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# SLIDING MODE ATTITUDE CONTROL OF CUBESAT WITH MAGNETORQUERS

**Abstract**

Attitude Control Systems (ACS) are commonly used in satellites with payloads which depend on the attitude, such as cameras, or with highly directional antennas. Low Earth Orbit (LEO) satellites can use the Earth's magnetic field for attitude control by actuating with magnetorquers, however this method has reduced controllability. This ACS is designed for the AAUSAT3 and AAUSAT4 satellites, placed in a polar LEO in a height of 780 km with an orbit time of 6000 seconds. Here, a study of a stable Sliding Mode Controller (SMC) for a magnetorquer-actuated satellite with CubeSat dimensions is reported, with comparison to the performance of a standard PID controller.

We compare convergence rate and the energy dissipated in the magnetorquers of a SMC to a constant gain Linear Quadratic Controller (LQC). The convergence rate is described by the time used to align the satellite's body axes within 10 degrees of the orbit axes from any initial orientation after detumbling. The results are averaged over multiple simulations of the satellite in an environment disturbed by gravity gradient, aerodynamic drag, solar radiation and residuel dipole. Robustness of the SMC has been secured by investegating a Lyapunov function candidate. The simulation results shows the SMC reaching the reference attitude three times as fast as the LQC. The maximum axis-wise deviation of the satellite attitude from the reference attitude, after settling, is better with a factor of two in favor of the SMC.

The energy dissipation is described by two periods; the energy used to reach a specific attitude and the energy used to maintain this attitude. The average power used for the satellite while converging towards the reference attitude is nearly the same for the two control structures, but as a result of the faster convergence rate with the SMC this uses less energy. Once settled the SMC uses less than half the energy maintaining the attitude compared to the LQC.

The results shows an advantage of the SMC when considering convergence time and energy dissipation, which is greatly improved compared to a LQC. Furthermore the error in pointing accuracy decreases by a factor of two.