Time-domain Image Reconstruction in an Experimental Prototype for Breast Cancer Detection

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Microwave tomography is rapidly developing into a promising imaging technique that could be useful in many different applications where a non-invasive detection of internal dielectric properties is required. Such a technique could be very useful in mammographical imaging in the search for breast cancer tumours. There is a considerable benefit in using microwaves in the diagnosis of breast cancer tumours due to a significant contrast in the dielectric properties between tumour and surrounding tissue compared to X-rays where the contrast could be as low as a few percent.

We have developed an experimental prototype of an electromagnetic tomographic system for microwave imaging of the breast together with a time-domain conjugate-gradient image reconstruction algorithm. The FDTD formulation is used to model the electromagnetic problem and for solving the forward scattering problem. The inverse problem is solved iteratively by minimising a cost functional containing the difference between the measured scattered field and the corresponding simulated field. Gradients are computed from solutions of the adjoint Maxwell equations and a line search is made to find the minimum of the functional. The measurements are made using a circular array of dipole antennas and conducted in frequency domain. Time-domain signals are synthesised by means of an inverse Fourier transform.

In this paper we present our latest advances on optimising the resolving capabilities and accuracy in the reconstructed image. This includes both experimental and algorithmic issues. We also evaluate the performance of the imaging method by reconstruction of tissue like phantom objects.