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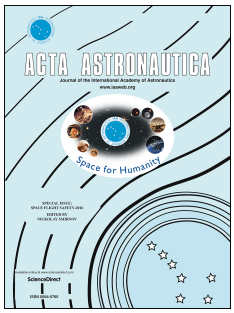

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Velocity-free adaptive backstepping control of underactuated spacecraft hovering in circular orbits with input saturation

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Abstract

This paper investigates the output feedback control problem of underactuated spacecraft hovering in circular orbits subject to unmatched disturbances and input saturation. Two underactuated cases without either the radial or in-track thrust are considered. Besides the unavailability of velocity information, the simultaneous loss of velocity measurements and thrust also gives rise to unknown system parameters, a problem not observed in fully-actuated hovering control. To address the lack of velocity measurements, a filter is designed to generate velocity signals. An augmented system is then proposed to deal with the input saturation. By using the inherent coupling of system states, the adaptive backstepping technique is then adopted to estimate the resulting unknown system parameter and design the velocity-free underactuated controller for either case. A Lyapunov-based approach is utilized to prove the stability of the overall closed-loop system, which indicates that all state errors, parameter and velocity estimation errors are asymptotically convergent in the absence of disturbances; and are uniformly ultimately bounded in the presence of disturbances. Finally, numerical simulations are presented to illustrate the performance of the proposed controllers.

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