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# ROBUST NONLINEAR CONTROL OF UNDERACTUATED SPACECRAFT USING A SINGLE THRUSTER

**Abstract**

Underactuation presents a major challenge in stability analysis, control, and performance of dynamical spacecraft systems. Albeit, spacecraft systems equipped with underactuated control system are substantially cheaper, lighter than its fully-actuated counterpart, and plays a role of fail safe in failure recovery subsystem. The complexity of this problem is a major contribution as to why there have not been considerable research in the topic compared to fully-actuated dynamical systems. The system in study is an underactuated small satellite orbiting around Earth where the available control torque is present in only two of the three principal axes for attitude reorientation. This paper proposes a robust nonlinear attitude control algorithm, specifically sliding mode control, for an underactuated spacecraft using a gimbaled single thruster. The stability of the sliding mode control law is examined using Lyapunov stability analysis and it is shown that the system converges to an equilibrium set in finite time. The proposed nonlinear attitude control system is assessed for performance through various simulated cases; namely, nominal, added time-varying disturbances, and non-eccentric orbit. Results from the performance analysis indicate the underactuated spacecraft converges to a bounded non-zero equilibrium set.