A Study on Guidance Technique for Precise Lunar Landing

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Concerning previous lunar landing missions in the history, their landing strategies were to land safely to any place in widely dispersed landing area. After JAXA's SELENE mission and NASA's LRO mission, precise pictures of lunar surface were obtained, and science communities are encouraged to propose exploration missions which target specific landing point. Those missions require precise landing technique which enables the lander to be landed next to specific "scientifically attractive rock" safely.

Traditional ways of guidance, navigation and control may not achieve this objective because of limitation of orbital determination accuracy, geographical error of lunar surface map, and short time landing sequence. To overcome these problems, autonomous navigation based on terrain pictures obtained by onboard camera is required, because it directly estimates relative states to aimed landing point. Autonomous guidance logic which robustly targets the landing point is also required, because short time landing sequence does not allow real-time flight plan update from the ground station.

This study focuses on autonomous guidance logic for precise lunar landing. First, as usually considered in general space mission development, an optimal solution in terms of minimum fuel consumption is investigated. Second, robustness of guidance logic is researched. The guidance logic must derive solution even in the condition with navigation errors and control errors.

Third, specific constraints of the mission are considered, e.g., specifications of the navigation sensors, features of the propulsion system and configuration of the spacecraft.

An example of solution is shown in Figure 1. This picture shows a trajectory from lunar circular orbit to final vertical descent initiation point. The guidance logic is developed based on previous works for small lunar lander mission SLIM[1][2][3].

In this paper, the concept of the guidance logic is introduced, followed by its consideration of robustness and accuracy with simulation results.

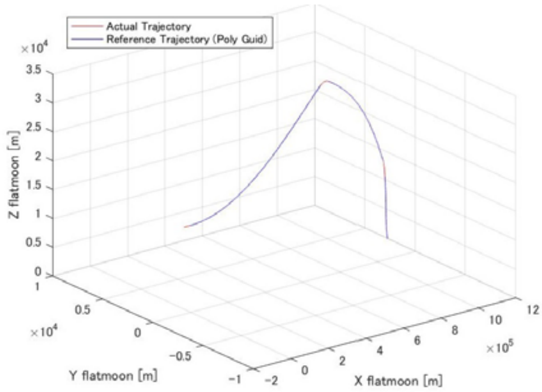

Fig. 1. An example of guidance solution.

References

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