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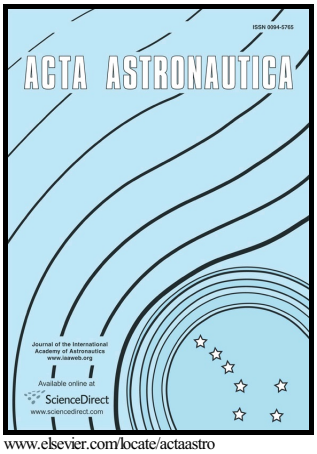

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PII: S0094-5765(15)30367-2
DOI: http://dx.doi.org/10.1016/j.actaastro.2016.11.037
Reference: AA6101

To appear in: *Acta Astronautica*

Received date: 31 December 2015
Accepted date: 25 November 2016

Cite this article as: Xu Huang, Ye Yan and Yang Zhou, Underactuated spacecraft formation reconfiguration with collision avoidance, *Acta Astronautica* http://dx.doi.org/10.1016/j.actaastro.2016.11.037

Underactuated spacecraft formation reconfiguration with collision avoidance

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Abstract

Underactuated collision-free controllers are proposed in this paper for multiple spacecraft formation reconfiguration in circular orbits with the loss of either the radial or in-track thrust. A nonlinear dynamical model of underactuated formation flying is introduced, which is then linearized about circular orbits for controllability and feasibility analyses on underactuated formation reconfiguration. By using the inherent dynamics coupling of system states, reduced-order sliding mode controllers are then designed for either case to indirectly stabilize the system trajectories to the desired formations. In consideration of the collision-avoidance requirement, the artificial potential function method is then employed to design novel underactuated collision-avoidance maneuvers. Rigorous proof substantiates the capabilities of such maneuvers in preventing collisions even in the absence of radial or in-track thrust. Furthermore, a Lyapunov-based analysis ensures the asymptotic stability of the overall closed-loop system. Numerical simulations are performed in a J_2-perturbed environment to verify the validity of the proposed underactuated control schemes for collision-free reconfiguration.