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BILAR: A COMPREHENSIVE APPROACH TO SPACE DEBRIS CHARACTERIZATION AND MITIGATION THROUGH A LIGHT CURVE DATABASE

Abstract

The new challenges posed by the growth of the space debris population and the spread of satellite mega constellations demand innovative solutions in the frameworks of Space Surveillance and Tracking (SST) and Space Traffic Management (STM), in order to develop services for improved characterization of Earth orbiting objects. Sapienza Space Systems and Space Surveillance Laboratory (S5Lab) leads the Benchmarking and Inversion of Light Curve for Attitude Reconstruction with Expert Centre Support (BILAR) project, carried out under a contract with the European Space Agency (ESA). BILAR is a system aimed at providing an integrated approach to photometric characterization of Resident Space Objects (RSO), with the employment of different tools oriented towards the creation of a light curve database to establish an attitude determination service. In this framework, both simulated and real light curve data can be acquired to feed the database. Simulated light curves can be obtained from a light curve laboratory, where satellite and space debris physical models are employed to acquire optical measurements, and from a virtual simulation environment, where an object digital twin is exploited. The light curve laboratory is based on robotic arms and a sun simulator to reproduce object observation, with the same concept applied in the virtual environment, where a rendering engine is used to obtain synthetic measurements. The design of both systems is part of the project, and requirements are drafted considering both the expertise of the personnel involved and the outcomes of a stakeholder survey targeting academic and industrial experts. In this work, preliminary results of the project are presented, as well as potential applications of the acquired data. First, the results of the stakeholder survey are discussed, followed by an analysis of the key requirements derived which are driving the simulation tools design. Specifically, the consequent design of the light curve laboratory and the virtual simulation environment is presented, discussing advantages and drawbacks of each system, and providing optical measurements obtained with current operational prototypes, also employed for system calibration and validation. The integration of simulated and real measurements contributes to the comprehensive development of the light curve database, whose analysis and process enables an improved understanding of the objects attitude. This service finds several applications which are discussed as well, ranging from support within Active Debris Removal missions to light reflection mitigation, ultimately supporting a long term sustainable usage of near-Earth space.