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ORBITAL DESIGN BASED ON IMPROVED ANT COLONY ALGORITHM

Abstract

With the development of China's space engineering and technology, the exploration of Mars has been becoming another significant development area of space technology. This paper researches the direct transfer orbit design of Mars exploration based on improved ant colony algorithm which has good convergence.

In this paper, the transfer orbit is constructed with Patched Conic Method (PCM) and revalued in the whole mechanical model integrated Sun, Earth and Mars for further performance analysis.

The main research works are following.

Firstly, based on the idealized two-body model and sphere of influence model, the mechanical model for flight is established, and the flight can be divided into three stages which consist of the Earth escape stage, the Sun transfer stage and the Mars capture stage.

Secondly, the orbits corresponding to the different stages are designed separately, and connected together with PCM principle. The concrete realization process contains four steps:

1. The ant colony algorithm is used to search the minimum energy launch window of the Mars exploration in 2018, which takes the launch and flight time as variables. The heliocentric transfer orbit and the escape orbit are designed by optimum solution. Then we select the launch azimuth.

2. The velocity and the position vectors of the Earth and Mars could be gotten with the arithmetic of planetary ephemeris, on the launch and flight time. Then the Lambert theory is used to get the detector's velocity in the launch and flight point.

3. The reverse calculation method is used to calculate the azimuth angle and velocity increment of the detector in the process of the Earth escape stage.

4. The minimum velocity increment in the Mars capture stage could be calculated based on the known orbit period which the detector would runs around Mars.

Finally, the whole mechanical model which includes EarthMarsSun and detector is established. The real energy consumption is selected as the assessment index to analyze the performance of orbit constructed by PCM. The simulation shows that the orbital design of Mars probe based on improved ant colony algorithm use much less time than the traditional method. The transfer orbit is reliable and could be as a design reference.

Keywords: Mars explorationEarth-Mars transfer trajectoryAnt colony algorithm