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The Pointing and Vibration Isolation Integrated Control Method for Optical Payload

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Abstract

A pointing and vibration isolation integrated control method for optical payload in the satellite system with a Pointing and Vibration Control Platform(PVCP) is developed and verified. Firstly, the dynamic model of the satellite system is formulated. This satellite system contains a payload, a PVCP and a satellite body. Three pointing control methods are proposed depending on different measurement information. By comparing the three methods, one reasonable control method is chosen for the pointing controller. This method could reduce the disturbance from the satellite body motion to the pointing control accuracy as well as the control error caused by the measurement accuracy of sensors. Then, the whole satellite attitude control loop is developed considering a rapid maneuver and rapid orientation mission. Finally, a series of verification experiments of the dynamic model of PVCP are carried out, and then the rotation accuracy, the stroke of PVCP, and the whole satellite attitude control loop are verified by numerical simulations. The results show that the pointing accuracy and attitude angular velocity of payload are improved using the integrated control method.

Keywords: Vibration Isolation; Pointing Control; Integrated Control; Attitude control; Attitude dynamic

1. Introduction

With the development of aerospace missions, higher attitude accuracy and stability are required for future space-based precision missions. However, the imaging quality of the optical payload is severely affected by vibrations and jitters from flexible appendages, flywheels, control moment gyroscopes and other vibration equipments. For examples, in the plan demonstration stage of Hubble Space Telescope, it pointed out that the micro vibration of the flywheel seriously affects the quality of space observation[1]. And the laser link of Japan's ETS-VI is affected by micro vibration which leads to an increase in bit error rate[2].

To improve the imaging quality, the vibration isolation technology has been widely discussed and implemented. Because of its simple structure and high reliability, passive vibration isolation system is developed to isolate high frequency vibration of vibration components in satellite. A vibration isolation platform system is used to isolate the vibration of the flywheel in Advanced X-ray Astrophysics Facility(AXAF) and achieved a good result[3]. The Violet satellite[4] used single vibration isolation on every CMG to obtain high control accuracy. Zhang et al.[5] designed an isolator with a spring-damper in three directions and installed it at the CMG outer gimbal axis, it can effective reduce the disturbing force and torque. However, pure passive vibration isolation system cannot effetely attenuate low frequency vibration. So the research on the active and passive integrated vibration isolation