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Author: Prof. Qun Fang
Northwestern Polytechnical UniversityNPU, China

Mr. Yi Yin
China
Mr. Gefei Shi
China

SPACECRAFT'S RESONANCE ORBIT DESIGN AND APPLICATION ANALYSIS

Abstract

In order to improve rapid, automatic, accurate orbital maneuver abilities, more and more attention is being given to spacecraft orbital maneuver technology with continuous thrust, whose foundation is non-Keplerian motion theory. In this paper, a new kind of resonance orbit is proposed and researched, which is one of typical non-Keplerian orbits. Resonance is a widespread natural phenomenon. When it happens, small inputs maybe bring on big changes to the system states. By using the concept of quasi-thrust, regular transformation can be used to describe the linear model of spacecraft non-Keplerian motions. Its non-Keplerian motion with continuous thrust can be regarded as one kind of forced vibrations, and the resonance will happen under some certain conditions. Therefore, the motion of spacecraft can be researched through resonance theory. Such corresponding non-Keplerian orbits are named as resonance orbits.

In this paper, the following three parts are discussed: 1) A general dynamic model for resonance orbit is established via the judicious choice of orbit parameterstime scaleand thrust representation. The parameter transferring mode of resonance orbit is analyzed, meanwhile, the directly way of parameter transferring is proposed. 2) Through analyzing the simulation results of a resonance orbit mission, the effluence of resonance frequency to the resonance orbits is studied deeply. At the same time, the advantages and disadvantages of using resonance orbits theory to orbit design are also studied. 3) The possibility and effect of resonance orbits used to deep space exploration has been given via analyzing a typical Earth-Mars mission used resonance orbits theory. The research results show: 1) One-segment resonance orbit needs less energy than traditional transfer orbit and its requirement for engine thrust is low under the condition of not considering flight time. 2) Changed resonance orbit's circle frequency, the peak thrust and the optimal-fuel trajectory will be influenced. 3) In deep space exploration missions, it is benefit using resonance orbits to design depart and arrival velocity vector, its energy consumption is smaller than that Lambert orbit when the flight time is same.

Keywords: Non-Keplerian orbit; resonance orbit; orbital maneuver; Levi-Civita transformation; K-S transformation; Deep space exploration