

Aerospace Europe Conference 2023

Joint 10th EUCASS – 9th CEAS Conference

Abstract #XXX (to be filled by the organizers)

Preferred Topics: SUSTSP / SYSINT / REUSSA (3 maximum from the list of topics)

Corresponding author: BONNAL Christophe

e-mail of corresponding author: christophe.bonnal@cnes.fr

Type: Oral / Poster (select)

Status of corresponding author: Regular / Student (select)

For student corresponding author: student member of one of the following:

3AF / AAAR / AIAE / AIDAA / CzAeS / DGLR / FTF / NVvL / PSAA / RAeS / SVFW / EUROAVIA

Title

Design of translunar injection trajectories using phasing loops in a TPBVP

Authors

Fu-Yuen HSIAO¹*, Chun-Wai Wong²

* Corresponding author

¹ Department of Aerospace Engineering, Tamkang University, New Taipei 25137, Taiwan, fyhsiao@mail.tku.edu.tw

² Department of Aerospace Engineering, Tamkang University, New Taipei 25137, Taiwan, ben9206wong@gmail.com

Abstract

This paper studies the design process of translunar injection (LTI) trajectories using phasing loops given initial and terminal conditions. Starting from the two-body problem (2BP) assumption, a highly perturbed restricted three-body problem (ER3BP) environment is eventually introduced in the investigation of the algorithms. Exploring the moon becomes a worldwide space mission recently, owing to the potential of human inhabitant. The Taiwan Space Agency (TASA), formally known as NSPO, initiated a preliminary study on the lunar exploration in 2019. Although low energy transfers, such as ballistic lunar transfer, are more and more welcome nowadays, translunar injection using phasing loops is still a safer and easier choice for an inexperienced space agency. This paper, as an extended work of [1], intends to develop a generic design process applicable to an arbitrarily given initial and final conditions. In specific, this problem can be formulated as a two-point boundary value problem (TPBVP) whose conditions include initial time, initial position of the lunar probe, arrival time, and desired final position. There are two major contributions achieved in this paper. In [1] the probe only aims roughly at the moon, in this paper, however, a more specific location is targeted. Moreover, the influence of the resolution of the probe thruster is also analyzed. The 2BP assumption is initially employed to determine coarse parameters. Then an algorithm of iterations are proposed to correct the trajectory subject to major perturbations, such as J2, lunar gravity and solar gravity, etc. In order to tune the parameters more efficiently, the restricted three-body problem (ER3BP) environment and Lambert's theorem are also introduced in the process. The Systems Tool Kit (STK) is also used to simulate the trajectory with the found parameters under the fully perturbed environment. The developed algorithm in this paper is potentially applicable to various lunar mission scenarios using phasing-loop transfer provided desired initial and terminal conditions.

References

- [1] Chun-Wai Wong, Fu-Yuen Hsiao (2021, November), "Design of Translunar Injection Trajectories Using Phasing Loop under ER3BP Environment". International Conference on Astronautics and Space Exploration (iCASE), 2021.
- [2] Li, M., & Jing, W. (2007, December). Translunar low-energy trajectories via Earth-Moon L1 Lyapunov orbit. In 2007 IEEE International Conference on Robotics and Biomimetics (ROBIO) (pp. 941-945). IEEE.
- [3] Giovanni Franzini, Mario Innocenti, "Relative Motion Dynamics in the Restricted Three-Body Problem", AEROSPACE RESEARCH CENTRAL, DOI: 10.2514/1.A34390.
- [4] Bucchioni, Giordana, and Mario Innocenti. "Phasing Maneuver Analysis from a Low Lunar Orbit to a Near Rectilinear Halo Orbit." Aerospace 8.3 (2021): 70.