Paper ID: 16395
student

SPACE EXPLORATION SYMPOSIUM (A3)
Poster Session (P)

Author: Dr. Yingjing Qian
Harbin Institute of Technology, China

Ms. Yingying Xiao
China
Prof. Wuxing Jing
Harbin Institute of Technology, China

QUASI-PERIODIC ORBIT DESIGN ABOUT THE EARTH-MOON LIBRATION POINT

Abstract

Quasi-periodic orbits about the translunar libration point have been used widely and their design method has been focused on. Traditionally the process of orbit design in the circular restricted three-body problem(i.e CR3BP) could be divided into two steps. Firstly, obtain the orbit's analytic solution. Secondly, the symmetry periodic orbit can be obtained through the numerical iteration of differential correction, in which the preceding analytic solutions serve as initial condition. A continuous Lissajous orbit in higher-order model can be obtained through multiple shooting in which some points taken from the analytic solution serve as patch points. In sum, with the methods above Halo orbit, Lissajous orbit and Lyapunov orbit in CR3BP could be easily designed. However, some defects are unavoidable when this method is used to get a high-accuracy quasi-periodic orbit about translunar libration point. References have provided many ways to overcome those defects. Folta and Howell propose that multiple shooting and a high-accuracy model (in J2000 inertial frame) can be used to design orbits. However, the calculation of this method is rather complex, which takes coordinate transformation twice. The first transformation is that patch points selected from an approximated orbit which is based on CR3BP model are transformed into J2000 inertial frame according to ephemeris data. After revision with multiple shooting in J2000 inertial frame, those revised patch points are transformed back into the rotating frame. Large amounts of calculation about rotational angular velocity are involved in this process. Meanwhile the rotational angular velocity is assumed in two-body model and this assumption would result in rounding errors. Andréa proposes the quasi-periodic bicircular model in which he finds high-accuracy initial values which can help Andréa get his orbits through multiple shooting. But the method to get high-accuracy initial values is very complicated. In order to avoid complex coordinate transformations between rotating frame and J2000 inertial frame and complicated calculations of high-accuracy patch points, two improvement measures are proposed in this paper. Firstly, the traditional ephemeris model is reformed and established in the Earth-Moon rotating frame, which can avoid large amounts of coordinate transformations during the multiple shooting. Secondly, based on the characteristics of quasi-periodic orbits about the translunar libration point, instead of massive calculations, simple coordinate transformations can provide necessary information for patch points of multiple shooting. Simulation results show that the proposed method can be used effectively to design quasi-periodic orbits about the translunar libration point.