Use of Hayabusa2/LIDAR range data to improve spacecraft trajectory for landing site selection

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Hayabusa2 spacecraft will arrive at the target C-type asteroid Ryugu around June 2018. Hayabusa2 will make a “touchdown” to sample materials on the asteroid surface. Based on near-global observations which will be made soon after arrival by remote sensing instruments, we have to evaluate, in a timely manner, scientific value and touchdown safety to select and rank possible landing sites. Since this procedure is time critical, landing site selection (LSS) training was organized and conducted in 2017. In the training, simulated observations are generated based on a high-resolution model of a hypothetical asteroid (called as Ryugoid) as well as proximity spacecraft operation plan. Here we use the simulated LIDAR range data and a Ryugoid shape model reproduced from the simulated optical navigation camera images, in order to show the possibility to improve the spacecraft trajectory relative to the asteroid.

Given the initial (or erroneous) spacecraft trajectory with respect to the asteroid, the spacecraft attitude information, the observed LIDAR ranges, and the shape model together with asteroid spin information (orientation and period), one can calculate LIDAR footprint positions in asteroid-fixed frame. At the initial stage of the proximity operation, the trajectory errors can be in the order of several tens of meters or sometimes more than a hundred meters, and then considerable deviations will be observed between the calculated LIDAR footprints and the shape model. By assuming that these deviations are mainly due to the trajectory error, orbit correction can be obtained from the residual time series. One simple way is to rotate the residual vectors from Ryugoid-fixed frame to J2000 frame and fit quadratic functions for each of X, Y, Z components of the time series. In the LSS training, this idea worked to some extent, and we were able to quickly provide the improved trajectory to LSS analysis team. In the training, however, point-wise LIDAR footprints as well as a perfect pointing of the LIDAR (zero alignment error) are assumed. We will report how these idealizations affect the results.

Keywords: Hayabusa2, LIDAR, orbit correction

