IAF ASTRODYNAMICS SYMPOSIUM (C1)
Attitude Dynamics (1) (1)

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THE EFFECTS OF POINTING ERROR SOURCES ON ENERGY DELIVERY FROM ORBITING SOLAR REFLECTORS

Abstract

Many proposals are being made for cleaner, more sustainable forms of energy production. Terrestrial solar photovoltaic (PV) farms could potentially deliver large quantities of energy to the grid, although these are limited to daytime use. The output from these PV farms could be enhanced, particularly around dawn and dusk, by the use of orbiting reflectors in polar orbit. These would reflect an image of the solar disk onto the PV farm to augment their energy output.

Pointing requirements are therefore to ensure that reflected sunlight is delivered to the terrestrial PV farm, avoiding the losses incurred by an offset of the image of the solar disk and the PV farm itself. The image of the solar disk would typically be of order 10 km for a reflector in a 1000 km orbit. Given the potentially large size of the reflectors, this presents a challenge for the attitude determination and control systems (ADCS) to ensure that the maximum quantity of energy can be delivered to a PV farm, typically requiring large control moment gyro actuators [1]. In addition, there exist numerous sources of error in the ADCS which can cause further degradation in the quantity of energy delivered to the PV farm. These errors can manifest in the resolution of the various sensors, flexible structural modes, manufacturing inaccuracies, and misalignments due to vibration during launch.

This paper will investigate the effects of pointing error sources on the reflector ADCS and so on the quantity of energy delivered to the PV farm. The reflectors in this paper will be hexagonal in shape with a side length of 250 m [2]. Initially, a pointing error analysis will be conducted using the pointing error engineering tool (PEET), developed by Astos Solutions to implement the common European cooperation for space standardisation (ECSS) pointing error framework. Following this, numerical simulations will show the typical losses in energy delivered to PV farms when the model accounts for pointing error sources in onboard sensors, actuator uncertainty and flexible structural modes.

References

[1] Viale, A., McInnes, C. R. (2023). Attitude control actuator scaling laws for orbiting solar reflectors. Advances in Space Research, 71(1), 604-623.
[2] Viale, A., Çelik, O., Oderinwale, T., Sulbhewar, L., McInnes, C. R. (2023). A reference architecture for orbiting solar reflectors to enhance terrestrial solar power plant output. Advances in Space Research

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