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Optimal Guidance for Lunar Module Soft Landing

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Abstract: In this paper, we consider an optimal control problem arising from the optimal guidance of a lunar module to achieving soft landing, where the description of the system dynamics is in a three-dimensional coordinate system. Our aim is to construct an optimal guidance law to realize the soft landing of the lunar module with the terminal attitude of the module to be within a small deviation from being vertical with respect to lunar surface, such that the fuel consumption and the terminal time are minimized. The optimal control problem is solved by applying the control parameterization technique and a time scaling transform. In this way, the optimal guidance law and the corresponding optimal descent trajectory are obtained. We then move on to consider an optimal trajectory tracking problem, where a desired trajectory is tracked such that the fuel consumption and the minimum time are minimized. This optimal tracking problem is solved using the same approach to the first optimal control problem. Numerical simulations demonstrate that the approach proposed is highly efficient.

Keywords: *optimal guidance law; lunar module; soft landing; optimal control with bounds on control and terminal states; control parameterization; time scaling transform; optimal trajectory tracking.*

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