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ATTITUDE CONTROL FOR THE LUMIO CUBESAT IN DEEP SPACE

Abstract

The Lunar Meteoroid Impact Observer (LUMIO) is a 12U CubeSat mission to observe, quantify, and characterise the meteoroid impacts on the surface of the Moon by detecting their flashes on the lunar far-side.

One of the major challenges of this mission is the high pointing requirement, which imposes high-precision tracking of a specific attitude that maximizes power generation. This is particularly challenging for this CubeSat since the reaction wheels only have a maximum momentum storage of 30 mNms for a one-year mission. In addition, de-tumbling and de-saturation manoeuvres are undertaken using only four thrusters which adds to the complexity of the control design.

This paper describes the attitude control strategy for the LUMIO mission focussing on the configuration design of the reaction wheels and thruster-based de-saturation. Due to the highly demanding constraints on the maximum momentum storage, the placement of the reaction wheels significantly affects the de-saturation strategy and requires optimization. Novel continuous and discontinuous de-saturation strategies are designed which can be implemented with the proposed minimal thruster configuration.

The attitude control system design is shown to (a) prevent the saturation of the reaction wheels, (b) minimize propellant consumption, (c) minimize the parasitic ΔV, (d) keep the pointing angle below a certain limit, and e) maximize power consumption. There is a complex coupling between the objectives (c) and (d), since the parasitic ΔV generated during desaturation and de-tumbling will not match that required by the orbital station-keeping.

The proposed LUMIO design could lay the foundations for a standardised minimum mass and volume ADCS system for CubeSats operating in deep-space. LUMIO is one of the two winners of ESA's LUCE (Lunar CubeSat for Exploration) SysNova competition, and as such it is being considered by ESA for implementation in the near future.