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Ultra-wideband microwave imaging of heterogeneities

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Microwave Imaging Background

The use of narrowband microwave imaging, in a tomographic setting has been applied to a number of detection scenarios. In most cases, the imaging algorithms provide shape and dielectric contrast images of buried objects, such as landmines, pipes and buried bars embedded in concrete. The literature is extensive and many imaging techniques employ a variant of a microwave tomographic algorithm and, in some cases, a microwave reflection tomography algorithm. The applications principally include non-destructive testing in a laboratory situation, or more recently, the imaging of cancer tumors. In these situations, it is straightforward to design cylindrical or planar arrays of antennas for these experiments. The principal geophysical application of microwave imaging has been restricted to narrowband ground-penetrating radar, employed principally for the determination of the subsurface permittivity distribution.

Proposed Research

In this research we propose the construction of a planar array of ultra-wideband antennas of the balanced Vivaldi type (8 to 12) with a frequency range from 120 MHz to 1.5 GHz that is carrier agnostic. The novelty involves the construction and calibration of such an array that will be used in a reflection tomography algorithm developed at the Electronics, Antennas & Telecommunications Laboratory (LEAT), University of Nice, Sophia Antipolis. We will investigate the application of the algorithm described in [1] and determine which configurations provide the best focusing, for a model scattering geometry. The future practical application of these results will be the imaging of het-

erogeneities in karstic lithology [2] at the LSBB (Laboratoire Souterrain à Bas Bruit, Rustrel). In particular, it is expected that impedance contrast imaging of fractures will be possible, principally due to two factors:

1. The utilization of the ultra-wide bandwidth and
2. The focusing properties of the antenna array.

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