



Microwave imaging with a time-domain reconstruction algorithm

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1. Extended Abstract

Breast cancer is a serious health problem and it is one of the most common cancer forms among women. In Sweden, for example, it is the second most cause of death from cancer among women. And this is very representative of the situation in the rest of the western world. X-ray mammography is routinely used in screening programs for detection of early stage tumors. However, this technology is associated with significant problems in detecting many tumors. One alternative could be MRI; however, it is not cost effective, bulky and not specific. Ultrasound is not suitable either, as it is very operator dependent, and also has problems with the specificity being low. Microwave imaging is an interesting alternative which can avoid many of the problems in X-ray mammography, and improve the possibilities to detect tumors.

In this paper a system for image reconstruction, and an algorithm for 3D microwave tomographic image reconstruction is developed and studied. The algorithm is an iterative electromagnetic time-domain inversion algorithm based on FDTD simulations of the electromagnetic problem, and computation of an adjoint Maxwell problem for calculating gradients, that are used in a conjugate-gradient optimization algorithm for updating the dielectric parameters, [1].

The purpose is to determine and optimize a reconstruction scheme that is suitable for microwave imaging of breasts, with the purpose to diagnose breast cancer tumors. We have earlier seen a significant variation in the image quality and in the ability to correctly image objects with the spectral content in the probing signals, [2]. To remedy this pulses with low frequency spectral content are used in the early iterations, and higher frequency spectral content are used for later iterations. The idea is analogous to the frequency hopping technique used in frequency domain algorithms. The present study is based on data generated from anatomically realistic breast models. In this presentation, the effect of using matching medium of different properties, and constraining the reconstruction to within the breast region is studied. We conclude that the choice of matching liquid in imaging systems is important and largely affects the image quality, there is also a clear advantage of using a constrained reconstruction domain.

2. References

1. A. Fhager, M. Gustafsson, S. Nordebo, "Image Reconstruction in Microwave Tomography Using a Dielectric Debye Model," *IEEE Transaction on Biomedical Engineering*, vol. 59, pp 156–166, 2012.
2. A Fhager, P Hashemzadeh and M Persson: Reconstruction quality and spectral content of an electromagnetic time-domain inversion algorithm, *IEEE Trans. Biomedical Engineering*, Vol. 53, Issue 8, Page 1594–1604, August, 2006.