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خلاصه مقاله:
In this paper a PDE observer based boundary control method is presented for attitude control and vibration suppression of a general form of flexible satellites considering torsional deflections in addition to bending for the first time. Attitude dynamics of the rigid hub together with the vibrations of solar panels form a coupled system of ordinary and partial differential equations which is controlled directly in this paper without discretization. Consequently, spill-over instability is avoided that may rise from the ignored vibration modes through simplifying partial differential equations into ordinary ones. The presented method requires the least number of feedbacks from boundaries which are estimated by the observer. Therefore, control system still uses information from vibrations in distributed parts while just attitude data shall be measured. Besides, no actuators excess to regular torque actuators in the main hub like reaction wheels are needed. Dynamic model is derived via Hamilton principle method which encompasses coupled ODE-PDE attitude dynamic equations plus the governing equations of torsional and bending vibrations. Bending deflections appear to be coupled with roll dynamics while torsional deflections affect pitch dynamics and vice versa. PDE observer is designed following the pattern of Luenberger scheme. After constructing error dynamics, Lyapunov stability criterion is applied to prove boundedness of observer states. Next, control laws are introduced that use boundary data estimated by the observer. Again a Lyapunov function is defined to cover total closed-loop system. Implicating Lyapunov stability criterion together with LaSalle invariance reasoning, asymptotic stability of the closed loop system is approved. Finally, finite element model of the satellite is obtained. Euler-Bernoulli beam elements are used in this regard and torsional generalized coordinates are added to them before calculating equivalent mass, stiffness and damping matrices of the dynamic system. Simulation of the closed-loop behavior illustrates good performance of this PDE observer based boundary controller.

کلمات کلیدی:
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