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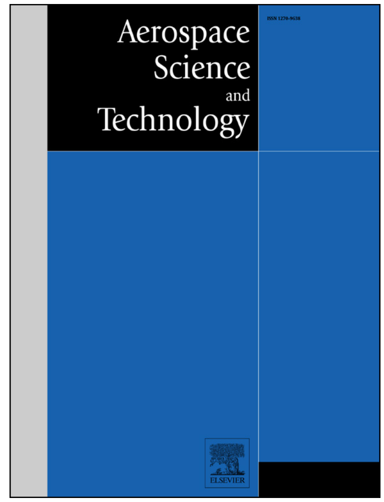

Robust Finite Time Control Algorithm for Satellite Attitude Control

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Abstract: Finite time controllers robust to inertia matrix uncertainty for satellite attitude stabilization control and attitude tracking control are developed in this paper. A three-stage finite sliding mode is constructed to improve system convergence rate. The singularity issue is solved by using the property of Euler Axis when it's paralleled to angular velocity. Based on this finite time sliding mode, finite time controller is developed to ensure the system state could reach the sliding mode in finite time. System inertia matrix uncertainty and disturbance torque is considered in this paper. The control torque constraint is also considered to ensure the norm of control torque does not exceed system upper bound. Finite time stability of the controller is proved and the controller performance is demonstrated by simulation results.

Keywords: finite time sliding mode; finite control; robust control; control torque constraint

1. Introduction

Recent years plentiful researches have been done on the field of satellite attitude control. Generally, satellite attitude control issue could be classified into two aspects: attitude stabilization control and attitude tracking control. The latter issue is more complex since the dynamic model is more complex than the former dynamic model. But the control algorithms for these two issues are generally all the same since the kinetic model of these two issues are all the same.

Sliding mode control is a mature and widely used control algorithm in satellite attitude control. The structure of standard sliding mode for satellite attitude control is simple and it has definite physical meaning. Moreover, sliding mode control is an inherent robust control algorithm. Because of these advantages, sliding mode control algorithm has attracted much attention and research. Jovan D[1] proposed a robust tracking controller under control input saturation. In this paper, a dynamic sliding mode is constructed and the parameter is updated with the convergence of system state. Lo[2] presented a smooth sliding mode control algorithm for spacecraft attitude tracking control. In this paper, a class of sliding mode is presented and a typical Lyapunov function is constructed. Xia[3] presented an adaptive sliding mode controller for satellite attitude tracking control with system inertia matrix uncertainty and bounded disturbances. Leavant[23,24] has done some work focused on high order sliding mode to improve the system accuracy.

However, the exponential convergence rate is a serious drawback of standard sliding mode control. The convergence rate descends severely and the system state converges to zero with