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A TARGET SELECTION MODEL FOR CREWED ASTEROID EXPLORATION BASED ON COMPREHENSIVE EVALUATION METHOD

Abstract

As one of the three destinations which support manned exploration, asteroid has aroused great interest during past years. Target selection is the top issue and critical technology for crewed asteroid exploration due to the enormous number of candidates and many researchers have presented different methods for this issue. But those methods are mostly based on the qualitative analysis of physical traits of asteroids and estimation of Δv and thus could not give the most valuable and feasible target in an objective way.

Motivated by this, we proposed a comprehensive selection model for target selection which consists three main steps. Step 1: Quantitative analysis of target-selection influencing factors. Firstly, the orbital filter criteria were proposed according to the carrying capacity of launch vehicles. Then the requirements for the absolute magnitude of asteroids were put forward by the constraints of ground-based observation and asteroid size. Next, the range of the rotation period was calculated based on the structural stability and thermal model of asteroids. Step 2: preliminary selection process Using the constraints proposed and calculated in step 1, we can narrow down the number of candidates into a small range. Then the Δv cost and mission period of each asteroid in this shortlist will be computed. Step 3: comprehensive selection process In this step, the physical traits of asteroids including absolute magnitude, rotation period, spectral type and the computed mission parameters including Δv, mission period were put into a same level and regarded as 5 evaluation indexes for target selection. We use AHP (Analytic Hierarchy Process) method to give the relative importance of these evaluation indexes, based on this, we use GCEM (Gray Comprehensive Evaluation Method) to give the final scores of the shortlisted asteroids. The asteroid who gets highest score would be the most optimal target for crewed exploration.

We investigated 635865 asteroids according to the data from MPC (Minor Planet Center), with the help of the demonstrated model, we finally gave the most suitable target for crewed exploration mission.

The proposed comprehensive selection model could recommend the most valuable and feasible target for crewed exploration based on the balanced consideration of both technical feasibility and scientific value of asteroids. Compared with traditional methods, our method is more objective and convincible due to the application of mathematical model during the decision-making process.