Singularity-free integral-augmented sliding mode control for combined energy and attitude control system

ABSTRACT

A combined energy and attitude control system (CEACS) is a synergized system in which flywheels are used as attitude control actuators and simultaneously as a power storage system. This paper, a subsequent to previous research on CEACS, addresses the attitude-tracking problem. Integral Augmented Sliding Mode Control with Boundary-Layer (IASMC-BL), a locally asymptotically stable controller, is developed to provide a robust and accurate solution for the CEACSôs attitude-tracking problem. The controller alleviates the chattering phenomenon associated with the sliding mode using a boundary-layer technique. Simultaneously, it reduces the steady-state error using an integral action. This paper highlights the uncertainty of inertia matrix as a contributing factor to singularity problem. The inversion of the uncertain inertia matrix in simulation of a spacecraft dynamics is also identified as a leading factor to a singular situation. Therefore, an avoidance strategy is proposed in this paper to guarantee a singular-free dynamics behavior in faces of the uncertainties. This maiden work attempts to employ the singularity-free Integral Augmented Sliding Mode Control with Boundary-Layer (IASMC-BL) to provide a robust, accurate and nonsingular attitude-tracking solution for CEACS.

Keyword: Spacecraft guidance and control; CEACS; Flywheels; Low earth orbit satellites; Sliding mode control; Synergism