IAF ASTRODYNAMICS SYMPOSIUM (C1)
Attitude Dynamics (1) (5)

Author: Dr. Danil Ivanov
Keldysh Institute of Applied Mathematics, RAS, Russian Federation, danilivanovs@gmail.com

Dr. Stepan Tkachev
Keldysh Institute of Applied Mathematics, RAS, Russian Federation, stevens_l@mail.ru
Prof. Mikhail Ovchinnikov
Keldysh Institute of Applied Mathematics, RAS, Russian Federation, ovchinni@keldysh.ru
Mr. Aleksey Shestopyorov
Keldysh Institute of Applied Mathematics, RAS, Russian Federation, alex.shestoperov@yandex.ru
Dr. Andrey Ovchinnikov
JSC Reshetnev Information Satellite System, Russian Federation, a.v.ovchinnikov@iss-reshetnev.ru
Dr. Sergey Meus
JSC Reshetnev Information Satellite System, Russian Federation, meus@iss-reshetnev.ru
Dr. Evgenii Yakimov
JSC Reshetnev Information Satellite System, Russian Federation, yen@iss-reshetnev.ru
Dr. Dmitry Roldugin
Keldysh Institute of Applied Mathematics of RAS, Russian Federation, rolduginds@gmail.com
Mr. Sergey Shestakov
Keldysh Institute of Applied Mathematics of RAS, Russian Federation, shestakov.sa@gmail.com
Dr. Anna Nuralieva
Keldysh Institute of Applied Mathematics of RAS, Russian Federation, annanuralieva@yandex.ru

COUPLED MOTION DETERMINATION AND STABILIZATION OF A SATELLITE EQUIPPED WITH LARGE FLEXIBLE ELEMENTS USING ADCS ONLY

Abstract

Satellites with flexible elements are used to solve a variety of applied problems. Such satellites includes telecommunication satellites with large-sized antennas, deep-space research satellites with solar sails, and satellites with robotic manipulators and external rods. During orbital and angular satellite maneuvering the vibrations inevitably excite due to the large dimensions of flexible elements, which are often made of light materials. These vibrations can not only degrade the accuracy of attitude of the entire satellites, but even lead to instability of the required motion. The installation of special damping actuators is desirable for damping low-frequency oscillations in the flexible elements. Usually piezoelectric devices installed on the non-rigid elements are used for this task. However, the case when the satellite is controlled using only the ADCS located on the main satellite body is of practical interest.

The paper considers the rigid satellite with a set of flexible elements attached to its body. The flexible motion determination along with attitude motion of the main body is estimated in real time using measurements of the star tracker and angular velocity sensor only. The damping of the oscillations and attitude stabilization in the orbital reference frame is performed by reaction wheels installed on the main body. The dependence of the flexible motion determination accuracy on the number of estimated vibration modes is studied. The comparison between the achieved motion determination accuracy using measurements of ADS sensors and using extra measurements of accelerometers installed on flexible elements or optical measurements is presented. A set of control algorithms based on LQR are proposed in

the paper. Its convergence rate and final stabilization accuracy taking into account inaccuracy in motion estimation and unknown disturbances are studied. The problem of the isolated vibration modes that have small influence on the main body motion is discussed.