Ph.D. Thesis Abstract for Min Rao

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Shear Strain Elastography for Breast Cancer Diagnosis

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The American Cancer Society estimates that about 182,460 women in the United States will be diagnosed with invasive breast cancer in 2008, and about 40,480 women will die from the disease this year. Early detection is currently the best hope for reducing the death rate of this devastating disease. Current detection methods include mammography, ultrasound, and magnetic resonance imaging. Each method offers its own benefits but also suffers from limitations. Ultrasound elastography has gained considerable interest as a possible alternative for breast cancer detection in recent years.

The goal of this dissertation is to develop strain imaging techniques to improve the image quality of axial and lateral strain elastograms and to evaluate the feasibility of estimating and utilizing shear strain elastography for classifying breast tumors. To achieve this goal, ultrasound simulation, tissue-mimicking phantom experiments, and *in vivo* studies were performed.

A comprehensive analysis of spatial angular compounding to obtain high quality axial strain images and strain tensor imaging using angular insonifications using beam steering on linear array transducers is presented. Theoretical analysis of the correlation between RF data acquired along different angular directions was performed. A scheme for optimization of the angular increment and the maximum beam steered angle was also developed.

Shear strain imaging for the detection and classification of bound (mimicking infiltrating cancers) and unbound (mimicking benign masses such as fibroadenomas) masses was performed for both a quasi-static uniaxial applied compression and a lateral shear deformation. Ultrasound simulation results demonstrate that the shear strain patterns obtained by applying a shear deformation show significant differences between bound and unbound inclusion phantoms when compared to shear strain images induced with axial compressions. Preliminary *in vivo* results demonstrate the potential to utilize axial-shear strain to classify a tumor as benign or malignant.

Finally, we developed a simulated two-dimensional transducer array for implementing real time three-dimensional data acquisition for strain imaging. Shear strain imaging in three-dimensions is presented. The impact of signal decorrelation in strain imaging resulting from the motion of tissue scatterers in all three dimensions is also investigated.

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