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SINGULAR STEERING LOGIC ANALYSIS USING CONTROL MOMENT GYROS FOR NANO-SATELLITE TSUBAME

Abstract

The Laboratory of Space Systems (LSS) at the Tokyo Institute of Technology has successfully developed and launched three small satellites. TSUBAME is the forth satellite that used as an engineering demonstration satellite for earth and celestial observation. Since these observation tasks of Nano satellite require rapid multi-target acquisition and high pointing accuracy, the single-gimbal control moment gyro (CMG) is considered as ideal torque-generating actuator due to its practical performance for the satellite. However, a singularity problem inherent in the system needs to be passing through or escaping from. This paper focuses on presenting two simple yet effective methods to solve the singularity problem for TSUBAME. The proposed approach is based on the singularity robust inverse which is called mixed-two-norm, least-square minimization method and original SDA (singularity direction avoidance) steering logic, respectively. The stability proof is based on a Lyapunov analysis and the properties of the quaternion representation of the satellite dynamics. Numerical simulations are included to illustrate the satellite performance of the steering logic.