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HAYABUSA2 OPERATIONAL DESIGN AND EVALUATION OF MINERVAII-1A/B ROVERS DEPLOYMENT

Abstract

Hayabusa2 asteroid explorer arrived at asteroid Ryugu in June of 2018. During stay around Ryugu, Hayabusa2 is trying several challenging missions. One of them is "Rover landing and exploration on the Ryugu surface." Hayabusa2 has some payloads which are deployed from the main spacecraft. MINERVA II-1A/B are 2 hopping rovers which are deployed from Hayabusa2. After detail remote sensing of Ryugu, Hayabusa2 tried MINERVA II-1A/B deployment operation, and rovers were successfully landed on the surface of Ryugu on September 21st, explored Ryugu, and sent us many data including beautiful Ryugu surface pictures.

Before deployment operation, MINERVA II landing site selection (MLSS) was made. In MLSS, we studied the smallest deployment area of rovers with consideration of guidance navigation and control (GNC) accuracy, optical camera shooting after rover deployment, and interference of other missions (lander deployment and touch-down).

Success of rover landing and guarantee of spacecraft safety are operational requirements. The rover deployment operation can be divided in 3 phases, 1) descending from home position (HP) to 60m altitude from the surface, 2) autonomous rover release, spacecraft ascent, and optical navigation camera (ONC) rover shooting phase, and 3) HP recovery phase. The autonomous sequence is needed to cover round-trip 40 minutes communication delay from Earth and to guarantee spacecraft safety at low altitude (under 60m) where gravity is relatively strong. Thus, for the success of this operation, autonomous sequence

design based on the analysis of spacecraft dynamics and GNC as well as the analysis of rover dynamics is one of the important issue. The targeted rover landing site, spacecraft trajectory, dV, ONC shooting attitude, abort monitoring function were designed to maximize rover landing success and opportunities of other Hayabusa2 missions while guaranteeing spacecraft safety.

In this paper, design and result of whole rover deployment operation are shown. In the design process, MLSS analysis result, ONC shooting analysis, GNC and operation sequence design are shown in detail. About the operation results, evaluation of operational requirements, spacecraft navigation and control accuracy, spacecraft trajectory from beginning to end of the operation, and batch filter estimation of 1st landing area of rovers by using ONC images and other data are shown in detail.