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DISTURBANCE REJECTION HAZARD AVOIDANCE CONTROL FOR ASTEROID LANDING

Abstract

Asteroid landing is usually challenged with both model and environment uncertainties due to the lack of previous knowledge of the target. Considering the magnitude of the forces acted on the vehicle are quite small in comparison with the thrusters, the mismatch between reality and the stored dynamic model can be treated as disturbances. Thus, an autonomous landing system capable of estimating and compensating these disturbances while fulfilling the task of sending the vehicle to the landing site without collisions with any potential hazards is required. In this paper, a real-time hazard avoidance control is proposed by setting 3D keep-out zone constraints and generating the descent trajectory via nonlinear model predictive control. To mitigate the dynamic model error, an extended state observer is adopted in the loop which includes the disturbances in the state, estimates them by measuring the output of the system, and makes compensations in the command vector. A simulation based on the 216 Kleopatra with highly uncertain gravitational field is conducted and the result shows that the disturbance rejection hazard avoidance control manages to keep the vehicle away from the hazards and realize a safe landing on the surface regardless of large model uncertainties. It enhances the autonomy of the system and reduces the effort of precise model building before landing.