Strategies for integrating ultrasound and microwave data for improved breast imaging

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1. Extended Abstract

Microwave imaging has become of increasing interest for biomedical applications. However, limitations in both resolution and accuracy motivate improvements in both hardware and imaging algorithms to enable clinical testing and application. For example, radar-based approaches require estimates of the properties of tissues to enable accurate focusing, and several strategies based on optimization have been recently introduced [1, 2]. For tomography, integration of prior information about tissue structure and properties has enabled more efficient and accurate reconstruction. The sources of this prior information include other imaging approaches (e.g. CT or MRI) (e.g. [3]), or integration of multiple approaches to microwave imaging [4]. For practical system integration, the combination of ultrasound and microwave approaches offers advantages. Previous exploration of this combination of techniques includes microwave-induced thermoacoustics [5] and tissue-type-images that fuse information in ultrasound and microwave tomography reconstructions [6]. In this contribution, we develop and evaluate strategies for improving microwave radar and tomography images using prior information derived from acoustic signals.

Our approach involves illuminating the breast with acoustic signals, then extracting information from these reflections to identify the location of tissue interfaces. These interfaces define the regions dominated by skin, fat and glandular tissues. Maps indicating the spatial location of these interfaces are developed using either delay-and-sum methods, or strategies introduced in [7]. The corresponding permittivities of the identified tissue regions are estimated. These maps are then integrated into radar image reconstruction algorithms in order to provide path-dependent velocity estimates, or into microwave tomography reconstructions as prior information. Numerical models for evaluating these approaches are created with magnetic resonance scans of the breast [8]. By comparing images obtained with microwave data only to those created with the combination of acoustic and microwave data, we understand the advantages and limitations of the proposed combined approach.

2. References

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