ADCS of THNS-1 Nanosatellite with Off-Pointing Capability

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One of the broad objectives of the THNS-1 nanosatellite, which mass will be less 5kg, is to demonstrate the availability of micro/nano-technology.

The attitude control system has a three-axis magnetometer, four two-axis sun sensors and a MIMU for providing an attitude knowledge. The extended Kalman filter will be used for determining the attitude angles and attitude velocity. Three reaction wheels will be used to perform off-nadir pointing manoeuvres with magnetorquers for momentum dumping. A gravity gradient boom with top mass, which was successfully used on many microsatellites in the world, will be used for passive nadir pointing stabilisation.

Computer simulations were used to analyse several possible attitude control modes, including: 1)nadir pointing control using the magnetorquers to assist the deployed gravity gradient boom, 2) nadir pointing control using the reaction wheels with the deployed gravity gradient boom, and 3) large angle maneuver within +/-15 degrees about the roll-axis using the reaction wheels with the deployed gravity gradient boom. A bang-bang controller was used for the first mode, whilst a quaternion feedback controller for the second and the third modes. In particular, a time-optimal controller and an energy-optimal controller were used for simulating the roll-axis maneuver mode. The optimal control rules of the reaction wheels are obtained via solving the two-point boundary-value problems. A genetic algorithm was included the solving process so that any initial values guesses were not needed. The simulation results are shown in the following figures (Fig.1-2 for the energy-optimal control, and Fig. 3-4 for the time-optimal control).

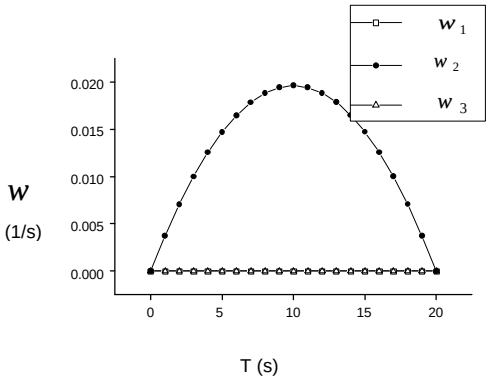

Fig.1 Variation of the angular velocities

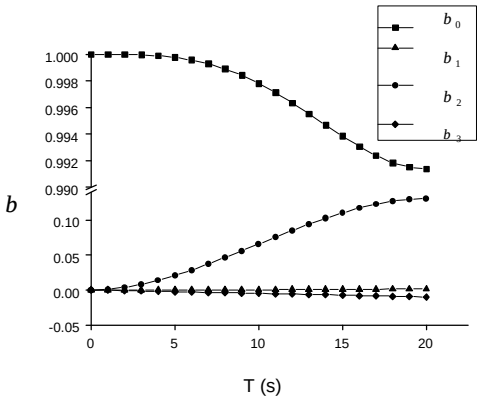

Fig. 2 Variation of the quaternion

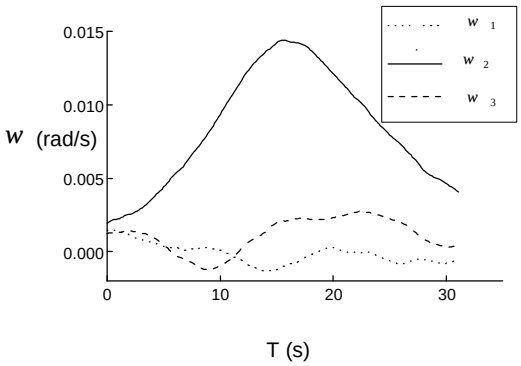

Fig.3 Variation of the angular velocities

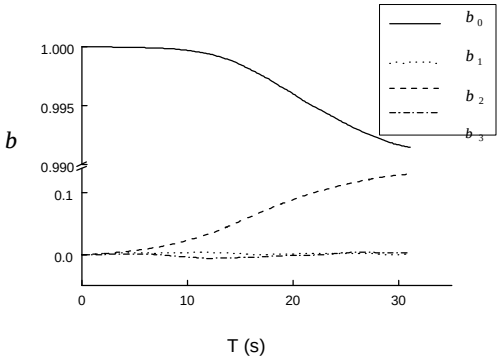

Fig. 4 Variation of the quaternion