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DETERMINATION OF SPACECRAFT INERTIAL PARAMETERS ON BOARD.

Abstract

In the proposed paper an algorithm for the determination of inertial parameters of a spacecraft (SC), i.e. its inertia tensor and center of mass position is suggested. In most cases knowledge of exact values of the inertial parameters is not very important, as the attitude of the SC is controlled by an automatic control system. But in some cases knowing exact inertial parameters values might be necessary. Inertial parameters can be calculated before launch, when the exact mass distribution within the SC is known. But mass distribution may change during flight, for example due to fuel depletion or due to loading/unloading of cargo. So it might be necessary to determine inertial parameters on board the SC during flight. Similar problems may arise when assembling large structures in space in near Earth (or other) orbits. In this paper the problem of the determination of the inertia tensor and center of mass position during the autonomous functioning of a SC is examined. Developed methods are designed for a class of SCs equipped with angular rate sensors and a system providing SC spin mode. A set of algorithms, developed to solve inertial parameters determination problems with different levels of accuracy and for different classes of spacecrafts is presented. These algorithms use SC angular velocity measurements, provided by angular rate sensors as input data for the determination of the SC inertia tensor. To determine the center of mass position optical sensor measurements, tracking directions to natural celestial objects are used as well. The algorithms are based on the idea of representing Euler equations solution as a harmonic sequence, or on numerical integration of these equations. The case of free precession of a SC is analyzed, as well as precession with small perturbations caused by the gravity field, solar radiation pressure and/or atmospheric drag. An analysis of the accuracy of the inertial parameters determination, for different flight situations, different classes of SC, depending on the accuracy of measurements, measurement period duration and other factors is presented.