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CONTROLLABILITY OF ORBITING SOLAR REFLECTORS UNDER STRUCTURAL FAILURES.

Abstract

The transition to a clean energy future can be aided using orbiting solar reflectors (OSRs) to augment the output of existing and future terrestrial solar power farms (SPFs) (Çelik McInnes, 2022). Given that the terrestrial SPFs are already in existence and with plans for more and larger SPFs in the future, their development is uncoupled from the development of the in-orbit infrastructure required for the OSR concept.

A defining feature of the OSR is their size. A reference architecture for the SOLSPACE project has shown the capabilities of a hexagonal OSR of 250 m side length (Viale et al., 2023). The proposed structure consists of six radial beams connected at a central joint and which are also connected by five levels of transversal beams. This structure is proposed to be assembled or manufactured in orbit, which removes the complexity of packing and deployment. Given their size, they are prone to impacts of micro-meteoroids and space debris . The effects can range from the deterioration of the reflector membrane to damage to the supporting structure. Additionally, manufacturing errors may lead to the failure of one of more beam joints.

First, a study of the robustness of the controller to uncertainties in the OSR inertia tensor will be made, which will be a direct follow-on to the previous work of these authors (Moore et al., 2023). Following this, the controllability of the OSR with varying centre of pressure due to degradation of the sail membrane, which results from micro-meteoroid or space debris impact, will be analysed. Finally, a Finite Element Model (FEM) will provide the coupling coefficients of the structural and rotational dynamics where the OSR supporting structure has suffered a range of failures. A fault tree analysis will be performed and the impact on the OSR control for each failure mode will be defined. The objective will be to show under which failures the OSR remains controllable and which failures would terminate the mission.

References

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Viale, A. *et al.* (2023). A reference architecture for orbiting solar reflectors to enhance terrestrial solar power plant output. Advances in Space Research, 72(4), 1304–1348.