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SYSTEM DESIGN OF CUBESAT SEMI-HARD MOON IMPACTOR: OMOTENASHI

Abstract

OMOTENASHI (Outstanding MOon exploration TEchnologies demonstrated by NAno Semi-Hard Impactor) will be the world's smallest moon lander. It will be launched by NASA's SLS (Space Launch System) EM-1 (Exploration Mission-1) with Orion spaceship in 2019. The missions of OMOTENASHI are (1) demonstration of nano-lander technology and (2) observation of radiation environment in Cis-lunar region. In the near future, industry, academia, and even individuals will be able to easily participate in space exploration. In the presentation, the system design of the spacecraft is shown. Since it must be within 14 kg mass and 6U CubeSat size, some new technologies have to be developed. To decelerate the orbital velocity of about 2500 m/s, a solid motor is employed, considering Isp (specific impulse) and dry mass of the propulsion system. However, even solid motor cannot decelerate whole 14 kg spacecraft within 6U size constrain. Therefore, unnecessary part of the spacecraft should be separated before deceleration. That is, the spacecraft consists of Orbiting Module (OM), Rocket Motor (RM), and Surface Probe (SP). After OM will be separated, only SP whose mass is 700g will arrive to the moon surface. OM has solar cells, a secondary battery module, a power converter, an onboard computer, a X-band transponder, a UHF-band transponder, an attitude control unit, a couple of gas-jet propulsion system, and radiation monitors. To reduce the mass of RM and SP, a laser ignitor is adopted for the ignition of the solid motor and it is installed on OM. Its optical fiber cable will be cut at the instance of the ignition, namely separation. SP has only a primary battery module, an onboaed computer with power distributer, 3-axis accelerometer, and UHF-band transmitter which are necessary for confirming successful landing. SP will survive for a few minutes on the moon surface. Since deceleration maneuver is conducted by the solid motor and its spinning attitude is controlled by open loop manner, a few tens m/s velocity error at the impact on the moon surface should be considered. To withstand high speed impact, hybrid shock absorption mechanism is used. That is, a crushable material is sandwiched between SP and RM and impact shock from RM side is reduced by the material. In case of impact from the other side, an air-bag is used. The air-bag is inflated in orbit.