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ROBUST ATTITUDE COORDINATION CONTROL OF FORMATION FLYING SPACECRAFT UNDER CONTROL INPUT SATURATION

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Abstract. *The attitude coordination control problem for formation flying spacecraft associated with time-varying reference attitude tracking subject to control input saturation is investigated in this paper. According to different cases, three kinds of continuous and bounded coordination controllers are proposed. With the use of hyperbolic tangent functions, a fundamental controller is presented for an ideal case. Accounting for unavailability of measurements of angular velocities, passive filters are applied to the velocity-free coordination controller design. When parametric uncertainty and external disturbances exist, by introducing some time-varying parameters in nonlinear saturation functions and constructing an adaptive parameter estimation term, a robust coordination controller is proposed. Barbalat's lemma is utilized properly for stability analysis of the closed-loop non-autonomous coordination systems. Simulation results are provided to show the effectiveness of the proposed control schemes.*

Keywords: Formation flying, Attitude coordination, Control input saturation, Velocity-free control, Robust control

1. Introduction.

Whether a spacecraft formation flying system, capable of sharing information and cooperating with each other, works well or badly, is determined by the fact that whether spacecraft in formation are coordinated properly in some sense. Based on where control decisions are made, coordination controllers are categorized into centralized and decentralized types [1]. Compared with the former, the latter is very fault-tolerant, and under decentralized control, single spacecraft failure will not lead to instability of the entire formation system. In some applications of decentralized attitude coordination control for formation spacecraft, e.g., interferometry, it is important that spacecraft maintain alignment with each other during formation maneuvers [2-4]. This requires that the coordination control should arrive at a compromise between the control actions for the station-keeping and formation-keeping behaviors [1]. Station-keeping is the behavior driving the spacecraft to its absolutely desired attitude, while formation-keeping is the behavior aligning the spacecraft with the other spacecraft in the formation. In this case, the idea of behavior-based control, which is determined by a weighted sum of multiple control actions, can be employed effectively to solve such a decentralized coordination control problem. This kind of behavior-based decentralized attitude coordination control is a very interesting topic, and various control strategies have been proposed in [1-7].

Although many results of single spacecraft attitude control have been given in detail [8-12], there are still gaps in the field of multi-spacecraft attitude control, especially behavior-based decentralized attitude coordination control. One of the gaps is the research on control input saturation. Most of the existing aforementioned literatures, such as [1-7], have carried out coordination controller design without control input saturation