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IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures II - Development and Verification (Deployable and Dimensionally Stable Structures) (2)

Author: Ms. Annalisa Tresoldi
University of Auckland, New Zealand, atre682@aucklanduni.ac.nz

Dr. Andrew C. M. Austin
University of Auckland, New Zealand, a.austin@auckland.ac.nz
Prof. Guglielmo S Aglietti
University of Auckland, New Zealand, g.aglietti@auckland.ac.nz
Dr. Jason Shore
University of Auckland, New Zealand, jason.shore@auckland.ac.nz

DEVELOPMENT OF A DEPLOYABLE SYNTHETIC APERTURE RADAR ANTENNA FOR A NANOSATELLITE CONCEPTUAL DESIGN.

Abstract

Synthetic Aperture Radar (SAR) technology is widely applied in Earth Observation missions providing all-weather day/night imaging capability not possible with optical systems. The frequency of observations and coverage capabilities have recently increased thanks to the cost-effective deployment of radar constellations enabled by CubeSats satellites. Low-cost missions and easier access to space strengthen the demand for spaceborne radar applications. However, SAR technology is complex and poses severe constraints in payload size and resource that are compounded when a CubeSat platform is considered. Accordingly, this work focuses on developing a viable concept design for a deployable SAR antenna to fit in a CubeSat design space (potentially ≤12U). Low-mass, low stow-volume, and high packaging efficiency are critical requirements to counter the physical constraints of a nanosatellite and compactly stow the instrumentation during launch. However, a large antenna aperture is important in orbit to enhance SAR performance. From a trade-off study of potential deployable antenna architectures and technologies, a reflectarray with a flexible and self-deployable system is considered the most promising solution for this application. This paper will present a flexible and passive deployable antenna structure to accommodate a SAR system with a simple and mechanically low-complex solution. A theoretical model will be implemented to study the elastic behaviour of the structure in terms of bending and twisting strain energy releasement. A finite element model will also be presented to validate the analytical model. The passive deployment system aims to be actuated by Commercial Off-The-Shelf components (COTS). A small number of pre-loaded torsional springs will assist the deployment through the release of the elastic energy stored in the flexible components of the system. The concept uses appropriate lightweight composite materials with elastic and viscous properties to enable and control the deployment after the stowage period, and until the final stage of tensioning. To achieve this, the antenna structure can be developed using either a flexible membrane architecture or a large-scale tape spring. A folded panel structure connected by a flexible hinged system is also proposed as a potential solution. This study seeks to provide a baseline antenna concept design that maximizes deployable structures capabilities and SAR performance. The eventual objectives of this research are real-time maritime surveillance in the extended territorial waters of New Zealand, and long-term measurements of Earth deformation using persistent-scatterer techniques.