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ROBUST BACKSTEPPING CONTROL OF MAGNETICALLY ACTUATED SATELLITES WITH UNSYMMETRICAL MASS PROPERTIES

Abstract

The work presented in this paper focuses on the attitude tracking control of magnetically actuated satellites with unsymmetrical mass properties. A nonlinear robust backstepping control is implemented for controlling a satellite with destabilizing gravity gradient moment. The proposed controller effectively compensates the external disturbances and the uncertainities in the moments of inertia matrix as considered in the spacecraft dynamics. Both the time dependent and time independent model uncertaities are considered in the controller design process. The controllablity of the magnetically actuated satellite system for a high initial angular velocity is proved. The stability of the system for a high angular velocity is also proved and it is shown that it is exponentially stable in the neighborhood of the origin with the proposed controller. Also, it is proved that the eigenvalues of the average control matrix for different orientations and angular velocities in the body reference frame will converge to the same values as time tends to infinity. It is also shown that the eigenvalues of the average control matrix of a magnetically actuated satellite system in the body reference frame will be equal to the correspoding eigenvalsues in the orbital reference frame. Simulations are carried out to show the efficacy of the proposed controller for the magnetically actuated satellite system with unsymmetrical mass properties.