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Implementation of a Monostatic Microwave Imaging System using a UWB Vivaldi Antenna

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Abstract : Microwave imaging is a portable, noninvasive, and non-ionizing imaging technique that employs low-power microwave signals to reveal objects in the microwave frequency range. This technique has immense potential for adoption in commercial and scientific applications such as security scanning, material characterization, and nondestructive testing. This work presents a monostatic microwave imaging setup using an Ultra-Wideband (UWB), low-cost, miniaturized Vivaldi antenna with a bandwidth of 1 – 6 GHz. The backscattered signals (S-parameters) of the Vivaldi antenna used for scanning targets were measured in the lab using a VNA. An automated two-dimensional (2-D) scanner was employed for the 2-D movement of the transceiver to collect the measured scattering data from different positions. The targets consist of four metallic objects, each with a distinct shape. Similar setup was also simulated in Ansys HFSS. A high-resolution Back Propagation Algorithm (BPA) was applied to both the simulated and experimental backscattered signals. The BPA utilizes the phase and amplitude information recorded over a two-dimensional aperture of 50 cm × 50 cm with a discreet step size of 2 cm to reconstruct a focused image of the targets. The adoption of BPA was demonstrated by coherently resolving and reconstructing reflection signals from conventional time-of-flight profiles. For both the simulation and experimental data, BPA accurately reconstructed a high resolution 2D image of the targets in terms of shape and location. An improvement of the BPA, in terms of target resolution, was achieved by applying the filtering method in frequency domain.

Keywords : back propagation, microwave imaging, monostatic, vivialdi antenna, ultra wideband
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