16th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Orbital Safety and Optimal Operations in an Increasingly Congested Environment (Joint Astrodynamics/Space Debris Session) (10-C1.7)

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LEDSAT: A LED-BASED LEO DEMONSTRATOR FOR SPACE DEBRIS ORBIT AND ATTITUDE DETERMINATION

Abstract

Optical Ground based space debris monitoring and orbit determination are mainly restricted to a short time window, with the observable exposed to sunlight and the observer in darkness. Most of the times, the target is detected by means of sidereal tracking or it is directly tracked to acquire its lightcurve. In both configurations the object luminous flux depends on the elevation angle, due to the atmospheric extinction, the Sun-object-observatory phase angle, and the object-observatory range. Among space debris, a large number of inoperative satellites and spent rockets lie in Low Earth Orbit (LEO), introducing high risks for operational spacecraft, including crewed vessels.

The LEDSAT (LED-based small SATellite) 1-Unit CubeSat project, managed by the Sapienza Space Systems and Space Surveillance Laboratory (S5Lab) at Sapienza - University of Rome and conceived in collaboration with the University of Michigan, has been accepted in 2017 for the European Space Agency "Fly Your Satellite!" Programme. The project aims at testing a Light Emitting Diodes (LED)-based payload for verification and improvement of the current methodologies of optical orbit determination. In the first project year, the LED-based payload radiometric properties have been validated, while the diodes

have been qualified for the LEO environment. The CubeSat will be launched in early 2020.

The satellite will be equipped with LEDs boards of different colors (red, green and blue), paired in opposite faces. This self-illuminating system increases the visibility to the totality of the Earth dark hemisphere, regardless of the phase angle, with a consequent improvement of the available data for orbit determination. Moreover, the emission in different visible spectral bands will allow to reconstruct the spacecraft attitude with the exploit of a theoretical model that is currently being finalized.

Since small satellites are usually deployed in large clusters and the identification in the first hours from deployment is difficult to achieve, the mission also aims at identifying the spacecraft immediately after deployment. This objective may be fulfilled with the usage of specific flashing patterns of the LED boards.

In this paper, a brief introduction of the challenges related to debris observation will be presented and the mission scientific concept will be explained. The observational improvements and their effect on the orbit and attitude determination accuracy will be analyzed. Finally, an update on the project current scientific development will be given and future perspectives, including the implementation of the proposed system as a standard for debris mitigation, will be outlined.