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FLIGHT RESULTS OF GNC SYSTEM FOR ARTIFICIAL LANDMARK ACQUISITION IN HAYABUSA2 TOUCHDOWN OPERATION

Abstract

Hayabusa2 is a Japanese sample return mission from the asteroid Ryugu. The Hayabusa2 spacecraft was launched on 3 December 2014, and arrived at Ryugu on 27 June 2018. It will stay there until December 2019 for in situ observation and soil sample collection. It will return to the Earth in December 2020. During the stay, the spacecraft performs several numbers of descent operation, for instance, to deploy rovers and to touchdown. On 22 February 2019, the spacecraft has successfully touched down on Rugyu. The surface of Ryugu is rough and full of boulders, and safe area for touchdown was limited. The target point named "L08-E1" has a radius of only 3 m, and the accuracy required to the guidance, navigation and control (GNC) of the spacecraft was challenging. The strategy adopted was a technique called "pinpoint touchdown" in which the spacecraft performs GNC with respect to a small, reflective, beanbag-like "target marker" that had been dropped in October 2018. This was used as an artificial reference point on Ryugu. In the touchdown operation, the spacecraft started approaching to Ryugu from the distance of 20 km. One of the main tasks for the GNC team was to navigate and control the spacecraft so that the target marker would be inside the field of view of its optical navigation camera at the altitude of 45 m. Once the target marker acquisition was succeeded, a pre-programmed autonomous sequence was started. The position accuracy required for the target marker acquisition was approximately 20 m. This was a challenging task for the GNC team, and it was necessary to improve the GNC design and accuracy. This paper introduces the GNC methods of Hayabusa2 and descent operation results focusing on the touchdown operation. The design process of controllers and accuracy improvements made through numerical simulations will be shown, and their performance will be evaluated with actual flight data.