32nd IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Small Earth Observation Missions (4)

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FEASIBILITY STUDY OF VLEO SMALLSAT PLATFORM BASED ON ON-ORBIT ACHIEVEMENTS OF SUPER LOW ALTITUDE TEST SATELLITE (SLATS)

Abstract

Super Low Altitude Test Satellite (SLATS) was successfully launched on December 23, 2017. After performing orbit transfer from the released high elliptical orbit, SLATS entered the very low Earth orbit (VLEO) region and flew for 111 days from 271.5km to 167.4km and completed its operations on October 1, 2019. VLEO is a promising area for remote sensing. Because of its closer distance from the Earth's surface, operations in VLEO enable higher spatial resolution for optical imaging and higher signal-to-noise ratio for active sensing using SAR or LIDAR.

As JAXA's first demonstrator to operate in VLEO, SLATS has achieved the following major operational results and proved the potential of VLEO utilization. 1) Technology acquisition of VLEO operations such as high-precision orbit control methods using an ion engine. 2) An aerodynamic database is constructed based on measured data of atmospheric density. The data show the on-orbit environment was thinner than predicted by the conventional NRLMSISE model. 3) Long-term atomic oxygen (AO) data and material degradation data in the VLEO environment is acquired for the first time in the world. 4) Optical imaging from VLEO using an ion engine was successfully conducted for the first time in the world by a small and high-resolution image sensor. It is confirmed that the degrading impact on the image quality from atmospheric disturbances and ion engine operations is negligible.

Despite the success of SLATS's mission, there are still challenges to be improved, such as operational lifetime, area coverage and quality of data products. To realize practical VLEO missions, we are currently conceptualizing a new VLEO platform that follows SLATS. By utilizing smallsat technologies, various missions can be realized with reduced costs and schedules. Moreover, the mass productivity of smallsat helps to expand observation coverage using multiple satellites, and large databases to be accumulated are useful for image super-resolution and other quality improving techniques. Our platform is designed to be 300kg-class size with key technologies such as an efficient propulsion and power system to compensate for the high-density atmosphere in VLEO. Two case studies are conducted for high-resolution optical imaging mission and LiDAR altimeter mission, and the feasibility of this platform is shown by multidisciplinary studies for thermal-structure analyses considering aerodynamic effects with SAP cant design and operational analyses with orbit control and power balance based on the measured atmospheric environment.

This paper presents JAXA's next VLEO satellite study based on the operational achievements of SLATS.