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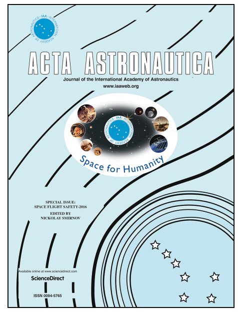

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Dynamics and Control of High Area-to-mass Ratio Spacecraft and Its Application to Geomagnetic Exploration

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Abstract

This paper studies the dynamics and control of a spacecraft, whose area-to-mass ratio is increased by deploying a reflective orientable surface such as a solar sail or **a** solar panel. The dynamical system describing the motion of a non-zero attitude angle high area-to-mass ratio spacecraft under the effects of the Earth's oblateness and solar radiation pressure admits the existence of equilibrium points, **whose** number and the eccentricity values depend on the semi-major axis, **the** area-to-mass ratio and **the** attitude angle of **the** spacecraft together. When two out of three parameters are fixed, five different dynamical topologies successively occur through varying the third parameter. Two of these five topologies are critical cases characterized by the appearance of the bifurcation phenomena. A conventional Hamiltonian structure-preserving (HSP) controller and an improved HSP controller are both constructed to stabilize the hyperbolic equilibrium point. Through the use of a conventional HSP controller, a bounded trajectory around the hyperbolic equilibrium point is obtained, while an improved HSP controller allows the spacecraft to easily transfer to the hyperbolic equilibrium point and to follow varying equilibrium points. A bifurcation control using topologies and changes of behavior areas can also stabilize a spacecraft near a hyperbolic equilibrium point. Natural trajectories around stable equilibrium point and these stabilized trajectories around hyperbolic equilibrium point can all be applied to geomagnetic exploration.

Key Words: High area-to-mass ratio spacecraft, Hyperbolic equilibrium point, Hamiltonian structure-preserving control, Bifurcation control, Geomagnetic exploration

1. Introduction

Orbital eccentricity long-term oscillations have been observed in gentle inclined orbit behaviour of satellites such as the ECHO balloon [1] and Vanguard [2]. This orbital dynamic system can be described by a Hamiltonian function written in two variables, the osculating orbit eccentricity e and the solar angle Φ between the direction of