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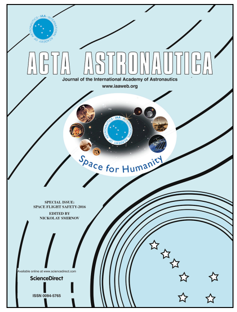


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# FAULT-TOLERANT ATTITUDE CONTROL OF MINIATURE SATELLITES USING REACTION WHEELS

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**An adaptive fault-tolerant nonlinear control scheme is proposed for precise 3-axis attitude tracking of miniature spacecraft in the presence of control input saturation, model uncertainties, external disturbances, and reaction wheel faults. Two configurations of reaction wheel assembly are examined in this chapter, (A1) Traditional four wheel setup where three reaction wheels are in orthogonal configuration along with one oblique wheel; and (A2) Four wheels in a pyramid configuration. Multiplicative reaction wheel faults are considered along with complete failure of one wheel (A1) and two wheels (A2). The proposed control algorithm does not require an explicit fault detection and isolation mechanism and therefore failure time instants, patterns, and values of actuator failures remain unknown to the designer. The stability conditions for robustness against model uncertainties and external disturbances are derived using Lyapunov stability theory to establish the regions of asymptotic stabilization. The benefits of the proposed control methodology are analytically authenticated and also validated using hardware-in-the-loop simulations. The experimental results clearly establish the robustness of the proposed autonomous control algorithm for precise attitude tracking in the event of reaction wheel faults and failures.**

## I. Introduction

Recent advances in micro and nano-technology have succeeded in changing the focus of both commercial and military aerospace industries toward smaller, lower-cost spacecraft design. Scientific payloads onboard a spacecraft for Earth observation and space monitoring rely on the attitude control system to be oriented towards a prescribed direction with high accuracy to increase the operational envelope and efficiency of miniature satellites. Most of the earlier and current spacecraft control systems generally employ redundant actuators to achieve required reliability utilizing various linear and nonlinear control algorithms. These conventional feedback control designs may result in unsatisfactory performance and instability, in the event

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