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Author: Mr. Paolo Marzioli
Sapienza University of Rome, Italy, paolo.marzioli@uniroma1.it

Mr. Andrea Gianfermo
Sapienza University of Rome, Italy, andrea.gianfermo@gmail.com
Mr. Lorenzo Frezza
Sapienza University of Rome, Italy, iverie19@gmail.com
Mr. Diego Amadio
Sapienza - University of Rome, Italy, amadio.1200335@studenti.uniroma1.it
Mr. Federico Curianò
Sapienza University of Rome, Italy, fcuriano@gmail.com
Mr. Niccolò Picci
Sapienza University of Rome, Italy, niccolo.picci96@gmail.com
Ms. Maria Giulia Pancalli
Sapienza University of Rome, Italy, mgpancalli@gmail.com
Ms. Eleonora Vestito
Sapienza University of Rome, Italy, vestitoeleonora@gmail.com
Mr. Justin Schachter
University of Michigan, United States, jschach@umich.edu
Mr. Matthew Szczerba
University of Michigan, United States, maszczer@umich.edu
Mr. Daniel Gu
University of Michigan, United States, dangu@umich.edu
Ms. Anny Lin
University of Michigan, Ann Arbor, United States, annyxlin@umich.edu
Prof. James Cutler
University of Michigan, United States, jwcutler@umich.edu
Prof. Patrick Seitzer
University of Michigan, United States, pseitzer@umich.edu
Dr. Simone Pirrotta
ASI - Italian Space Agency, Italy, simone.pirrotta@asi.it
Dr. Fabrizio Piergentili
Sapienza University of Rome, Italy, fabrizio.piergentili@uniroma1.it
Prof. Fabio Santoni
Sapienza University of Rome, Italy, fabio.santoni@uniroma1.it

USAGE OF LIGHT EMITTING DIODES FOR SMALL SATELLITES TRACKING, EARLY IDENTIFICATION AFTER LAUNCH AND LIGHT-BASED COMMUNICATION

Abstract

With the increasing number of cluster and mega-constellation launches, there is an urgent need for new

spacecraft tracking techniques during all the mission phases, from in-orbit deployment to disposal. In this framework, the usage of Light Emitting Diodes (LEDs) on the spacecraft external surfaces can provide significant improvements to the early identification of small satellites after launch in large clusters and for orbit and attitude determination. When applying the conventional RF-based identification to large cluster launches, strong uncertainties on the identity of small satellites of the same cluster remain even months after the launch. The implementation of LEDs can provide immediate recognition after deployment, if assigning specific flashing patterns to each satellite. The implementation of LEDs can also improve the precision achievable of optical orbit determination, making the satellites trackable throughout the eclipse phase. Any simple optical observatory can acquire the satellite LEDs flashes. This permits a great improvement of the spacecraft optical trackability and of the achieved precision in orbit and attitude determination. The LED-based orbit determination is focused on the celestial coordinates acquisition with respect to the background stellar field. Attitude reconstruction is possible when implementing LEDs, executing different flashing patterns, on different surfaces of the spacecraft. The improvement of orbit determination could help to augment the situational awareness for the small satellite population, as well as performing less and more accurate collision avoidance maneuvers. The attitude determination can be applicable both for an improved trajectory estimation at low altitudes, when heavily influenced by drag force, and for planning future Active Debris Removal (ADR) missions. As example of LEDs in-orbit applications, the LEDSAT CubeSat, conceived by Sapienza University of Rome and by the University of Michigan, is equipping LEDs on all its external faces. The CubeSat is part of the Italian Space Agency (ASI) IKUNS Programme, it has been selected for the second edition of the ESA Fly Your Satellite! Programme, and it will be launched in 2020. This paper will describe the solutions offered by the implementation of LEDs on the external surfaces of small satellites for early recognition after deployment in large clusters and orbit and attitude determination. All the improvements offered by the LEDs in the framework of orbital debris mitigation, improved orbit determination and clusters early identification will be presented. Finally, an example of LED-based operations will be presented with an overview of the LEDSAT CubeSat mission.