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ROBUST ATTITUDE CONTROL AND OBSERVATION SYSTEM DESIGN FOR A FLEXIBLE SATELLITE WITH AN IMMEASURABLE APPENDAGE

Abstract

This paper investigates the attitude control system and vibration observing system of a flexible satellite assembled with an immeasurable coilable mast. Multiple uncertainties including parameter perturbation, environmental disturbance and actuator saturation are considered in the attitude dynamic model. After the coilable mast is expanded, the whole satellite consists of a rigid main-sat, a bendable and twistable connector and a rigid sub-sat. To achieve high-precision attitude tracking of the rigid main satellite, a robust control law composed of a nominal controller, a finite-time compensator and a proportional-derivative controller is proposed. The finite-time compensator is constructed to neutralize lumped system disturbance. Then the system stability is analyzed based on Lyapunov function and system state transition matrix theory. Furthermore, an observation system is designed to estimate the vibration behavior of flexible coilable mast based on the proposed control law. The finite-time compensator is utilized again to approximate the vibration disturbance indirectly. Both control law and observation law can be performed in real time for the on-orbit satellite. Finally, numerical simulations are carried out to verify the effectiveness of proposed control law and observation system. Simulation results indicate that the desired attitude can be tracked in high accuracy by the rigid main satellite and the vibration state of flexible appendage can be estimated in real time. Therefore, the original immeasurable attitude control system of a flexible satellite can be stabilized and estimated effectively by the proposed control law and observing method.