Attitude Control System for Kanazawa-SAT3 Microsatellite

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Kanazawa University has been developing a micro satellite, Kanazawa-SAT^3. This satellite is equipped with a device to observe celestial bodies emitting gravitational waves with X rays, and aims to elucidate the mechanism of black hole formation by estimating the time of arrival and direction of arrival of gravitational waves.

In this research, we studied algorithm for attitude control of the satellite. We plan to spread SAP (Solar Panel) after the satellite is separated from the rocket, and stop rotation of the satellite by attitude control called de-tumbling. After that, we plan to judge if the current location sunshine or shady by using STT (Star Tracker) and solar sensors. If it is sunshine, we plan to capture the sun. If it is shady, we plan to decide attitude of the satellite by using STT, and wait until it is sunshine. We plan to turn SAP to the sun and turn mission devices to the deep space direction.

We studied attitude control used GAS (Geomagnetic Aspect Sensor) and MTQ (Magnetic Torque), and implemented the control system. We constructed the environment for unit test of RW (Reaction Wheel) used for attitude control of the satellite. We measured errors of GYR (Gyro Sensor) used for detecting angular velocity of the satellite, and corrected the errors.

MTQ is a device that controls the attitude of the satellite by generating torque by interference with the geomagnetism by applying a voltage to flow an electric current to the magnetic coil. GAS is a device for detecting the direction of the geomagnetic vector. MTQ and GAS are controlled by OBC (On Board Computer) and MC (Media Convertor). We can get maximum torque when MTQ generates torque is orthogonal to the geomagnetism. Because the torque generated by MTQ influence on the detection value of GAS, we have to wait after stopping to input voltage to MTQ to be stabilize output voltage of GAS. This waiting time is revealed to be more than 200 msec by our measurement. And we implemented de-tumbling-mode used to stop rotation of the satellite, unloading-mode used to unload when the rotation per minutes of RW is saturated, and manual-mode used to assign directly the effective voltage to input MTQ as attitude control using MTQ.

RW is a device to generate a control torque from the reaction of a rotor which is accelerated by a motor and is controlled by transmitting commands from the OBC by serial communication under RS-422 standard. The unit test has already been carried out by substituting OBC for PC, however the cable has a bad influence on the operation because RW is a rotating object. Therefore, we studied and constructed a system for wirelessly connecting the RW and PC by making the RS-422 communication wireless. Specifically, commands from the PC are wirelessly transmitted to Arduino by XBee, and the RW is controlled via the RS-422 transceiver. We use air-bearing for the operation test to reduce friction.

GYR have characteristics that fluctuate the bias voltage is fluctuated in a stationary state and it is also

changed by temperature change. To reduce the fluctuation, we multiply the bias voltage by the average used the program implemented on microcomputer in a stationary state. We calculated the correction function basis on the measurement result of the GYR’ s bias voltage by temperature change.

In the future, we plan to evaluate de-tumbling-mode and unloading-mode implemented to MC, evaluate RW by performing the operation test using the wireless RS-422 communication system, make circuit board for satellite to mount GYR.

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