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Space Debris Detection, Tracking and Characterization (1)

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SIMULTANEOUS MULTI-SITE OPTICAL SETUP FOR IMPROVED POSITION AND ATTITUDE DETERMINATION

Abstract

The increasing space debris population poses a threat for both space and ground infrastructure. Possible in-orbit collisions and non-negligible casualty risk caused by large re-entering objects justify an ever-increasing international effort in the tracking, monitoring and cataloguing of the population of space objects.

General monitoring techniques involve radar or optical measurements. Optical sensors are typically cheaper and more suitable for the development of distributed networks. In addition, new techniques have been developed to take advantage of the photometric information that optical images can provide. Such data, extrapolated as lightcurves, can provide a useful information for the reconstruction of the attitude and angular velocity.

Optical measurements are however subject to different limitations. Since they do not provide, together with the angular data, a direct range information, it is not possible to retrieve a 3-dimensional position from just one measurement. The availability of this information, however, would be of paramount importance for a direct estimation of the height of space objects, which heavily influences the drag force they are subject to. Additionally, the attitude reconstruction through photometric analysis is no easy task and the information retrievable by using independent sensors can be not sufficient for the optimisation algorithms to converge to reliable attitude or angular velocity estimates.

In the framework of the MODSS project funded by Regione Lazio, the Sapienza Space Systems and Space Surveillance Laboratory (S5Lab) of Sapienza University of Rome, together with the Institute for Complex Systems (ISC) at the Italian National Research Council (CNR) have developed a network of sensors specifically designed to perform simultaneous optical observations from different sites. This optical network is constituted by three telescopes, located in Rome and Collepardo, Italy, and Malindi, Kenya. The different baselines between these sensors, which are approximately 100 km for the Rome-Collepardo configuration and approximately 6000 km for Rome-Malindi, facilitate the 3D position reconstruction and attitude determination of respectively LEO and GEO objects. The optical systems rely on scientific complementary metal–oxide–semiconductor (sCMOS) devices. This technology provides a dramatic increase to the rate of performable measurements, which must be precisely synchronised to allow the integration of two simultaneous bidimensional data. The instrumentation has been tested and calibrated

by tracking objects whose precise ephemerides are publicly available, and the accuracy of the obtainable measurements has been characterised.

The network configuration, together with the results of the calibration of the experimental setup will be described in detail in this paper.