SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration – Part 2 (3B)

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THE ORBIT DESIGN FOR MARS DETECTOR WITH THE MINIMUM ENERGY

Abstract

The deep space exploration to Mars has been a hotspot and the detectors' orbits are the primary concern. The key factors are to realize the flight with the minimum energy consumption and fulfill some constraints.

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 constraint is focused on the visibility limitation that the orbit key point could be locked by the ground station in China. This means that the important orbit maneuver, such as captured by Mars, should be carried out over China to sure the available orbit operation.

The main research works are followed.

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. Under the visibility limitation, listing all the orbital energy parameters in period of time to launching and arrival with the exhaust algorithm, picking the minimum energy from the energy contour figures, the minimum energy orbit's transfer date to launching and arrival could be determined.

2. The velocity and the position vectors of the Earth and Mars on the launching and arrival date could be gotten with the arithmetic of planetary ephemeris, and then the Lambert theory is used to get the detector's velocity in the launching and arrival 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 and the captured position error in Mars are selected as the assessment index to analyze the performance of orbit constructed by PCM.

The simulation shows that under the visibility limitation, the transfer orbit is reliable and could be as a design reference.

Keyword: deep space exploration to Mars, Patched Conic Method(PCM), visibility limitation, the minimum energy orbit