Paper ID: 38452
student

ASTRODYNAMICS SYMPOSIUM (C1)
Interactive Presentations (IP)

Author: Mr. Yat Hei Ng
The Hong Kong University of Science and Technology, Hong Kong SAR, China

Dr. Chit Hong Yam
ispace, Inc, Japan

MATCHING OF PATCHED–INTEGRATED TRAJECTORIES FOR CIS-LUNAR TRANSFERS

Abstract

In preliminary orbit design, patched-conic approximation model has been widely used to compute gravity-assist trajectories. While it can often give a good and quick estimate of multiple-flyby trajectories, there are missions which the patched-conic model fails to provide sufficiently accurate results. For example, low-energy transfers in the vicinity of the Moon. An alternative approach is required to calculate an initial estimate for such missions.

The aim of this paper is to develop a method that can efficiently search for lunar gravity-assist trajectories for transfers to the libration orbits or ballistic captured orbits. A metric is developed to rate the feasibility of pairs of forward- and backward-propagated trajectories. Correlations of the metric and the actual ΔV involved on the mission are discussed.

Recently there are literatures discussing the matching of patched-integrated trajectories for transfers to quasi-halo orbits at the Earth-Moon L2. The matching is based on the states and the effective potentials at the perilune, which can provide pairs of feasible trajectories for the transfer to lunar-centric orbits. This paper is an attempt to extend the idea to match incoming forward trajectories with backward-propagated halo orbits; and elliptical captured orbits about the Moon.

In the matching process, sets of forward trajectories and elliptical orbits are generated by adding small perturbations on different directions. Then the trajectories are propagated and the states at the perilune are extracted. By searching the closest points with the perilune of the forward trajectory on the ellipses, a Lambert fit is performed to evaluate a the mismatch ΔV between the discontinued orbit pairs. This ΔV serves as a parameter to evaluate the feasibility and rank different possible pairs for extraction of fit pairs.

An N-body integrator is applied to evaluate the ΔV required in a higher fidelity model. We analyze the correlation between the ΔV from our approximated model versus the actual values and formulate a new fitting metric. The computation of the fitting metric is very fast and we expect by filtering out the bad matching pairs of trajectories, the overall computational effort can be reduced by at least 3 orders of magnitude.

Our tool can give insights to preliminary orbit design for lunar transfer missions by quickly providing good initial guesses of patched-integrated trajectories. Such method can be very useful in aiding the design of low-energy flybys and captured orbits, e.g. the JAXA CubeSat mission EQUULEUS and low-cost transfer for a lunar landing mission.