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Author: Mr. Enrico Bassissi
Politecnico di Milano, Italy

Mr. Andrea Pasquale
Politecnico di Milano, Italy
Prof. Michèle Lavagna
Politecnico di Milano, Italy

LEVERAGING WEAK-STABILITY BOUNDARIES FOR LIBRATION POINTS ESCAPES AND DISPOSAL

Abstract

In the near future, the exploitation of the Cislunar environment will open the frontier of space for increasingly daring and challenging explorations. Low energy transfers in this context have a fundamental role, especially when the objective is to reduce at the most the propellant use and to enable new classes of missions. In fact, leveraging the gravity of the Earth, Moon and the Sun [Romagnoli, Circi, 2008], allows to construct transfers which are particularly efficient, although with an increase in complexity and sensitivity.
The objective of this work is to exploit low-energy transfers to efficiently escape the Cislunar space. First, escape trajectories from the Earth-Moon Libration Points are built in the Bi-Circular Restricted Four-Body Problem (BCR4BP) framework [Scheuerle 2021], accounting for the Sun-Earth-Moon-probe interaction, and the trajectories with the desired characteristics are saved in a database. Secondly, a clustering step is performed, employing dynamical systems theory to gain insights embedded in the BCR4BP dynamical flow, to reduce the dimension of the database and extract the different escape trajectories groups as a function of the design variables used. Then, an initial condition generator based on the database and on numerical continuation technique is implemented, giving the possibility to construct initial guesses once the desired heliocentric transfer is assigned. The methodology is deeply tested and its strengths and weaknesses are highlighted and discussed. Finally, this work prospects also the possibility of repeating the aforementioned analysis for other departure conditions, here the extension to Sun-Earth Libration Points is presented and applied in a real case scenario like Comet-Interceptor.

Construction of Ballistic Lunar Transfer in the Earth-Moon-Sun System, *Stephen T. Scheuerle*, Purdue University School of Aeronautics and Astronautics, West Lafayette, Indiana - May 2021
Earth–Moon Weak Stability Boundaries in the restricted three and four body problem, *Daniele Romagnoli, Christian Circi*, Scuola di Ingegneria Aerospaziale, Università di Roma "La Sapienza", Roma, Italia - October 2008