Quantitative ultrasound imaging using acoustic backscatter coefficients

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Current clinical ultrasound scanners render images which have brightness levels related to the degree of backscattered energy from the tissue being imaged. These images offer the interpreter a qualitative impression of the scattering characteristics of the tissue being examined, but due to the complex factors which affect the amplitude and character of the echoed acoustic energy, it is difficult to make quantitative assessments of scattering nature of the tissue, and thus, difficult to make precise diagnosis when subtle disease effects are present.

In this dissertation, a method of data reduction for determining acoustic backscatter coefficients is adapted for use in forming quantitative ultrasound images of this parameter. In these images, the brightness level of an individual pixel corresponds to the backscatter coefficient determined for the spatial position represented by that pixel. The data reduction method utilized rigorously accounts for extraneous factors which affect the scattered echo waveform and has been demonstrated to accurately determine backscatter coefficients under a wide range of conditions.

The algorithms and procedures used to form backscatter coefficient images are described. These were tested using tissue-mimicking phantoms which have regions of varying scattering levels. Another phantom has a fat-mimicking layer for testing these techniques under more clinically relevant conditions. Backscatter coefficient images were also formed of in vitro human liver tissue.

A clinical ultrasound scanner has been adapted for use as a backscatter coefficient imaging platform. The digital interface between the scanner and the computer used for data reduction are described. Initial tests, using phantoms are presented. A study of backscatter coefficient imaging of in vivo liver was performed using several normal, healthy human subjects.