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Author: Mr. Zubin Olikara
Institut d'Estudis Espacials de Catalunya (IEEC), Spain

Prof. Gerard Gomez
University of Barcelona, Spain
Prof. Josep J. Masdemont
Universitat Politecnica de Catalunya (UPC), Spain

END-OF-LIFE DISPOSAL OF LIBRATION POINT ORBIT SPACECRAFT

Abstract

In this study we investigate end-of-life trajectories for spacecraft in orbit about the Sun-Earth L1 and L2 libration points. A plan for decommission is often required during the mission design process. While collinear libration point orbits are unstable causing spacecraft to naturally depart their vicinity, certain outcomes are preferable to others. For example, a terminal trajectory passing near the Earth must abide by international space accords.

An important consideration is that limited fuel is available towards the end of a spacecraft's mission. Thus, natural dynamics are the primary component of the spacecraft's motion. This motivates the use of tools from invariant manifold theory to study possible outcomes. Furthermore, zero-velocity surfaces define general regions of space, potentially connected across the libration points, that can be used to categorize the motion.

We initially consider two main classes of outcomes: long-term orbits that are nominally stable and orbits colliding with a solar system body. The first class includes highly-elliptic Earth orbits that are potentially reachable with minimal fuel expenditure. An additional option is to perform a small maneuver in order to be captured in a planet-like orbit about the Sun. The second class of outcome, collision orbits, sets a finite spacecraft lifetime. A trajectory re-entering Earth's atmosphere is the most basic possibility. With proper phasing, impact with the Moon may also be feasible for a spacecraft departing a Sun-Earth libration point orbit.

We seek to organize and compare the costs associated with the multitude of decommission possibilities by performing a parametric study. A set of baseline Sun-Earth libration point orbits, including both halo- and Lissajous-type orbits, will used as representative departure points. These results could form a basis for the design of end-of-life trajectories for libration point missions.