Paper ID: 77910
student

IAF ASTRODYNAMICS SYMPOSIUM (C1)
Orbital Dynamics (1) (8)

Author: Mr. Junhua Zhang
National Key Laboratory of Aerospace Flight Dynamic, Northwestern Polytechnical University, China, zhangjunhua@mail.nwpu.edu.cn

Dr. Jianlin Chen
Northwestern Polytechnical University, China, jianlin.chen@nwpu.edu.cn
Mr. Wenchao Li
Northwestern Polytechnical University, China, wenchao_li@hotmail.com
Prof. Josep J. Masdemont
Universitat Politecnica de Catalunya (UPC), Spain, josep.masdemont@upc.edu
Ms. Min Shi
Northwestern Polytechnical University, China, minminxiaomu@163.com

JET TRANSPORT-BASED ANALYSIS OF SPACECRAFT ABSOLUTE REACHABLE DOMAIN UNDER A SINGLE IMPULSE

Abstract

With the increasement of space on-orbit service missions, it is necessary to precisely address spacecraft motion range under single impulses for improving the safety and decreasing fuel consumption of spacecraft close approaches. The concept of the absolute reachable domain, referring to the set of all feasible positions that spacecraft can reach under a single impulse, will be introduced in this paper. In such a way, spacecraft maneuvering ability can be described in advance to provide a theoretical basis for the spacecraft in-orbit service mission.

Currently, a large number of researchers have studied the solution of spacecraft absolute reachable domain under a single impulse. However, all of them only consider the Kepler orbital motion and the J2 perturbation, which often leads to the significant difference relative to practical engineering missions due to the omission of other main orbital perturbations. To overcome this weakness, a semi-analytical method will be proposed to precisely compute spacecraft absolute reachable domain under a single impulse in this paper, with the usage of the Jet Transport (JT) technique. The influence of, are analyzed.

Firstly, the transition relationship between Cartesian coordinates and cylindrical coordinates is employed to map four main orbital perturbations, including non-spherical gravity, solar radiation pressure, solar and lunar attractions, from Earth's inertial reference frame to cylindrical coordinate reference system. Secondly, spacecraft dynamical model is established by using cylindrical coordinates and a single impulse with fixed size and arbitrary direction is modelled as an interval set. Finally, the influence of a random single impulse can be described as the propagation behavior of an interval set along the spacecraft dynamical model, which can be precisely and efficiently implemented by the JT technique. As a result, the envelope of the absolute reachable domain can be obtained as a polynomial.

Numerical simulations, considering different types of orbital perturbations, are carried out to compute spacecraft reachable domain under a single impulse. The simulation results show that 1) the newly proposed method obtains the same spacecraft reachable domain as that of the traditional analytical method in the Keplerian problem; 2) the newly proposed method successfully solves the calculation of spacecraft reachable domain under the influence of main orbital perturbations, which can not be analytical solved by the existing methods; 3) the high precision for computing absolute reachable domain can be achieved by adjusting the expansion order of the JT method.