30th IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Constellations and Distributed Systems (7)

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IN-ORBIT DEMONSTRATION OF PROPELLANT-LESS FORMATION FLIGHT THROUGH SEPARATION OF JOINTED TWO CUBESATS IN THE MAGNARO MISSION

Abstract

Recently, small satellites such as CubeSats have been applied to a variety of missions such as scientific observations and remote sensing. One of attractive applications that can be achieved by small satellites are multi-satellite missions such as formation flights and constellations. Although, the relative orbit between satellites should be actively controlled to achieve these missions, in some cases, it is difficult to minimize the thrusters to an available volume and power consumption for CubeSats. Herein, a 3U Cubesat called MAGNAROMAGnetically separating NAnosatellite with Rotation for Orbit control is developed by Nagoya University, JAPAN, to demonstrate a new method for formation flights without thrusters. MAGNARO consists of two CubeSats: MAGNARO - Tigris (2U sized CubeSat) and MAGNARO - Piscis (1U sized CubeSat). In MAGNARO, a new method for formation flights without thrusters will be demonstrated. In this method, the magnetically connected two Cubesats are spun up to large angular velocity (2 Hz) by magnetic torquers, and the jointed satellites are separated precisely with electromagnetic force under the environment of central fugal force by the attitude spin. With this central fugal force, the separated two satellites can make a formation without thrusters. After the separation, aero drag force of two CubeSats is changed with attitude control to keep the satellite formation. In this proposed method, precise attitude control is a key technology for attitude spin in magnetic separation and for attitude control in orbit control using aero drag force. To achieve precise attitude control, the dominant magnetic disturbance torque caused by the magnetic separation system is estimated using Kalman filter and compensated with feed-forward controller using magnetic torquer. To keep and change the formation, precise information of aero drag force is needed. Parterres related to aero drag force are estimated before the separation in orbit. Based on the estimation results of the in-orbit estimation, the orbit controller is updated to achieve more accurate orbit control. In this paper, the concept of a new method for formation flight, an orbit control method using both magnetically separation and aero drag force, implementation of the proposed method to 3U Cubesat, and the current status of the satellite project targeting launch in 2024 are presented.