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Suppressing Vibration in a Three-axis Flexible Satellite: An Approach with Composite Control

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Abstract : This paper introduces a novel composite control approach that addresses the challenge of stabilizing the three-axis attitude of a flexible satellite in the presence of vibrations caused by flexible appendages. The key contribution of this research lies in the development of a disturbance observer, which effectively observes and estimates the unwanted torques induced by the vibrations. By utilizing the estimated disturbance, the proposed approach enables efficient compensation for the detrimental effects of vibrations on the satellite system. To govern the attitude angles of the spacecraft, a proportional derivative controller (PD) is specifically designed and proposed. The PD controller ensures precise control over all attitude angles, facilitating stable and accurate spacecraft maneuvering. In order to demonstrate the global stability of the system, the Lyapunov method, a well-established technique in control theory, is employed. Through rigorous analysis, the Lyapunov method verifies the convergence of system dynamics, providing strong evidence of system stability. To evaluate the performance and efficacy of the proposed control algorithm, extensive simulations are conducted. The simulation results validate the effectiveness of the combined approach, showcasing significant improvements in the stabilization and control of the satellite's attitude, even in the presence of disruptive vibrations from flexible appendages. This novel composite control approach presented in this paper contributes to the advancement of satellite attitude control techniques, offering a promising solution for achieving enhanced stability and precision in challenging operational environments.

Keywords : attitude control, flexible satellite, vibration control, disturbance observer
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