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DEPLOYMENT OF A MICROSATELLITE CONSTELLATION AROUND THE MOON USING CHAOTIC MULTI BODY DYNAMICS.

Abstract

The deployment of a microsatellite constellation around the Moon is collecting growing interest, driven by the possibility to offer communication and navigation support to both probes and manned exploration missions. The primary focus of the study is to design a mission profile which allows transferring and deploying the satellites of such a constellation from one single launch opportunity, considering deployment conditions equivalent to those expected for the Artemis-1 mission. In particular, the major challenge consists in transferring the satellites into multiple orbit planes, which differ by the value of the RAAN and the inclination, compatibly with the constraints set by the propulsion and power systems currently available for microsatellites. This goal is achieved by taking advantage of the Sun-Earth-Moon multi-body dynamics. In the first phase of the mission the microsatellites are captured along a highly eccentric lunar capture orbit, with the apocenter in the neighbourhood of the Earth-Moon libration point L1. In this region, the linear dynamics expressed using the Hamiltonian formalism can be characterized by a set of 6 parameters. Previous works by the authors showed that these 6 parameters are related to the osculating orbit elements of low-energy lunar capture orbits and can be adjusted using relatively small Delta-V to achieve the desired orbit elements at capture. This technique is used to modify the semimajor axis, inclination and RAAN for the microsatellites, producing their deployment into the desired orbit plane. Using this strategy, the deployment of the constellation is possible within 28 days from the capture at the Moon. The designed mission profile is verified using numerical analysis, propagating the nonlinear equations of motion in the DE405 ephemeris model, simulating the real behaviour of thrusters and control devices. The analysis allows estimating the propellant usage and the stability of the constellation coverage properties, indicating that the solution proposed is compatible with current microsatellite technology.