Paper ID: 77356
oral
student

IAF SPACE EXPLORATION SYMPOSIUM (A3)
Small Bodies Missions and Technologies (Part 2) (4B)

Author: Mr. Zhihui Sui
Beijing Institude of technology, China, sui_zhh@bit.edu.cn

Prof. Pingyuan Cui
School of Aerospace Engineering, Beijing Institute of Technology, China, cuipy@bit.edu.cn
Dr. Jiateng Long
School of Aerospace Engineering, Beijing Institute of Technology, China, jlong@bit.edu.cn
Prof. Shengying Zhu
Beijing Institute of Technology, China, zhushy@bit.edu.cn

ADAPTIVE CONTROL METHOD FOR FLEXIBLE LANDING OF ASTEROID WITH MULTIPLE CONSTRAINTS

Abstract

Asteroid exploration is an important part of deep space exploration. With the development of space technology, more and more countries and organizations have made asteroid exploration plans. Landing exploration plays a crucial role in the final mission of asteroid exploration. Due to the small size and weak gravity of the asteroid, when the spacecraft is attached to the surface of the asteroid, it is easy for the detector to rebound and overturn in the rigid attachment mode. At present, there is a flexible landing mode. On the basis of soft landing, the detector adopts the structure of flexible materials, which can consume the residual kinetic energy generated by the collision and effectively prevent the detector from bouncing and capsize during landing.

In the process of flexible landing of asteroid, the following difficulties will be encountered. Firstly, compared with the rigid structure of the detector, the dynamic characteristics of the flexible detector are complex. Secondly, in the process of flexible landing, multiple constraints on the detector may not be satisfied at the same time, which may make the controller unable to generate control sequence. In addition, the dynamic model of the flexible detector cannot be accurately modeled, and the dynamic parameters are highly uncertain, which greatly improves the difficulty of stable landing.

This paper mainly does the following research work. For the flexible distributed parameter system, the "spring damp and torsional spring" analytical model of the flexible detector was established to calculate the flexible force and torque. The model can not only characterize the flexible characteristics of the detector, but also facilitate the estimation and control of the state of the detector attachment process. Secondly, dynamic priorities were set for various constraints under different conditions. On the basis of ensuring the high priority constraints, the local performance index is designed to minimize the performance of low priority constraints, so as to ensure the feasible solution space of the detector under the complex multi-constraint conditions. Then, the unknown disturbance is approximated by radial basis function neural network (RBFNN). A single evaluation network adaptive dynamic programming method is used to approximate the numerical solution of the time-varying HJB equation. Finally, the stability analysis of the controller is carried out with Lyapunov method. The simulation results show that the weight vector of the evaluation network and the Hamiltonian function converge in a finite time, and the detector can effectively track the nominal trajectory.