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ROBUST ATTITUDE CONTROL FOR FLEXIBLE SATELLITE WITH MULTIPLE UNCERTAINTIES AND ACTUATOR SATURATIONS

Abstract

In this paper, the attitude tracking model of a microsatellite with a flexible appendage named coilable mast is formulated firstly. Then the satellite attitude control system is presented as a highly nonlinear and coupled system with multiple uncertainties including parametric perturbations, external disturbances and vibration disturbances of coilable mast. For a clear description, the control system is divided into a nominal system where is no disturbance and a lumped equivalent disturbance representing all above uncertainties and disturbances. To achieve high-precision attitude control, a robust attitude control law consisting of a robust compensator and an intelligent proportional-derivative (IPD) controller is proposed even considering about the actuator saturation. The robust compensator is constructed based on an auxiliary system and an observer to estimate and neutralize the lumped equivalent disturbance completely in a finite time. The IPD controller is designed to realize the desired attitude control for the nominal system under actuator saturations. Both the dynamic model and the proposed controller are based on unit quaternions to avoid singularity problem. Stability analysis indicates the asymptotic convergence of the closed-loop control system. Numerical simulations are carried out based on the proposed controller and a standard H_∞ controller respectively. Simulation results indicate that the proposed control system shows better performance including smaller attitude tracking errors and larger convergence speed under actuator saturations. Furthermore, the flexible vibration of the coilable mast is completely attenuated under its own damping effect since the proposed controller stabilizes the rigid satellite body effectively.