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THE COUPLING CONTROL OF ORBIT AND ATTITUDE FOR HAZARD AVOIDANCE BASED ON MODIFIED REFERENCE MODEL

Abstract

The scientifically interesting areas on the planetary surface always spreads of all kinds of hazards, therefore, spacecraft should have the hazard avoidance ability to ensure the safety. For the constraints of in-orbit observation and the field of view of the descent camera, some new hazards cannot be detected until spacecraft is very close to them, called here hidden hazards. The paper focuses on the issue of hazard avoidance for landing on small bodies, and a thrusters' command strategy based on the tracking of the modified reference model is introduced in the presence of such hidden hazards. First, the potential function method is used to generate the nominal trajectory, because it's able to guide the spacecraft to the target and guarantee the safety at the same time. In addition, optical camera is fixed to the spacecraft, thus, attitude should keep stable during hazard avoidance. In order to avoid the complex mapping strategies that maps the designed continuous control forces and torques into thrusters' force, coupling control of orbit and attitude by on-off thrusters at each time step is considered. However, when new hazards are detected, emergency maneuvering derived from the potential function method may cause transient behavior of the nominal trajectory. And, traditional thrusters' command strategy based on the tracking of the reference linear models by Lyapunov method is not suitable to track the transient behavior, because it's hard to allocate the candidate Lyapunov function matrix appropriately. In this paper, the reference model is modified by feeding back a term proportional to the tracking error instead of modifying the candidate matrix. The unconcerned state error term is set to zero, and the transient state term is set to an appropriate constant. The idea is to prevent the system's attempt to aggressively maneuver toward the reference model. And, as the tracking error approaches zero, the reference model approaches its original form. Therefore, the system asymptotically tracks not only the transient behavior, but also the original form. Finally, mathematical simulations are performed based on the environment of small body to verify the performance of the proposed method, in the presence of hidden hazards, the transient behavior of nominal trajectory is very obvious, and the control method based on modified reference model shows improved tracking performance over the traditional one based on reference model.