Paper ID: 3872
student

38th STUDENT CONFERENCE (E2)
Student Conference I (1)

Author: Dr. Takaya Inamori
University of Tokyo, Japan

# MAGNETIC DIPOLE MOMENT ESTIMATIONS AND COMPENSATIONS FOR ACCURATE ATTITUDE CONTROL IN NANO-SATELLITE MISSIONS

**Abstract**

Nano-JASMINE (Nano-Japan Astrometry Satellite Mission for INfrared Exploration) is planned as a 20 kg nano astrometry satellite by the ISSL laboratory, University of Tokyo in cooperation with the NAOJ (National Astronomical Observatory of Japan). The main objective of the mission is to precisely measure the distances to stars in our galaxy using parallax. In order to obtain accurate astrometry data, the satellite should be stabilized to less than $4 \times 10^{-7} rad/s$ during observations, which is difficult to achieve using only a conventional feed-back controller because of the magnetic disturbance. During nano-satellite missions, the magnetic torque is the dominant disturbance and of the main source of the attitude instability. This research presents a unique method to estimate and compensate the residual magnetic moment. A Extended Kalman Filter is used with data from gyro sensors and magnetic sensors to estimate the magnetic disturbance, which is compensated for using a feed-forward controller.

In order to compensate magnetic disturbance accurately, several points should be considered. Firstly, sensor noises such as bias, scale factor, and alignment errors should be canceled before magnetic moment estimations and should be considered during magnetic compensations. Secondly, no-steady current of the residual magnetic moment should be also considered. In practice, residual magnetic moment will change with time because of changes from the current loop's devices and solar batteries. Finally, effect of the non-linear model and how to deal with this problem are discussed. An Unscented Kalman Filter is adopted for more accurate estimations.

For more practical considerations of the magnetic disturbance compensations, this method is also examined in PRISM (Pico-satellite for Remote-sensing and Innovative Space Missions") mission. PRISM is 8.6 kg nano-remote sensing satellite developed by ISSL University of Tokyo, which was launched as a piggy-back satellite of GOSAT using H2A rocket in 2009, January 23rd. Using telemetry data from PRISM and off-line estimations, residual magnetic moment is estimated and this information is up-linked to the satellite for in-orbit magnetic moment compensation. The method of the residual magnetic moment estimation is feed-backed and refined using the results of the magnetic moment estimations' experiments.

Based on in-orbit experiments using PRISM satellite and simulation results, this research concludes that the use of the magnetic disturbance estimation and compensation are indispensable for the Nano-JASMINE mission and useful for other nano-satellite missions which require highly accurate attitude control.