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DISTRIBUTED PASSIVE AND ACTIVE VIBRATION CONTROL FOR SPACECRAFT WITH LARGE FLEXIBLE APPENDAGE

Abstract

In recent years, the high resolution remote sensing satellites and laser communication satellites have become the research focus. These spacecraft require not only high control accuracy and stability, but also fast maneuver and fast stabilization ability, to accomplish the agile imaging and attitude tracking tasks.

However, fast attitude maneuvers can cause elastic deformations and vibrations in flexible appendages of the spacecraft. These low frequency vibrations attenuate slowly due to the damping characteristics of the spacecraft itself, which prevents the payloads from working effectively. In the early Hubble Space Telescope mission, the imaging quality is low due to the vibrations caused by changing environment temperature. In addition, Control moment gyroscope (CMG), which is the actuator to realize the fast attitude maneuver, has become the main vibration source on the spacecraft, because of the static and dynamic imbalance of the CMG's rotor. These vibrations caused by the CMG would seriously affect the image performance of high resolution remote sensing satellites.

So this paper focuses on the above vibration problems and discusses the Distributed passive and active vibration control method for the vibration sources, such as the flexible appendage and the CMG. The passive vibration isolation platform is employed to reduce the vibrations caused by the CMGs and the robust input shaper is designed for attenuating the vibrations induced by the flexible appendages. So the first step constructs the dynamic model of the spacecraft with the passive vibration isolation system and the flexible appendages by Newton-Euler method and Kane equations. Then under the attitude maneuver mission, the transmissibility matrix of this vibration isolation system is obtained based on the reasonable assumptions, and the influence of the spacecraft's angular velocities on the performance of the passive vibration isolation system is discussed. Aiming at reducing vibrations caused by the flexible appendage, the third step designs a multiple mode input shaper utilizing the modal information. Finally, the numerical simulations for attitude maneuver control are presented and the simulation results show that the combined active and passive vibration control method can attenuate the vibration of the flexible appendages and improve the attitude stability.