IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Interactive Presentations - IAF MATERIALS AND STRUCTURES SYMPOSIUM (IP)

Author: Mr. xin wang
National Key Laboratory of Aerospace Flight Dynamics,Northwestern Polytechnical University, China, wangxin1989@mail.nwpu.edu.cn

Prof. Xiaokui Yue
Northwestern Polytechnical University, China, xkyue@nwpu.edu.cn
Prof. Yuan Jianping
National Key Laboratory of Aerospace Flight Dynamics,Northwestern Polytechnical University,Xi'an, China, jyuan@nwpu.edu.cn

VIBRATION ISOLATION FOR SENSITIVE PAYLOADS OF SPACECRAFTS VIA STEWART PLATFORM WITH THE X-SHAPE SUPPORTING STRUCTURE

Abstract

With the rapid development of space technologies, the requirements of precise pointing and extreme stability increase a lot for spacecrafts. For some spacecrafts, sensitive payloads, including space telescopes, imaging sensors, space-borne optical interferometer are essential for the missions, which require a relatively quiet working environment. Generally spacecraft includes multiple instruments, such as reaction wheels, cryogenic coolers, control moment gyroscopes and solar array drives, which can produce micro-vibrations. However, the micro-vibrations from the spacecraft and orbital perturbations both have a serious influence on the performance of sensitive payloads. For the sensitive payloads, it has become a more and more challenging problem on the performance requirements of low vibration and jitter as the vibration sources in the spacecraft increases.

To guarantee the performance of sensitive payloads, the multi-degree-of-freedom vibration isolation systems are needed. Stewart platform, as one of the most popular approaches, is excellent for 6-DOF vibration isolation and precision pointing of sensitive payloads. Based on it, a special 6-DOF vibration isolator is designed by six X-shape structures as legs in a passive manner for improving the vibration isolation performance. Passive isolation control is a reliable, low-cost method which is effective for attenuating high frequency vibrations. However, in general, it is not available for low frequency vibration isolation, especially cannot provide good trade-off between resonant peak and high frequency attenuation, and trade-off between pointing command keeping and disturbance rejection. Therefore, it is necessary to apply active isolation control for the isolation system. Regarding to the time-varying factors and uncertainties of the system, a novel adaptive control strategy is designed as the active control part to keep the sensitive payloads from external interference.

Compared with the simplified linear-stiffness legs, the nonlinearity of the X-shape structure enhances the vibration isolator to have better vibration isolation performances. Besides, the structural parameters of the X-shape structure including layer number, assembly angle and spring stiffness can be tuned arbitrarily, which is beneficial for precise pointing. Numerical simulation reveals that the isolation system can realize good vibration isolation in all six-DOF directions and better vibration isolation performance has been obtained.