Ultrasonic Attenuation Imaging and Analysis

Haifeng Tu

Under the supervision of Professor James A. Zagzebski
At the University of Wisconsin-Madison

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Attenuation is used diagnostically to detect liver steatosis and to diagnose masses in the breast, uterus and thyroid. However, up to now, only qualitative estimates are carried out. Our goals are to incorporate methods for determining attenuation locally, and for forming attenuation images, into ultrasound machines.

In this research, a local attenuation estimation algorithm based on a reference phantom method was developed. Frequency and angular compounding were applied to attenuation estimations, and these have lead to substantial reductions in the variance. Correlation relationships among attenuation estimates done at closely spaced beam angles and adjacent frequency components are key to increase the efficiency of compound attenuation imaging. These have been studied both with theoretical models and with experiments in well-characterized media. A 1 cm diameter inclusion in a tissue mimicking phantom can be imaged easily after applying spatial and frequency compounding.

In addition, Video Signal Analysis (VSA), a B-mode based attenuation estimation method done using a reference medium, was investigated. VSA can be done using image data from clinical machines. Its accuracy, however, may be limited when broad bandwidth pulses are applied and/or the sample and reference have significantly different acoustical properties.

Also, factors that would affect attenuation estimations in a negative way were addressed. Backscatter changes and variation in speed of sound are studied, and their impact is described. In the preliminary tissue work, limited clinical trails on volunteers have provided promising results on attenuation measurements in normal human livers.