20th IAA SYMPOSIUM ON VISIONS AND STRATEGIES FOR THE FUTURE (D4)
Modern Day Space Elevators Entering Development (3)

Author: Dr. Francisco Salazar
National Institute for Space Research - INPE , Brazil

Dr. Antonio Fernando Bertachini Almeida Prado
Instituto Nacional de Pesquisas Espaciais (INPE), Brazil

STRATEGIES FOR NON-PLANAR CONFIGURATIONS OF GEOSTATIONARY TETHERED COLLECTING SOLAR POWER SATELLITE SYSTEMS

Abstract

To collect additional solar energy during the hours of darkness and to overcome the limited Terrestrial solar power due to the diurnal day–night cycle, the concept of a Geostationary Tethered Collecting Solar Power Satellite System has been proposed by several authors in the last years. This tethered system consists of a long tether used to link two bodies: a single large panel with a capability of collecting solar energy, and an Earth-pointing microwave transmitting satellite. In this manner, the solar energy would be collected directly from the space and beamed back down to any point on Earth. Planar configurations, when the panel and the microwave transmitting satellite are placed on geostationary orbits, have been usually investigated to maintain the tethered system around the Earth. However, this configuration implies that the panel and the microwave transmitting satellite must to orbit the Earth in exactly the same orbital plane of all geostationary satellites. However, the geostationary band is getting more crowded every year. Thus, non-planar configurations in geostationary orbits (e.g. Displaced Geostationary Orbits, Light-Levitated Geostationary Cylindrical Orbits) have been studied by various authors to increase the number of slots over a particular longitude. In this paper, we consider both in-plane and out-of-plane librations, and derive a linear control strategy for a non-planar configuration of a tethered collecting solar power system. The microwave transmitting satellite is placed on a geostationary orbit, and the panel, perturbed by the solar radiation pressure, achieves a specific stable out-of-plane configuration applying a tension control law in conjunction with out-of-plane thrusting. The tension control law and the out-of-plane thrust are derived from the linearization of the governing nonlinear differential equations about an out-of-plane equilibrium point, so that the equilibrium solution is asymptotically stable. The numerical simulations show that the linear control strategy designed from this approach performs well for the nonlinear system, and the solar power system can be guided to the desired non-planar configuration.