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EARLY IDENTIFICATION AND ATTITUDE RECONSTRUCTION OF LED-EQUIPPED SATELLITES FOR SPACE TRAFFIC MANAGEMENT AND IMPROVED TRACKABILITY

Abstract

Satellites provided with Light Emitting Diode (LED) units can significantly improve their trackability with low impact on the satellite mass, peak power, and energy consumption. Such systems can significantly help initial identification when released in a large clusters and orbit determination throughout their orbital lifetime. LEDs are also an effective way of permitting attitude reconstruction from ground-based observations.

Two of the first LED-equipped satellites, WildTrackCube-SIMBA and LEDSAT, launched in 2021 and operated by the S5Lab group at Sapienza University of Rome, gave positive results in the demonstration of LED units for STM tasks. The satellites are able to flash automatically and to update their patterns, when needed, via RF command.

The satellite identification, which is crucial for nano-satellites, was achieved within one week after release, and in general possible several weeks after launch. The LEDs allowed an easy pattern recognition and an effective optical data integration for attitude reconstruction.

The follow-up for the first LED satellites is now to design, develop, and fly autonomous LED units that are autonomously provided with energy generation, storage systems, and automatic units for LED flashing management. Such units can be fitted into all formats of CubeSats, from nano-satellites to large orbital platforms, with total functional autonomy with respect to the main satellite bus. When the main platform experiences a failure, attitude data can be retrieved from the spacecraft without any information from the on-board sensors, for better tracking prior to re-entry or for planning and achieving Active Debris Removal. Each LED board flashes an independent pattern used to identify the flashing face. Brightness information can be used then to infer the angle at which it is being observed. Experiments are ongoing with LEDSAT and WildTrackCube-SIMBA and are showing promising results. The attitude determined from ground observations of the LEDs is comparable with the attitude computed using the on-board sensors.

This paper deals with the in-orbit results of the perviously LED-equipped satellites in terms of satellite recognition, orbit determination, and attitude determination, with the goal of future implementation of LEDs on autonomous units. After an introduction on the development and experimentation since 2017, the main results from the two satellite LED payloads in the first year of operations will be presented. The future work on autonomous units will be then presented, with reference to the achieved results and their possible improvements in the upcoming years.