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DYNAMICS AND CONTROL OF SOLAR POWER SATELLITES

Abstract

The aim of this effort is investigating the long term orbit-attitude coupled rotational dynamics and control of solar power satellites (SPS) in geosynchronous orbit (GEO). The challenge in this effort is the fact that solar power satellites are large structures. As an example, the 5 km by 15 km Integrated Symmetric Concentrator SPS concept employs lightweight mirrors in a GEO orbit. Because these large structures can't be launched as a single piece, satellites need to be assembled in space. Therefore, gravity gradient stabilized orbit approach will be employed initially. Since there will be no attitude requirements, building satellite on orbit will be less complex. The satellite will be modeled as a flexible structure with a particular shape. The disturbance torques will be gravity gradient torque, solar radiation pressure, and the torque due to the microwave beam to the Earth's surface. The gravity gradient torque is due to nonhomogeneous mass of the satellite, and differential distance to the center of Earth. Solar radiation pressure and microwave beam torques affect the satellite because the center of pressure is not the same point with the center of mass of the satellite. Different shape models will be rigorously tested under these perturbations. First part of the paper is the investigation of the dynamics of the solar power satellites. Then, the system analysis of the satellite will be conducted. The stability of the attitude of the satellite will be analyzed under the disturbances. After that, the control synthesis for the satellite will be employed. For desired dynamics behavior of the satellite, linearized optimal control methods will be investigated. Finally, precise modeling of the disturbance environment, such as variable solar radiation pressure during penumbra/umbra conditions, will be added to the simulations. In addition, previous work related to the paper will be re-examined.