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DESIGN, ANALYSIS AND VALIDATION OF THE ADCS FOR THE LUMIO MISSION

Abstract

The LUnar Meteoroid Impact Observer (LUMIO) is a 12U deep-space CubeSat mission with the goal of observing, quantifying, and characterizing the meteoroid impacts on the lunar farside. The spacecraft is designed to operate on a quasi-halo orbit at the Earth-Moon L2 Lagrangian point to complement ground-based observation of our natural satellite. The highly non-linear dynamics of the system together with stringent pointing requirements drive the design of a robust Attitude Determination and Control System (ADCS) capable of effectively achieving mission goals satisfying scientific requirements while being compliant with operational constraints. This paper presents the relevant requirements, the design choices, and the analysis performed to validate the CubeSat ADCS design. An overview of the subsystem is provided discussing the component trade-off and the final configuration adopted. The current high-level ADCS architecture is based on four Reaction Wheels (RW) and a Reaction Control System (RCS) as actuators, three sun sensors, one star tracker and an Inertial Measurement Unit (IMU) as sensors for attitude determination. High-fidelity numerical simulations are performed using state-of-the-art in-house tools to assess the performances of the system in different operative scenarios from release to demise in terms of pointing accuracy, momentum budget and total impulse. Monte Carlo simulations are also performed to statistically assess the robustness of the design to uncertainties in the center of mass position and thrust misalignments. The latter ones have indeed a significant impact on the spacecraft momentum budget due to the long firing time expected for orbital maneuvers and the frequent station-keeping burns required on the operative orbit, and needs to be properly considered. The presented design is developed during the Phase B study under ESA contract. The consortium is led by the Deep-space Astrodynamics Research and Technology (DART) group at Politecnico di Milano, with the Argotec team responsible for

the System design and platform manufacturing. This work lays the foundation for future investigation and implementation of this innovative mission concepts paving the way for future missions in the cislunar environment.