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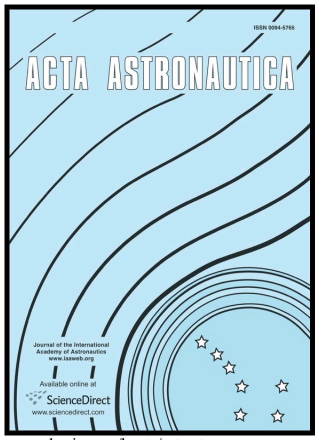

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Robust Distributed Control of Spacecraft Formation Flying with Adaptive Network Topology

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Abstract

In this study, the distributed six degree-of-freedom (6-DOF) coordinated control of spacecraft formation flying in low earth orbit (LEO) has been investigated. For this purpose, an accurate coupled translational and attitude relative dynamics model of the spacecraft with respect to the reference orbit (virtual leader) is presented by considering the most effective perturbation acceleration forces on LEO satellites, i.e. the second zonal harmonic and the atmospheric drag. Subsequently, the 6-DOF coordinated control of spacecraft in formation is studied. During the mission, the spacecraft communicate with each other through a switching network topology in which the weights of its graph Laplacian matrix change adaptively based on a distance-based connectivity function between neighboring agents. Because some of the dynamical system parameters such as spacecraft masses and moments of inertia may vary with time, an adaptive law is developed to estimate the parameter values during the mission. Furthermore, for the case that there is no knowledge of the unknown and time-varying parameters of the system, a robust controller has been developed. It is proved that the stability of the closed-loop system coupled with adaptation in network topology structure and optimality and robustness in control is guaranteed by the robust contraction analysis as an incremental stability method for multiple synchronized systems. The simulation results show the effectiveness of each control method in the presence of uncertainties and parameter variations. The adaptive and robust controllers show