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OPTIMAL TRAJECTORY DESIGN FOR THE LUNAR VERTICAL LANDING

Abstract

After the end of the cold war, competition for space exploration discontinued is becoming more intense recently. In most countries, the lunar exploration mission has been executed as the first goal of this space exploration. For the investigation of the moon, the soft landing technology is most important ones. Generally, this soft landing is divided into two phases: powered descent phase and approach phase. In the powered descent phase, the landing module velocity is reduced to zero by the main thruster. Then the module attitude is adjusted so that it is vertical to the moon surface and vertically descends. For this lunar landing process, the optimal control strategies are applied to reduce the fuel consumption. There are many researches for this optimal lunar landing trajectory. To find such optimal solution, two-dimensional approaches has been already studied in many researches. However, most of these researches are focused on the powered descent phase and did not consider the final constraint for the vertical landing. This condition was dealt in some papers by using the attitude states. However, in this case, the cost function of optimal problem consists of the parts for the translation and rotation motion. Thus, it is required the weighting factor between these different physical properties, and the optimal trajectory is dependent on this weighting factor. And the final constraint for an angular speed is also considered for this approach. Therefore, in this paper, the simple way is suggested to find the vertical lunar landing trajectory by using the final control constraint. Using this approach, the optimal solution can be found as easily and the dynamics and formulation of optimal control is similar to that of the previous researches.