ASTRODYNAMICS SYMPOSIUM (C1)
Mission Design, Operations & Optimization (2) (2)

Author: Dr. Fenglei Wu
Beijing Aerospace Command and Control Center (BACCC), China, wufenglei@139.com

Dr. Weiguang Liang
Beijing Institute of Spacecraft System Engineering, China Academy of Space Technology (CAST), China, lwgbacc@163.com
Mr. Peng Zhang
Beijing Aerospace Command and Control Center (BACCC), China, deisinii@163.com
Dr. Weihua HAN
Beijing Aerospace Command and Control Center (BACCC), China, hanweihua@aoe.ac.cn
Mr. Cheng WANG
Beijing Aerospace Command and Control Center (BACCC), China, 570805917@qq.com
Dr. Jie GONG
Tsinghua University, China, qingshuilanlan@126.com

ORBIT TYPE SELECTION AND ORBIT KEEPING ANALYSES FOR RELAY SATELLITES AROUND THE EARTH-MOON L2

Abstract

Chinese Chang'e 5-T1 mission designed to test the lunar return technology has achieved a great success. The Service Module of Chang'e 5-T1 spacecraft has returned to the Moon's orbit and circled the Earth-Moon L2 libration point successfully, which interests people to review the value of the Earth-Moon L2. Spacecrafts flying around the Earth-Moon L2 have the advantage of observing the far side of the Moon and serving as the relay satellites for the communications among the Earth, the Moon and the deep space. This essay focuses on the orbit type selection and orbit keeping analyses related to the relay satellite orbits around the Earth-Moon L2. Firstly, the candidate relay satellite orbits such as Halo, quasi-Halo, Lissajous, axial and vertical orbits are discussed. The feasibility and applicability of these orbits are analyzed in details with the orbital characteristics of relay satellites. Secondly, the orbital parameters of the relay satellites are further discussed. The smaller the distance away from L2 is, the better the orbit is mainly considering the cost of orbit keeping and satellite tracking, which is verified by simulation. The distance away from L2 in the direction perpendicular to the Earth-Moon line should exceed 5,000km considering the influence of lunar obscuration, orbit determination errors and satellite control errors. Finally, orbital control strategy during the long-term operation has been analyzed. Taking the Chang'e-5T1 Service Module flying around the Earth-Moon L2 as an example, the actual delta-V consumption of Lissajous orbit presents obvious difference with the estimated data based on the Circular Restricted Three Body Problem model before the mission. Hence, gravitational field distribution of celestial bodies, non-circular orbits, solar gravity and other celestial bodies' gravitation act as perturbations and affect the stability of flying-around orbits significantly, which should be considered. The Halo orbit is hard to realize in the Earth-Moon system, while it is not difficult to realize quasi-Halo orbit. The delta-V requirement for keeping the relay satellite circling Earth-Moon L2 outside the lunar obscuration is approximately 0.1m/s per day.