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STUDY ON ONBOARD EXPLICIT CELESTIAL DESCENT GUIDANCE USING RECEDING HORIZON CONTROL ADAPTABLE IN MICROGRAVITY ENVIRONMENTS

Abstract

For proximity operations of small bodies such as asteroids and comets, descent technology from a home keeping position or orbit to a target point is essential for observation and access to the surface of the bodies. The descent technique must not only provide the precise guidance needed to accomplish the mission, but should also be performed autonomously onboard the spacecraft due to the long roundtrip communication delay with the Earth when exploring more distant bodies. For this reason, it is desirable to have a simple algorithm that can be implemented onboard with low computational resources. It is also desirable to reduce the amount of fuel used during descent. Author proposes an explicit guidance method using the Receding Horizon Control in desecent, instead of the Implicit descent by following the reference trajectry that has been used in Hayabusa2 mission and so on. In this guidance method, a prediction horizon and control horizon are set for each V slot during descent based on the obtained navigation value information, and the two-point boundary value problem continues to be solved so that the position error can be reduced to zero after a predetermined elapsed time. This algorithm has the advantage of simultaneously converging not only the position error but also the velocity error, since the position error is corrected as the descent time progresses and a deceleration maneuver is always applied except the beginning of guidance or when there is a large position error correction by naviation . The algorithm is so simple that it can be adapted on-board, and in a microgravity environment, it can guide descent with an accuracy of several meters. In addition, the algorithm always provides a deceleration maneuver to the spacecraft, which prevents overshooting and reduces the amount of V. In this paper, the details of the guidance method and the results of evaluation with conventional methods will be described, as well as the evaluation of adaptable celestial environments. The possibility of application to actual missions will be presented through these results.