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FAST DESIGN OF LOW-THRUST TRANSFER ORBIT FOR MANNED ASTEROIDS EXPLORATION

Abstract

The methods for fast design of low-thrust transfer orbit for manned asteroids exploration were studied in this paper. The concept of Ephemeris Matching Method (EMM) was proposed, with which the initial launch window and the candidate optimal probe sequences were found quickly. The EMM measures the relative size of transfer energy consumption by examining the closeness from the target planet's ephemeris (or positions and velocities) to the matching planet's ephemeris (or positions and velocities) at departure or arrival times. Time nodes and other parameters were optimized for specific probe sequences by Genetic Algorithm based on the fast low-thrust Lambert's transfer. Then, the final orbit and thrust control laws were optimized by Homotopic method based on the Pontryagin's maximum principle. The results showed that the EMM could quickly and accurately find out the optimal initial launch window and the candidate probe sequences, whose computational efficiency is much higher than the Branch-and-Bound and other traversal searching methods; the Genetic Algorithm can further refine the optimal launch times and determine the optimal probe sequence; and the Homotopic method could finally optimize and output the low-thrust orbit which could well meet the Pontryagin's maximum principle's optimality conditions. The above integrative methods need not large-scale of numerical searching and calculations, and could greatly improve the efficiency for solving the manned asteroids exploration and other multi-objective rendezvous problems.