**Design of a Spiral Antenna Target for Calibrating SAR Images used in Material Characterization**

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ABSTRACT

Synthetic Aperture Radar (SAR) imaging has become indispensable in many microwave and millimeter-wave nondestructive testing and evaluation applications. Typically, SAR imaging techniques produce a contrast image of changes in the reflectivity or scattering of the target. Additionally, when the image is calibrated using reference targets with known reflectivity, it becomes possible to accurately extract microwave material properties such as complex permittivity and permeability. The material properties are calculated using a model-based inverse iterative solver, resulting a quantitative 3D map of material properties. However, successful characterization of these properties requires a diverse set of calibration targets with accurately known reflectivity. Prior work utilized calibration techniques that were inaccurate or cumbersome, requiring multiple scans of the target. This work aims to simplify the calibration procedure so that the calibration can be performed as part of the scan of the material under test (MUT) with small calibration targets placed around or on the MUT.

In order to accurately calibrate SAR images for material characterization, calibration targets capable of producing known and diverse reflectivity values over a wide range of frequencies are necessary. For this purpose, this paper introduces a novel design for a SAR image calibration target using a spiral antenna optimized for operation in the Ka-band frequency range (26.5-40 GHz). A minimum of three independent calibration targets with diverse reflectivity values are required for an accurate calibration. With well-designed spiral antennas, it is possible to generate these diverse reflectivity values by simply changing their orientation.

In this presentation, the concept of material characterization using microwave and millimeter-wave SAR imaging will be discussed. The presentation will also cover the challenges with calibrating SAR images and will introduce the spiral antenna calibration targets. The spiral calibration targets are optimized using full-wave electromagnetic simulation tools. These optimized spiral targets are manufactured on printed circuit board (PCB) and their response measured using polarimetric SAR imaging techniques. Finally, the calibration method will be demonstrated to calculate spatial permittivity maps of several different MUTs.

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