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EARTH-MOON TRANSFER TRAJECTORY FOR THE LUNISAT MICROSAT

Abstract

Accurate propulsion and ADCS systems have evolved so that they are now suitable for the inclusion in microsatellites. Such complex systems enable the planning of interplanetary missions with small satellites, which have several benefits compared to bigger satellites, e.g. smaller total mass and low cost, while maintaining comparable performances in terms of boarded payloads and navigation accuracies. The MicroSatellite LuniSat will travel from a Low Earth Orbit (LEO) into a Low Moon Orbit (LMO) to deploy several nanosatellites. In order to achieve this final orbit, several transfer trajectories have been evaluated, based on the chosen class of propulsion system: chemical thrust or low-thrust. Both would require a distinct transfer trajectory. Transfer trajectories are simulated using GMAT, an accurate trajectory simulation software developed primarily by NASA that employs actual ephemeris of solar system bodies in order to compute and optimize orbit maneuvers. The initial phase of the mission will be the release of LuniSat Microsatellite into LEO orbit by the last stage of the launch vehicle. The overall mass of the satellite will be less than 60kg, to reduce launch costs. Chemical thrusters typically have a low specific impulse, but the expressed force is several orders of magnitude higher than a common low-trust engine. In contrast, low-thrust systems have a very high ISP, therefore the overall efficiency is very high, but maneuvers take a considerable longer time, since the exerted force is of the order of mN. Additional benefits of low-thrust propulsion systems are the relative ease of the system with respect to chemical counterparts, as most of the suitable low-thrust systems employ solid propellants, as iodine. As a result, no pressurized vessels are present onboard, which would add complexity and mass to the system. For the chemical propulsion, a two-impulse LEO-LMO transfer trajectory is assessed, based on the performance of suitable miniaturized chemical thrusters available on the market. This trajectory would require less time, because of the higher thrust, and the deltaV would be lower, since gravity losses are minimized for impulsive maneuvers. A transfer trajectory using a platform-compatible low-thrust propulsion system is then analyzed, comparing it with the two-impulse case. This trajectory would require several burn and coast phases, depending on the chosen optimization parameter for the trajectory, such as maneuver duration, or propellant usage. In the end, this work aims at studying the possible transfer trajectories to the Moon of the LuniSat microsatellite using advanced dynamical simulation models.