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DEMONSTRATION OF THE PROPELLANT-LESS CONSTELLATION WITH JOINTED CUBESATS SEPARATION BY CENTRIFUGAL FORCE IN THE MAGNARO MISSION

Abstract

Missions with a small satellite constellation such as a multi-point simultaneous observation and communication network are being proposed all over the world. To achieve these missions, constellation deployment and keeping are the key technologies. Generally, thrusters are used for these technologies. Although the method with thrusters can accelerate satellites largely, thrusters take large space of small satellites. The other method without thrusters is using attitude maneuver of the satellites to control environmental forces such as aero drag and solar radiation pressure. This method can change satellites orbit without large devices, whereas this method takes a long time to change the orbit due to weak environmental force. To settle these issues, our research group proposed a constellation deployment and keeping method using jointed satellites separation by centrifugal force. Small satellites can be spun up in a short time owing to their small moment of inertia. The proposed method firstly spins up combined small satellites to a large angular velocity and separates them. Then, the satellites are accelerated, and their orbits are changed. Afterward, the difference in the phase angles between two satellites gradually becomes larger. Then, by controlling their orbit with environmental force, the two satellites form a constellation in along-track formation. With this method, satellites can form a constellation without large devices and in a shorter time than the method with only environmental force. To demonstrate this method, our research group is developing a cubesat called "MAGNARO". MAGNARO is composed of 2U and 1U cubesats, and they are connected with the magnetic force between magnetic holders on the 2U cubesat and iron plates on the 1U cubesat. In the mission, MAGNARO is spun up to 720 degrees/s, and 2U and 1U satellites get 1.3 m/s and 0.63 m/s delta-V, respectively by the separation. After that, with aero drag force, MAGNARO changes its orbit and forms a constellation in along-track formation. For high speed rotation, MAGNARO has large magnetic torquers that are also used as structure. In addition, to decrease the phase angle error in high speed rotation, MAGNARO performs precise attitude determination using an acceleration sensor. Currently, MAGNARO development is in the engineering model development phase, and the flight model development will be finished in 2021.