Paper ID: 14542
oral
student

ASTRODYNAMICS SYMPOSIUM (C1)
Orbital Dynamics (1) (6)

Author: Mr. Keita Tanaka
University of Tokyo, Japan

Dr. Junichiro Kawaguchi
Japan Aerospace Exploration Agency (JAXA), Japan

TRANSFER AND STABILIZATION IN L2 SMALL HALO ORBITS VIA LOW CONTINUOUS THRUST

Abstract

The locations where the gravitational forces from two celestial bodies and the centrifugal forces are canceled each other are known as the Lagrange points and there exist five equilibriums in the three-body system. The Lagrange points are time-invariant and therefore suitable for a mission which should keep its orientation with regard to the celestial bodies

A motion of spacecraft near the collinear Lagrange point becomes a quasi-periodic orbit because of the difference of the frequencies between the in-plane and the out-of-plane motion and this property can cause a problem from a practical point of view. For example, when spacecraft orbits around the L2 in the Earth-Moon system, it sometimes has to be hidden behind the Moon and out of communication with the Earth in the meantime.

On the other hand, a complete periodic orbit can be obtained by sufficiently increasing the amplitude of the orbit enough to get non-linear contributions from the system. This halo-type orbit has the merit of no-maneuver to keep a closed loop but its orientation with regard to the planets significantly changes during the period. Our ideal is an orbit which can keep its position near the Lagrange point and avoid crossing the shadow area of the bodies.

To obtain a halo-type orbit in the immediate vicinity of Lagrange points, an active maneuver should be required. It is an appropriate solution to introduce electrical propulsion systems to control the orbit because this maneuver should be continuous. The direction and the magnitude of acceleration are, however, practically limited and some kinds of control laws are necessary.

This paper discusses how to design small halo-type periodic orbits around the L1/L2 via low-level continuous acceleration. It starts with the linearized form of the equations of motion and develops the maneuver law to achieve a small halo orbit. Then, it shows this control law is also applicable to the non-linear system using several calculation examples. Furthermore, the ways to send spacecraft into this type of periodic orbits are also discussed. The results show the developed injection and stabilizing methods can be applicable to the actual space missions.