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VISUAL FEEDBACK ATTITUDE MANEUVER FOR HAYABUSA2 ASTEROID FLYBY OBSERVATION

Abstract

The asteroid explorer Hayabusa2, developed and operated by JAXA, arrived at the asteroid Ryugu in June 2018 and performed pinpoint touchdown and other proximity operations. After returning to the earth in December 2020 and completing the asteroid sample return, it left the earth's gravity sphere and is now flying toward the next asteroid "1998 KY26" as "Extended mission".

On the way to the next asteroid arriving in 2031, Hayabusa2 will carry out flyby mission near the asteroid "2001 CC21" in July 2026. During this flyby, it is planned to capture the image of the rapidly moving asteroid relative to the spacecraft using the narrow view camera fixedly mounted on Hayabusa2.

To get larger size images of the rapidly moving asteroid preventing blurring, attitude maneuver is considered applying visual feedback attitude control using the position and the velocity of the asteroid in the onboard camera image. The position of the asteroid in the image is obtained by image recognition based on brightness in real time onboard and the attitude angle error and the attitude angular velocity error are calculated from this information. Then, onboard feedback attitude control maneuver is carried out using these errors.

This visual feedback has advantages for non-blurred imaged that it can control asteroid position and velocity fluctuations in the image caused by orbital error. In addition to it, continuous shooting during attitude maneuver can help to get the latest "shutter chance" for larger asteroid images.

This paper shows visual feedback attitude control algorithm for the asteroid flyby observation considering constraints listed below,

- Saturation of the control torque from reaction wheels.
- Time interval of measurement determined mainly by image capturing frequency.
- Measurement error and delay from image processing algorithm and hardware configuration.

Then the performance of the controller is evaluated through numerical simulations which include Monte Carlo simulation considering orbital error in the transverse direction (orthogonal to the flyby velocity) and orbital error in the direction of the flyby velocity.

Finally, high success rate for non-blurred image capturing from proposed flyby observation strategy is shown.