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SELF-STABILIZING AND CONTROLLED ORBITS FOR PROXIMITY OPERATIONS AT NEAR-EARTH ASTEROIDS

Abstract

The most critical phase of missions to Near-Earth Asteroids (NEA) is the proximity phase in the immediate vicinity of the targets. This phase must serve mission objectives, thus the required vehicle motion about the target asteroid is governed by scientific or technological goals. However, the complex dynamical environment faced by the vehicle restricts the possibilities of feasible motion. Free, i.e., not actively controlled motion is advantageous for the initial reconnaissance phase as measurements are not disturbed by maneuvers by the orbit control system. In a later phase, however, it is desired to control the vehicle such that any surface area of the asteroid can be examined. The objectives of this research are to determine the limits of possible uncontrolled motion and to gauge the effort of constraining motion to desired areas. The gravitational field is modelled after the asteroid 433 Eros and it is accounted for solar radiation pressure as well as third-body perturbations. In the class of uncontrolled orbits, Solar-Stabilized Terminator Orbits (SSTO) are investigated. The feasibility of SSTOs is analyzed as a function of spacecraft mass and reflective cross-section, asteroid mass, distance to Sun, and orbiting radius after 21 and 60 days in a parametric study. Then, active control of inclination, line of nodes, and orbiting radius is introduced, assessing the control effort of restraining the spacecraft to specific orbits. Subsequently, it is examined whether resonances occur at certain orbital altitudes depending on asteroid radius, rotation rate, and orientation of rotational axis. The results of the analysis will be presented.