increasing number of space activities has led to the growth of the population of resident space objects, i.e. satellites and space debris. The availability of a complete catalogue of orbiting objects is therefore extremely useful for the reliability evaluation of present and future missions. The existing catalogs are essentially based on radars, or optical measurements obtained by on-ground instruments. The main limitation of this approach is related to the distance between observer and orbiting object. Such limitation can be solved by using space-based measurements. Within the framework of this application, the paper proposes the use of star sensors as orbiting observers, profiting from their disseminated optical sensors. Indeed, star sensors are typically mounted on-board of satellites for the attitude determination. The proposed approach provides the opportunity of using them for objects' detection, thus minimizing the impact in terms of cost and system architecture with respect to dedicated space object observer missions.

This work presents a preliminary study of the Italian Space Agency project SPOT (Star sensor image on-board Processing for Orbiting objects deTection). The paper is aimed at evaluating the visibility of orbiting objects from several satellites. The main factors which affect the visibility have been considered: the sensor characteristics (sensitivity, field of view, exposure time, and boresight direction), the optical properties of the observed objects, the environment influence, and the relative velocity between target and observer. The NORAD catalogue has been used to simulate the orbiting objects propagated by using SGP4. The simulations have been performed selecting up to 12 satellites in LEO as simultaneous observers. Results show that in one month, about 15% of the objects in the catalogue can be detected by at least 1 of the 12 observers. However, the majority of the observations occurs in the first five days, which suggests an increase in the number of observers instead of an increase in the observation duration. Moreover, observers in similar orbits detect the same targets. Thus, the system efficiency can be maximized considering observers located in very different orbits.

The future scenario in the space market will be characterized by small-satellite missions. Consequently, the main feature of the future space debris and operating satellites will be their small size. The difficulty

in tracking these objects from on-ground measurements can be faced by space-based measurements. To this purpose, this paper is a starting point in the evaluation of the proposed approach.