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IN-ORBIT IDENTIFICATION OF MOMENT OF INERTIA MATRIX FOR HIGH POINTING SATELLITES

Abstract

The Remote Sensing class of spacecraft requires high pointing control, stability and fast maneuvers for the various remote sensing/science payloads. During different mission phases, several Attitude Control System and fault detection algorithms onboard the spacecraft require accurate knowledge of the spacecraft 3-by-3 inertia matrix. Before launch, the inertia matrix of the spacecraft is estimated by adding together the moments of inertia of the individual components of the spacecraft. The moments of inertia of individual components are computed with respect to the predicted center of mass of the overall spacecraft before being summed. During the mission life the Spacecraft inertia changes due to fuel depletion. It necessitates estimating inertia accurately using on-orbit data. This paper details the Extended Kalman filter based inertia matrix estimation algorithm formulation, design, analysis and simulation results. The spacecraft is in closed loop controlled mode and the desired sinusoidal three axis persistent torque excitation is provided by selecting appropriate reference rates. The three axes computed control torque (realized using reaction wheels) and gyro measured spacecraft rates are used as the inputs for the algorithm. The algorithm estimates the diagonal inertia elements to an accuracy of 1.5% of actual values. Extensive simulation studies show that estimated inertia is the actual inertia plus the contribution due to the constant wheel torque scale factor. It is proposed not to compensate for the wheel torque scale factor in the estimation algorithm. Since the estimated inertia is used in the feed forward torque computation, the extra torque component gets nullified by wheel scale factor and the desired feed forward torque will be realized on the Spacecraft. A case study was done for Cartosat-2 mission which is a high resolution earth imaging satellite providing better than one meter panchromatic imaging capability using 2.5m camera. Considerable reduction in targeting errors was observed on up linking the estimated inertia by the proposed algorithm for feed forward torque computation.