Paper ID: 69948
student

IAF ASTRODYNAMICS SYMPOSIUM (C1)
Interactive Presentations - IAF ASTRODYNAMICS SYMPOSIUM (IP)

Author: Ms. Chengyu Zhang
Beijing Institute of Technology (BIT), China

Prof. Zixuan Liang
Beijing Institute of Technology, China
Prof. Pingyuan Cui
Beijing Institute of Technology, China
Ms. Dantong Ge
Beijing Institute of Technology, China

DISTRIBUTED GUIDANCE FOR FLEXIBLE SPACECRAFT LANDING ON ASTEROID

Abstract

As an essential step of sampling return missions, asteroid landing has become increasingly attractive in recent years. However, for a microgravity asteroid, even small residual impact energy will cause rebound and overturn of the spacecraft. To suppress the rebound and overturn, a flexible spacecraft concept, made of flexible material in the shape of a circular plate, is proposed. Due to the large damping coefficients of flexible materials, residual impact energy can be effectively consumed, and thus the flexible spacecraft has reliable rebound suppression capability. In addition, the circular plate shape can prevent spacecraft from overturning by lowering the center of gravity. The flexible spacecraft is configured by several load mounting nodes, and each node equips its thruster, sensor, localized controller, and communication equipment, which are overlapped mounting. During the landing, the spacecraft's translational and rotational motions are controlled by sharing a set of thrusters.

Sharing thrusters leads to strong coupling between the rotational and translational dynamics, which makes the separated orbit and attitude guidance approach no longer applicable. In this paper, a distributed guidance method is developed to control the overall flexible spacecraft's orbit and attitude motion simultaneously through the coordination of the motion of each lumped mass point. The composite motion of lumped mass points can approximate the overall motion of the flexible spacecraft, and the relative height difference of lumped mass points can also reflect the attitude of the flexible spacecraft. Therefore, the working principle of the integrated translation and rotation distributed guidance scheme is that each localized controller cooperates to adjust the relative height difference and composite motion of lumped mass points. To qualitatively characterize the effort required to adjust the relative height difference, a pseudo-attitude control effort index is derived, which is a function of the relative height difference. By weighting the attitude control effort index into the minimum orbit control efficiency index, an analytical distributed guidance law is obtained, which guarantees the near-fuel optimality. Monte Carlo simulations show that the attitude requirement of the flexible spacecraft can be realized during landing, and the analytical guidance law has good computational performance.