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Ultrasound Angular Scatter Imaging and Sound Speed Determination with Array Transducer

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At the University of Wisconsin-Madison
August 26, 2007

This research work centers on two topics: speed of sound (SOS) estimations in tissues by array transducers using *image quality* features and *texture orientation* in pre-beamformed data, and generation of angular scatter images.

SOS is a fundamental property of tissue. It is partially responsible for ultrasound contrast and holds potential diagnostic importance. Direct methods of measuring sound speed by timing passage of ultrasound across known distances are clinically impractical for most anatomical sites. However, B-mode image quality requires concordance between the SOS in the subject and that assumed in the beamformer, which can be used for estimating the speed. Metrics of image quality are developed for estimating a global SOS. They peak when the beamformer�s assumed SOS agrees with that of the sample. Metrics include lateral correlation (sharpness) and brightness over an area (ability of the array to concentrate tx/rx acoustic energy). Image sharpness of edges or discrete point reflectors is characterized by edge widths. Lateral correlation and an axial �rise-up edge metric� were noteworthy in terms of robustness and accuracy.

A depth effect is observed where the optimal beamformer SOS for shallow depths is less than expected, approaching the expected values as depth approaches 1.5-2 times the physical aperture.

Pre-beamformed echo data exhibit texture orientation that varies with assumed SOS, from arching downward, to horizontal at the correct SOS, to arching upward at overestimated SOS�s. After image processing, the Radon transform is used to extract texture orientation versus assumed SOS. Linear fitting and statistical analysis are coupled to texture orientation measurements. An initial study in two phantoms and a human volunteer are promising in terms of accuracy and the large depth range over which the method performs well.

A novel approach to constructing angular scatter images using arrays is introduced. The scattering angles are broken into ranges, and each scatter point and receiving element address is labeled with an angular bin. Angular bins form acoustic lines, similar to conventional beamforming. The method was demonstrated with a linear array on animal tissue. A generalized bistatic geometry of two linear arrays arranged coplanar and opposite to each other is suggested.

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last updated: 08/01/2008