Paper ID: 82967
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IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Interactive Presentations - IAF MATERIALS AND STRUCTURES SYMPOSIUM (IPB)

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FEASIBILITY EVALUATION OF THE SCISSOR PETAL REFLECTOR CONCEPT

Abstract

Large-aperture deployable reflector antennas face a growing demand for extremely high-frequency radio waves, necessitating highly accurate reflector surfaces. Mainstream deployable reflectors, using flexible metal mesh, suffer from drawbacks: allowing high-frequency wave passage and struggling with surface accuracy due to flexibility. Hence, solid-surface deployable reflector antennas have gained attention, but face challenges in packing efficiency due to their rigidity. Traditional designs segment mirror surfaces into petals, complicating efforts to reduce stowage diameter and height concurrently.

We propose the Scissor Petal Reflector, a novel structural concept aimed at enhancing packing efficiency. This design integrates a scissor structure, consisting of a pair of crossed bars connected by rotational joints, into the support system of the petal reflector. It aims to improve packing efficiency by linking the scissor stowage and deployment movements with the petal.

The Scissor Petal Reflector comprises a central hub, petals surrounding the hub, scissor ribs supporting the petals, and scissor hoops connecting the ribs. The petals are hinge-connected to the scissor ribs on their backsides, while the roots of the scissor ribs connect to the central hub, which has a vertical slide guide. During stowage, lowering the hub's guide from the deployed state causes the scissor ribs to retract toward the central hub, resulting in the petals rising from a horizontal to a vertical configuration. Subsequently, the petals rotate around their hinge connections, overlapping and converging towards the hub's center to achieve the stowed state. Deployment follows the reverse process: as the guide moves upward, the scissor ribs expand away from the central hub, transitioning the petals from vertical to horizontal. Finally, the petals unfold, forming a parabolic surface supported by the scissor hoops, completing the deployment process.

We validated this concept through CAD modeling and motion analysis for stowage and deployment. Additionally, a physical model was 3D printed based on the CAD design to verify stowage and deployment operations. These studies established the detailed deployment mechanism of the Scissor Petal Reflector. Geometric considerations suggested the possibility of improving both width and height packing efficiency through adjustments in petal segmentation, aperture size, and scissor thickness. This research demonstrates the feasibility of our proposed solid-surface deployable reflector concept.