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Author: Prof. Tatsuaki Hashimoto  
Japan Aerospace Exploration Agency (JAXA), Japan

SEPARATION VELOCITY ESTIMATION OF ARTEMIS-I RIDESHARE CUBESATS

**Abstract**

Ten CubeSats were launched by NASA SLS Artemis-I rocket on 16 November 2022. They were mounted on Orion Stage Adapter (OSA) of Artemis-I and separated from OSA during its spinning phase. Its spin rate has been announced by NASA, but the accurate spinning phase of the separation timing of each CubeSat was unknown. In this presentation, a method to estimate the separation velocity of a specific CubeSat from the known separation velocity vectors of other CubeSats is proposed.

OMOTENASHI (Outstanding MOon exploration TEchnologies demonstrated by NAno Semi-Hard Impactor) was one of the CubeSats on Artemis-I, but it lost contact approximately one hour after the separation due to its battery depletion. From the attitude at the loss of communication, it was estimated that its solar array would face the sun direction about four months later. Since a flyby of the moon would magnify orbital errors, accurate initial orbit estimation was essential in order to estimate the orbit four months later.

To solve this problem, the estimation method of OMOTENASHI separation velocity, especially its separation direction was developed. Though the most of the CubeSats were failed their initial orbit determination, BioSentinel, EQUULEUS, and LunarH-Map provided accurate trajectories. Considering the separation timing of those CubeSats, the spin rate and phase of OSA could be estimated. From the information, the separation vector of OMOTENASHI was estimated.

Unfortunately, OMOTENASHI could not be found nor recovered. Therefore, an end-to-end confirmation of the proposed estimation could not be conducted. But the initial trajectory was also estimated by limited data (about 30 minutes) of ranging and doppler measurements. In the presentation, both estimation results of the proposed method and the orbit determination are compared.