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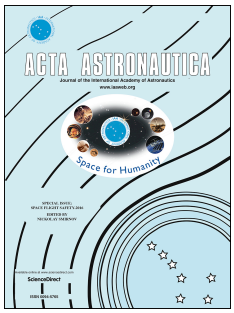

Asymptotic stability of a satellite with electrodynamic attitude control in the orbital frame

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Asymptotic stability of a satellite with electrodynamic attitude control in the orbital frame

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Abstract

A satellite in a circular near-Earth orbit is under consideration. The three-axis stabilization of the satellite in the orbital coordinate system with the use of electrodynamic attitude control system is studied. No constraints are imposed on the Earth's magnetic field approximation. The gravity gradient disturbing torque acting on the satellite attitude dynamics is taken into account as the largest disturbing torque. With the use of the Lyapunov direct method, conditions under which electrodynamic control solves the problem are obtained. The restrictions on the control parameter values for which one can guarantee the asymptotic stability of the programmed satellite motion are found and represented in an explicit form. Comparison of the results of numerical simulation and analytical investigation demonstrate effectiveness of the proposed approach.

Keywords: Satellite, Attitude stabilization, Geomagnetic field, Asymptotic stability
2010 MSC: 70E17, 70K20, 70Q05, 93C15, 93D21

1. Introduction

Electrodynamic effects caused by interaction of a satellite with the geomagnetic field is a secure basis for a variety of potent control tools developed for spacecraft missions.

Magnetic attitude control systems based on interaction of the intrinsic magnetic moment of the satellite with the geomagnetic field do not require working body consumption and can be successfully applied to long-operating satellites [1–3]. They are quite simple, have low cost, mass, power consumption, small sizes and high reliability [4, 5]. This comes at the cost of underactuation since control torque is always perpendicular to the local geomagnetic induction vector

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