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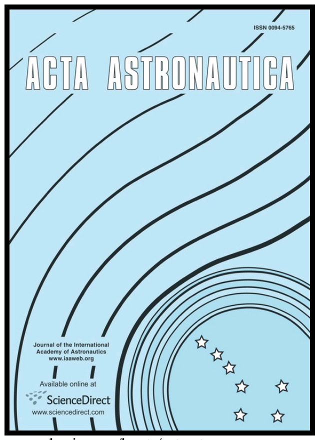

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Robust Optimal Sun-Pointing Control of a Large Solar Power Satellite

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ABSTRACT

The robust optimal sun-pointing control strategy for a large geostationary solar power satellite (SPS) is addressed in this paper. The SPS is considered as a huge rigid body, and the sun-pointing dynamics are firstly proposed in the state space representation. The perturbation effects caused by gravity gradient, solar radiation pressure and microwave reaction are investigated. To perform sun-pointing maneuvers, a periodically time-varying robust optimal LQR controller is designed to assess the pointing accuracy and the control inputs. It should be noted that, to reduce the pointing errors, the disturbance rejection technique is combined into the proposed LQR controller. A recursive algorithm is then proposed to solve the optimal LQR control gain. Simulation results are finally provided to illustrate the performance of the proposed closed-loop system.

Keywords: Solar power satellite; Space solar power station; Attitude dynamics; Optimal control; LQR

1. Introduction

Recent years have witnessed the resurgence of space-based solar power research, and in particular the solar power satellite (SPS) paradigm has received much attention due to its potential for generating large amounts of clean electrical power. The SPS concept, firstly proposed by Peter Glaser in 1968 [1], consists of three main components: a solar array to collect solar radiation and convert it into direct current (DC) electricity, a DC-to-microwave converter and an antenna that directs a microwave beam towards the surface of the Earth. The main benefits of a SPS as opposed to a solar power system on the ground are that sunlight is not attenuated by the Earth's atmosphere, collection is not influenced by the day-night cycle and the SPS has higher end-to-end efficiency [2-3].