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Attitude Acquisition from an Arbitrary Tumbling State using Two Skewed Reaction Wheels

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Abstract

A novel technique has been designed that creates rapid nutation damping and accurate spin rate control for a spacecraft with arbitrary inertia ratio. In this approach the satellite incorporates two symmetrically inclined reaction wheels in a V configuration and stabilization is achieved by simultaneously controlling the angular velocity of the satellite and the wheels. The method furnishes gyroscopic stiffness and steers interchange of momentum between the wheels and the satellite main body. A Monte Carlo type approach is used to verify stability and it is shown that the controller provides automatically logical recovery of the desired spin for any initial state and inertia ratio. Moreover, results of single wheel simulations demonstrate the efficacy of the proposed concept.

Keywords: Attitude Acquisition; Active Nutation Control; V-configuration Reaction Wheels; Attitude Control

I.Introduction

Disturbance torques during the deployment of a satellite can result in a tumbling motion, which leads to high angular rates. Moreover, active nutation damping to acquire operational nutation angles from any initial tip-off conditions in a sufficiently short time is crucial at times. Small satellites are currently being used in different mission regimes that need fast detumbling maneuver capabilities. Detumbling consists of damping some or all angular velocity components of the satellite to zero. In this work, the stabilization of the satellite can be obtained by damping all angular velocity components of the satellite and the spin rate becomes controllable when two wheels are installed in a V configuration. Therefore the proposed control laws are applicable for both spin stabilized and three-axis momentum-biased satellites.

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