INTEGRATED DESIGN OF TRAJECTORY OPTIMIZATION AND TRACKING GUIDANCE FOR MARS ATMOSPHERIC ENTRY

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Abstract: *As two integral parts of traditional reference trajectory tracking guidance, trajectory optimization and tracking guidance design are usually carried out separately so far. Due to the thin atmosphere of Mars and low lifting body configuration, Mars entry vehicles have only low control authority, which severely limit the performance of tracking guidance and control system. At the same time, there are larger state errors and parameter uncertainties in the course of Mars atmospheric entry, which will lead to the degradation of reference tracking guidance algorithms. In order to improve the accuracy and robustness of reference tracking guidance for Mars atmospheric entry, we developed the integrated design of reference trajectory and optimal guidance method in this paper, which takes into account both the tracking capacity of control system and the effect of uncertainties during Mars atmospheric entry. Firstly, the sensitivity matrixes of system state variables with respect to uncertainties and perturbations along the entry trajectory are defined. The introduction of the sensitivity matrixes is the key to integrated design of reference trajectory optimization and tracking guidance. Secondly, the gain matrix of tracking guidance is contained into the reference trajectory optimization process through the dynamic equations with state sensitivity. The trajectory optimization process and the subsequent tracking guidance process are linked together by the introducing the gain matrix. Thirdly, the performance index of state sensitivity is defined according to specific design requirements (e.g. terminal height, velocity and heading error can be combined and weighted to construct the performance index of state sensitivity), and this performance index is a function of the state sensitivity. Then, the comprehensive performance index can be constructed by using the weight factor method to combine the performance index of state sensitivity and original optimal performance index. Finally, this weighted optimization problem can be easily solved by Gauss Pseudospectral Method (GPM) or other direct optimization algorithms.*

Keywords: *Mars entry, trajectory optimization, tracking guidance, integrated design*

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