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ACTIVE-PASSIVE INTEGRATED VIBRATION CONTROL FOR THE CONTROL MOMENT GYROS AND ITS APPLICATION ON SATELLITES

Abstract

Control moment gyroscope (CMG) is common used as the actuator for satellite's attitude control, because CMG don't consume working medium and don't pollute space environment. However, because of the fixing error and manufacture error of CMG, the high-frequency vibrations would be caused when the CMG is employed to control the satellite attitude, and these vibrations would make the satellite pointing performance reduce. So it is necessary to isolate these vibrations. Traditional vibration isolation method for the CMG is installing a vibration isolation platform between satellite bus and the CMGs, such as the Stewart vibration isolation platform. But the vibration isolation platform occupies a lot of space, even increases the weight and complexity of the satellite system. In order to reduce volume and weight of the CMGs, Honeywell International Inc. introduced the concept of a momentum control system. This system includes a structure (frame) consisting of struts and joints to support the CMGs and the electronics. This arrangement reduces the required electronics and thus the weight. But this system cannot isolate the vibrations caused by the CMGs. A kind of moment control unit has been designed for the CMGs in our research team based on the above idea of the momentum control system. This moment control unit contained four control moment gyroscopes (CMGs) to realize the rapid attitude maneuver and a vibration isolation system for each CMG. However the vibration isolation performance maybe doesn't meet the requirements of the high resolution remote sensing satellite. For improving the vibration isolation performance and making full use of the space of moment control unit, an active-passive integrated vibration control method for the designed moment control unit is presented. The core idea of this method is that, for the moment control unit, we will change some rigid struts into passive spring damper or active-passive integrated vibration control rod. In this paper, the first step proposes the improved scheme of truss structure which can achieve the best vibration isolation performance. The second step establishes the dynamic model and analyzes the dynamic characteristics of the improved control moment unit. Then the dynamic model is simplified and analyzed its frequency domain characteristics. Finally, the improved structure is applied on a satellite, the dynamic model of the satellite system is established and the improvement effect of attitude control of the satellite is verified by numerical simulation.