ASTRODYNAMICS SYMPOSIUM (C1)
Attitude Dynamics (1) (3)

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QUATERNION-BASED LEADER-FOLLOWING ATTITUDE COORDINATION CONTROL FOR SPACECRAFT FORMATION FLYING

Abstract

In this article, we investigate the decentralized attitude coordination control problem of spacecraft formation flying systems via a virtual leader. The unit quaternion parameters are adopted for global attitude representation without singularity. Consider a group of N spacecraft modeled as rigid bodies in which the equations of dynamics and motion for each spacecraft are described by the unit quaternion. The equation of dynamics includes the control torque and external disturbance of each spacecraft. In addition, suppose that there exists a virtual leader, labeled as spacecraft 0, whose attitude is a time-varying reference attitude of the group. A topology graph G is applied to represent the union of communication topology links between neighboring spacecraft, and matrix A denotes the weighted adjacency matrix of graph G with nonnegative elements. The objective of this article is to design an effective controller which can guarantee the attitude and angular velocity synchronization of spacecraft, which means that the attitude and angular velocity of each spacecraft should track the reference ones of leader. The auxiliary error variable composed of attitude tracking error and angular velocity tracking error is given. Then, a coordination controller consisting of the auxiliary error variable, control gain matrix and adjacency matrix of graph G is proposed. Further, a Lyapunov function composed of auxiliary error variable and inertia matrix of spacecraft is given, then the derivative of Lyapunov function is deduced to be negative which represents that the auxiliary error variable will converge to zero under the designed controller, i.e., the objective of this article is achieved. Finally, the simulation results and detailed explanations are provided to show that the designed controller is successful in attitude and angular velocity tracking performance, even in the presence of external disturbance.