Breadboard model of asteroid tracking system for DESTINY^{+} mission

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DESTINY^{+} (Demonstration and Experiment of Space Technology for Interplanetary voYage, Phaethon fLyby and dUst Science) is a mission proposed for JAXA/ISAS Epsilon class small program, currently in the pre-project phase (Phase-A) with a launch targeted for 2023. The mission plans to conduct high-resolution imaging during close flyby of asteroid (3200) Phaethon, which is considered as a parent body of Geminid meteor shower. Two cameras are planned to be onboard DESTINY^{+}, the Telescopic Camera for Phaethon (TCAP) and the Multiband Camera for Phaethon (MCAP). While MCAP is designed for low spatial resolution imaging, TCAP is planned to perform high-resolution imaging, especially from ~40 seconds before to ~9 seconds after the closest approach with an imaging rate of more than 1 frame per second and the surface of Phaethon will be imaged with a spatial resolution up to 3.5 m/px at closest approach. Both cameras will be mounted and installed on the wall of spacecraft bus, thus orientations of the cameras are mainly controlled by the attitude of spacecraft. However, since the relative flyby speed and closest distance to Phaethon are expected to be 30 to 40 km/s and about 500 km, it is significantly difficult to track the asteroid only by the rotation of the spacecraft itself. Therefore, an asteroid tracking system is required for TCAP to obtain unblurred high-resolution images. The tracking system is also required to operate autonomously during the high-speed flyby. We have conducted conceptual studies of the tracking mirror as well as control algorithms to properly navigate the mirror based on feedforward or feedback loop. To realize the designed concept, we have developed a simple breadboard model focusing on the rotating mechanism which is the most important part of tracking mirror. The breadboard model consists of a rotating mirror, a 2-phase stepping motor and its driver, a motor reducer, and a FPGA board to control the driver. Required performances for the breadboard model of tracking system are (1) the rotating mirror should be able to orient a desired direction with an enough accuracy, (2) the mirror should be able to rotate smoothly with an enough accuracy during the exposure of TCAP. We will report the current development status of breadboard model of asteroid tracking system for TCAP and show its initial results of the performance test.

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