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ADAPTIVE CONTROL BASED ON DISTURBANCE OBSERVER FOR NON-COOPERATIVE SPACECRAFT PROXIMITY OPERATIONS USING T-S FUZZY APPROACH

Abstract

With the continuous development of space technology, the number of some non-cooperative targets such as satellites and space debris that have lost or even become uncontrollable in space is gradually increasing, which pose a threat to other spacecrafts operating in orbit. It is necessary to approach the non-cooperative target for some operations, such as on-orbit maintenance, capture and so on. These space programs generally require high-precision relative position tracking and attitude synchronization. This paper deals with the relative motion control of a chaser spacecraft approaching a non-cooperative target in deep space. In view of the unknown model uncertainties induced by varying masses and moment of inertia for the chaser spacecraft, a six-degrees-of-freedom relative motion kinematics and dynamics model is established via the Takagi–Sugeno (T–S) fuzzy approach, which alleviates the online computation burden for the control algorithm in the paper. Besides, a T-S fuzzy sliding mode disturbance observer is constructed to estimate the external disturbance in real time with the large dimension of the system variable. Furthermore, a adaptive controller is designed by using backstepping methord, where uncertainties for non-cooperative target is estimated online and the conservativeness of disturbance observer is induced. The stability and finite time convergence of the closed-loop system is obtained within the Lyapunov framework. Numerical simulations are performed to demonstrate the feasibility and effectiveness of the proposed control stragety.