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ROBUST SLIDING MODE CONTROLLER DESIGN FOR GLOBALLY FAST ATTITUDE TRACKING OF TARGET SPACECRAFT

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Abstract. *This paper investigates the attitude tracking control problem for target spacecraft. A novel robust sliding mode controller based on Euler parameters and Lagrange-like model is proposed to solve this problem in the presence of model uncertainties and external disturbances. This controller can guarantee globally fast reachability of target spacecraft attitude trajectory by using a globally fast sliding mode model, which combines the advantages of linear-hyperplane-based sliding mode control and terminal sliding mode control and then provides globally fast convergence of attitude tracking errors. The convergence and stability of the closed loop system are proven theoretically. Numerical simulation is finally presented to validate the analysis.*
Keywords: Spacecraft control, Attitude tracking, Robust control, Lyapunov stability

1. **Introduction.** Spacecraft attitude control problem can usually be classified into the tracking problem and the stabilization problem. The recent decades have witnessed active studies in spacecraft attitude tracking control technology for its significant applications like spacecraft formation flying and target observation [1-4]. Some advanced control theories and methodologies for tracking problem of a nonlinear system have also been developed, see for example [5,6]. In practice, the model uncertainties of spacecraft and different space disturbances always reduce the control effect. Many literatures have proposed various approaches to solve this problem [7-10]. In particular, some specific space missions like uncooperative space target survey, rendezvous and docking (RVD) usually require the capabilities for rapid tracking and pointing of space target, but the current research mainly focus on attitude tracking control with asymptotical stability and convergence, which implies that the control objective is achieved in infinite time [11,12]. Therefore, it is highly desired for above specific space missions to achieve control objective in shorter time, and the finite time control technology provides an ideal solution to deal with the problem. The finite time control of dynamical systems is of interest because systems with finite-time convergence and stability usually demonstrate some nice features such as faster convergence as well as better disturbance rejection properties [12,13].

Based on the sliding motion on switching surface and the Lyapunov stability theorem, sliding mode control (SMC) provides a simple but ideal methodology for the analysis and design of robust control system of spacecraft as its important features like disturbance rejection, uncertainty insensitivity and fast response [14-16]. In the work of [10,17-24], spacecraft attitude tracking problem is handled by varied robust control methodologies. On the one hand, the linear-hyperplane-based robust sliding mode controllers are respectively proposed in [10,17-20], which guarantee the asymptotical stability and convergence. That is, spacecraft attitude parameters reach the desired trajectory in infinite time. On