Paper ID: 71294
oral
student

IAF ASTRODYNAMICS SYMPOSIUM (C1)
Orbital Dynamics (2) (9)

Author: Mr. Ruilong Li
National Key Laboratory of Aerospace Flight Dynamics,Northwestern Polytechnical University,Xi'an, China, liruilong@mail.nwpu.edu.cn

Prof. Zhanxia Zhu
National Key Laboratory of Aerospace Flight Dynamics,Northwestern Polytechnical University,Xi'an, China, zhuzhanxia@nwpu.edu.cn
Mr. Zhengxu Pan
National Key Laboratory of Aerospace Flight Dynamics,Northwestern Polytechnical University,Xi'an, China, pzxmlgj@163.com
Prof. Jianping Yuan
National Key Laboratory of Aerospace Flight Dynamics,Northwestern Polytechnical University,Xi'an, China, jyuan@nwpu.edu.cn

GLOBAL ANALYSIS OF ECLIPSE AVOIDANCE FOR LONG-TERM QUASI-DRO ORBIT

Abstract

Among the numerous constraints of trajectory design, eclipse avoidance is the most commonly considered, as spacecraft is dependent on the power provided by the solar panel. Therefore, it's necessary to reduce the eclipse duration of an occulting body through trajectory optimization. The Quasi Distant Retrograde Orbit (Quasi-DRO) is located in the cislunar space, which have high application value due to its strong stability and quasi periodic characteristic, and received more attention in recent years. However, the motion of Quasi-DRO is closely to the moon, which cause a long and frequent eclipses. Although some researchers have given strategies and specific parameters to meet eclipse avoidance, but the global picture of eclipse avoidance with all extent of parameters was not investigated in detail, especially for long-term Quasi-DRO. Therefore, the propose of this work is considering a pure numerical approach to globally analysis and optimization the parameter of Quasi-DRO.

An efficient two-level optimization strategies is proposed, considering two key flight parameters as free-variable, one is initial phase from 0 to 360 degree on the invariant curve which affect the shape of Quasi-DRO, another is initial epoch from 2024 to 2028 which obtain state information of celestial bodies in the ephemeris model. In the optimization process, a fixed-step grid search algorithm is used as level-1 to different initial phase and initial epoch to get a global picture of eclipsing with parallel computation, after narrowing down the orbital parameters, local optimization with nonlinear programming is used as level-2 while considering eclipse avoidance path constraint, the objective is compounded by the duration of a single eclipse, the interval between two eclipses and the number of eclipses. To determine whether a particular trajectory passes through the shadow of an occulting body, the geometric model of lunar eclipsing is established and eclipse avoidance path constraint is determined.

To generate Quasi-DRO, the orbit family is constructed firstly using multiple shooting torus correction method and continuation under CRTBP, then a 2:1 lunar synodic resonant periodic orbit of the Quasi-DRO family is selected to keep the repeatability of the geometry relationship between the spacecraft and celestial bodies, a 4 years trajectory is constructed finally using multiple shooting under Sun-Earth-Moon ephemeris model while CRTBP as an initial guess.

Numerical simulation demonstrates that the optimized orbit can avoid eclipse in 4 years flight time. The method used in this paper is useful for a preliminary design of long-term Quasi-DRO mission.