Paper ID: 10763
student

ASTRODYNAMICS SYMPOSIUM (C1)
Guidance, Navigation and Control - Part 3 (9)

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AN ON-ORBIT MASS PROPERTIES IDENTIFICATION ALGORITHM FOR LARGE SPACE STRUCTURES

Abstract

The mass properties of a spacecraft, consisting of inertia matrix, center of mass position and total mass, are necessary for system controller design. However, during flight especially when docking, it is impractical to measure varying mass properties for large space structures such as space stations. These considerations have led to the development of an algorithm for the on-orbit determination of vehicle mass properties applicable to vehicles using reaction control. The purpose of this paper is to address the problem of identifying mass properties of large space structures with unknown energy-dissipating torques. For such system, many existing identification methods are inadequate for their complexity or lack of completeness and feasibility analysis. In contrast, the method proposed here is based on a full dynamic model holding the disturbing torques and theoretical validation. It includes two schemes considering different actuators: one employs angular rate gyro data and thruster outputs, while the other uses accelerometer, angular rate gyro data and control moment gyro outputs. The momentum and angular momentum equations of the structure in different situations are derived for identification, taking into account gravitational and aerodynamic moments. After linear and integral transformations, a recursive least squares algorithm is then developed to identify the inertia matrix and center of mass simultaneously, which was not covered in previous researches. Mass identification is in the combination of the preceding estimation results. Observability and reliability of mass properties identification in a theoretical context is then analyzed via error matrix. At last, Simulation results show that the proposed approach is simple and effective, making it suitable for on-board real-time computation.