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Adaptive Sliding Mode Control for Spacecraft Body-Fixed Hovering in The Proximity of an Asteroid

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An adaptive sliding mode control scheme for autonomous body-fixed hovering maneuvers of a rigid spacecraft in the proximity of an asteroid involving parameter uncertainties and time-varying external disturbances is proposed in the framework of geometric mechanics. The kinematics and dynamics models of the six-degree-of-freedom relative motion of the spacecraft about the asteroid are described using the Lie group $\mathrm{SE}(3)$**, which is the set of positions and orientations of the rigid spacecraft in three-dimensional Euclidean space. The relative configuration (position and orientation) between the spacecraft and asteroid is described in terms of exponential coordinates on the Lie group of rigid body motions. An adaptive sliding mode control scheme on the Lie group** $\mathrm{SE}(3)$**, where the bounds of parametric uncertainties and disturbances are not required in advance, is proposed to guarantee the asymptotic stability of states for position and attitude stabilization in the presence of parametric uncertainties and external disturbances. Detailed design principles and a rigorous stability analyses are provided. Numerical simulation results demonstrate the effectiveness of the proposed control scheme for autonomous body-fixed hovering over an asteroid with relatively low control inputs.**

Keywords: adaptive sliding mode control, asymptotic stability, Lie group $\mathrm{SE}(3)$, external disturbances, parameter uncertainties, input saturation.

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