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LESSONS LEARNED FROM CUBESAT MOON LANDER OMOTENASHI

Abstract

OMOTENASHI (Outstanding MOon exploration TEchnologies demonstrated by NAno Semi-Hard Impactor) was developed to be the world's smallest moon lander. It was launched by NASA's Space Launch System (SLS) Artemis-1 with Orion spaceship on November 16th, 2022. The mission objectives of OMOTENASHI were (1) demonstration of nano-lander technologies and (2) observation of radiation environment in Cis-lunar region. The spacecraft consists of three parts, Orbiting Module (OM), Rocket Motor (RM), and Surface Probe (SP), because the separation in orbit is essential to reduce deceleration

mass for landing. To decelerate the orbital velocity from 2500 m/s, a small solid rocket motor is employed. By the ignition of the RM, RM+SP will be separated from the OM. Since the deceleration is conducted by the solid rocket motor, roughly 50 m/s velocity error at the impact on the moon surface will remain. To withstand the high-speed impact, a crushable material which is sandwiched between the SP and the RM, would be used.

Unfortunately, however, the spacecraft could not complete its sun acquisition control and its battery had been depleted at about one hour after the separation from SLS. We had investigated the cause of the anomaly. Because the spacecraft was rotating with about 50 deg/s angular velocity facing almost anti-sun direction when its power lost, we consider its attitude is conserved and its solar cells will face sun from February, 2023. We are searching a signal of the spacecraft and trying to re-establish the communication to the spacecraft. Since the spacecraft flew by the moon on November 21st, 2022, we had given up the moon landing. But we are planning to demonstrate some technologies for CubeSat moon landing such as the separation mechanism of the SP, an ignition of the RM, etc.

In this presentation, after the mission outline, spacecraft design, and planed in-orbit operation of OMOTENASHI had been shown briefly, the situation during the first contact pass will be explained. And the cause of the anomaly is presented. If the communication with OMOTENASHI has been re-established before the conference, the results of the searching operation of the signal, the recover operation, and some experiments for the CubeSat moon landing technologies will be also presented. Finally, lessons learned from the development of the CubeSat moon lander are summarized.