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OPTIMIZATION AND STANDARDIZATION OF LIGHT EMITTING DIODES (LEDS) PATTERNS FOR IMPROVED SATELLITE TRACKING AND MONITORABILITY

Abstract

Installation of Light Emitting Diodes (LEDs) payloads on satellites for ground-based optical tracking can significantly improve the period of satellite tracking and the achievable tracking precision. The optical tracking of a satellite equipped with LEDs is extended from the sunlit region (when the ground-

based telescope is in darkness and the satellite is in sunlight) to the whole eclipse phase, with a consequent improvement of the availability of optical measurements. The optimization of patterns for LED boards can introduce an improvement in the achievable measurement quality. If executing orthogonal patterns, such as Pseudo-Random-Number codes, the ground segment can discriminate satellites among a large cluster or identify the satellite faces pointing towards the observer for attitude reconstruction. To achieve a more precise orbit determination, alternated long and short flashes can contribute to the satellite identification and celestial coordinate identification. More specialized patterns can highlight the satellite functional status, especially for the execution of the satellite safe mode or to indicate that the satellite is facing specific issues, e.g. a component failure, excessive temperatures, currents or voltages on components and power lines, or to indicate that the satellite has entered its De-Commissioning mode. The improved tracking of the LEDs and the increased knowledge of the satellite functional status can contribute to Space Situational Awareness (SSA) and Space Traffic Management (STM). This will improve the sustainability of the LEO environment, especially if LEDs are adopted by a large number of satellites. From this perspective, the standardization of LED flashing sequences could further enhance the tracking and monitorability of spacecraft. The effectiveness of LED-based payloads is currently being tested by LEDSAT, a 1U CubeSat conceived by Sapienza University of Rome and University of Michigan, participating in the ESA Fly Your Satellite! and ASI IKUNS Programmes. The satellite is undergoing ambient testing at Sapienza and will be launched in 2021. During its orbital lifetime LEDSAT will test various patterns for verifying the aforementioned possibilities of the satellite. This paper deals with the optimization of the LED patterns for implementation and execution on satellite missions. Different study cases and LED functionalities will be described in the perspective of the near-future STM and SSA tasks. The actual LEDSAT patterns will be used as a case study for the paper, reporting the optimizations undertaken for producing the satellite flashing sequences. The paper will present the future perspectives for LED implementation on satellites and the possible standardization of LED patterns.