Paper ID: 12255
poster
student

Exploration of Near Earth Asteroids (06)
Poster Session (P)

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ON ORBIT DESIGN AROUND A MICRO GRAVITY ASTEROID

Abstract

The interest of exploring small body has been growing over these years, especially the near Earth asteroids which have potential threat to the Earth. The masses of the asteroids are mostly very small compared with that of the planets, so the asteroids' central gravity is too small to have the probe orbit them all the time. Therefore, it is necessary to study the problem of accompanying fly or orbiting an asteroid. The mathematical models of perturbed elliptic restricted three-body problem and perturbed two-body problem could both be used in this problem. In the Sun-asteroid-probe restricted three-body model, the perturbed sources are the planets, the Moon and the solar pressure. For an near Earth asteroid with a mass of $O(10^{10})$ kg, the distance of the collinear equilibrium point L1 is about $O(10^{-7})$ AU far away from the asteroid. In this case, the perturbation accelerations are very large and the orbits around L1 are not stable, so the probe will run away from L1 very soon without orbit maneuvers. In the model of perturbed two-body problem, the asteroid is considered as the central body, and the perturbation of the Sun is considered as the third body perturbation. The ratio of the perturbation acceleration of the Sun to the central gravitational acceleration is about $O(10^{-1} - 10^{0})$for a probe $O(10^{1})$ km far away from the asteroid. The perturbation of the Sun is so large that the probe around the asteroid will also run away without control. As a result, orbit maneuvers are required in the mission of accompanying fly or orbiting the asteroids. The means of classical chemical propellant and low-thrust electric propulsion are both tried to keep the probe staying in the vicinity of L1 or orbiting the asteroid, the results show that the method of classical chemical propellant does not work well because of the large perturbations. On the other hand, the method of low-thrust electric propulsion works well. The probe can stay in the vicinity of L1 or orbit the asteroid for a long time. In order to reduce the thrust time and the fuel consumption, the method of optimal bang-bang control is used in the computation of optimal low-thrust orbit.