SPACE PROPULSION SYMPOSIUM (C4)
New Missions Enabled by New Propulsion Technology and Systems (6)

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STATIONKEEPING WITH AN ELECTROSPRAY PROPULSION SYSTEM FOR LOW LUNAR POLAR MISSION ON A 6U CUBESAT

Abstract

The suitability of electrospray propulsion for station keeping of a 6U CubeSat in lunar orbit is evaluated. Lunar CubeSat missions are of interest with the launch of several CubeSat on-board the first SLS launch. For interplanetary CubeSat mission electrospray thrusters have the potentialities to provide suitable performances within mission constraints. An electrospray thruster electrostatically accelerates charged droplet or ions, producing small thrusts at high specific impulse. To investigate the feasibility of utilizing an electrospray system for station keeping, maximum variations of orbital parameters for lunar polar orbits are evaluated. This was completed with the PlanODyn suit for orbit long-term propagation developed at Politecnico di Milano. Using PlanODyn the Gauss-planetary equations were integrated over time considering a 100 x 100 LP165P gravity model of the Moon and both the Earth and the Sun considered as third body. Over a period of two months typical variations of orbital elements for low quasi-circular lunar polar orbits without any propulsion system were assessed. Moreover, the orbit evolution of different orbits was evaluated, with varying eccentricity and inclination and fixed initial epoch, semi-major axis, argument of perigee, longitude of the ascending node and mean anomaly. Maps of the maximum variation of all the keplerian elements for these orbits were created. These maps have eccentricity that varies between 0.01 and 0.045 and inclinations that span from 85 to 95 degree. A micro-electrospray propulsion system being developed at the University of Southampton was then considered in the simulation to assess its ability to keep a stable orbit. Both power and mass/volume were constrained for a 6U CubeSat using a model of a micro-electrospray thruster that allowed to estimate a feasible value of the thrust and the specific impulse. With thrust value of 0.3mN and 1mN and specific impulse value of 1000 s or 4000 s some different maneuvers were performed to assess the ability of the propulsion system to maintain a prefixed value of an orbital parameter. In this way the same kind of maps were created when the electrospray propulsion system is used. It is demonstrated that the micro-electrospray system makes a significant difference to the variation with time of the polar orbit when a proper maneuver is used considering also that the thrust value of such system is much lower than typical perturbations of these low polar orbits. A preliminary CAD design of the propulsion system that fits in a 6U CubeSat is also proposed.