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SPACE POWER SYMPOSIUM (C3)
Space-Based Solar Power Architectures – New Governmental and Commercial Concepts and Ventures (1)

Author: Mr. Ian McNally
University of Glasgow, United Kingdom, i.mcnally.1@research.gla.ac.uk

Prof. Daniel Scheeres
Colorado Center for Astrodynamics Research, University of Colorado, United States,
scheeres@colorado.edu
Prof. Gianmarco Radice
University of Glasgow, United Kingdom, Gianmarco.Radice@glasgow.ac.uk
Dr. Matteo Ceriotti
University of Glasgow, United Kingdom, matteo.ceriotti@glasgow.ac.uk

ATTITUDE AND ORBITAL DYNAMICS OF LARGE SOLAR POWER SATELLITES

Abstract

In contrast to existing power sources, solar power from space is highly promising in its 24-hour power supply capability and CO2 clean nature as a new energy system that can guarantee the sustainable development of our planet. In space, collection of the Sun's energy is unaffected by the various obstructions which reduce efficiency or capacities of Earth surface solar power collection. The solar power satellite (SPS) is conceptually simple: a large satellite designed to act as an electric power plant in orbit. It consists of three main segments: a solar energy collector to convert the solar energy into direct current (DC) electricity, a DC-to-microwave converter, and a large antenna which beams the microwave power to the ground. Designs for geostationary SPS are extremely large in scale, more than an order of magnitude larger than the International Space Station. The problem of how to control the orbital and attitude motion of such large structures, accounting for various perturbing forces, is therefore a topic worthy of further study. The primary objective of the proposed research is to perform a detailed study of SPS orbit and attitude dynamics, obtaining a comprehensive understanding of the effect of perturbations on orbits of large SPS structures over a time-frame commensurate with proposed SPS lifetimes (30-40 years). Analytical equations derived by the process of averaging of the SPS equations of motion shall be used in determining the long-term orbital behaviour. The attitude dynamics and stability of SPS designs including the Abacus, SunTower, and Integrated Symmetrical Concentrator SPS shall be assessed. Previous studies have simply assumed a geostationary orbit (GEO) then designed control systems for maintaining it thus. It may be possible to identify a superior option in terms of the orbital mechanics. Therefore, once the orbital evolution is attained, possible alterations to the nominal GEO may be made and suitable control strategies to maintain the orbit will be derived. The paper will also consider the consequences of possible failures, which would lead to uncontrolled orbital evolution thus jeopardising other missions. The minimum backup system configuration that would be necessary to ensure mission safety and determine the performance levels of a malfunctioning SPS shall also be determined.