**0716 Edge Shadow by Interference of Diffracted and Reflected Waves in B-Scan Ultrasound Images**

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*PURPOSE:* The shadow produced at the margins of near perfectly reflecting objects of large radius of curvature, in which refraction cannot occur, is considered. In our previous work, phase cancellation at the transducer surface has been invoked as a possible explanation for such phenomena. A theoretical model is presented supporting this new hypothesis. *METHODS AND MATERIALS:* A soft-tissue phantom containing air-filled cylinders was scanned utilizing a 3.5 MHz transducer with the scanhead perpendicular to the central axis of each cylinder. We present a theoretical description of scattering off of a large radius of curvature reflector for a tangentially oriented propagation vector assuming an incident continuous plane wave. *RESULTS:* Discrete edge shadows occur off of air-filled cylinders within the phantom, appearing as thin echo free regions between the reverberation artifact and backscattered echoes. The resulting diffracted wave is shown to be $\pi/2$ (90 degrees) out of phase with the reflected and transmitted waves for the incident beam. *CONCLUSION:* The waves backscattered from scatterers within a correlation length across the tangent produces two terms, $\pi$ (180 degrees) out of phase, resulting in phase cancellation or, equivalently, destructive interference, which predicts a refraction independent shadow at curved surfaces.

**0725 Simulation of Imaging Contrast of Nondiffracting Beam Transducer**

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In 1987, J. Durnin discovered a nondiffracting solution of the free-space scalar wave equation, which represents a beam of very large depth of field compared to the conventional focused Gaussian beam; but the nondiffracting beam has relatively higher side lobes. In this report, we study the side lobe effects of the nondiffracting beam in ultrasonic imaging with a computer-generated scattering model. Cylinders with various diameters and scattering strengths were scanned to obtain B-scan images. Contrast-detail plots were calculated for 1) focused Gaussian, 2) nondiffracting, and 3) transmitting with nondiffracting beam and receiving with dynamic Gaussian focusing pulse-echo imaging systems. The results show that transmitting with nondiffracting beam and receiving with dynamic Gaussian focusing gives good contrast while maintaining a large depth of field. These results have implications in cardiac imaging where multiple transmit focal planes cannot be used to obtain depth of focus because of time constraints. This work was supported in part by grant CA-43920 from the National Institutes of Health.

**0728 Acoustical Microscopy on a Variety of Tissue Biopsy Samples and the Feasibility of In Vivo Measurements**

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Last year, we reported on an evaluation of human skin biopsy samples with acoustical microscopy and compared our results with conventional light microscopy methods. We used the Olympus UH3 Scanning Acoustical Microscopy (SAM) operating at frequencies between 600 MHz and 1 GHz. Here we report on an extensive extension of the original study to include a variety of tissue types and disease processes. Biopsy samples from liver, kidney, pancreas, aorta, myocardium, and bone were evaluated. In many cases, tissue was obtained by needle biopsy; in others, tissue was obtained at surgery. In most cases, the tissue specimens were fixed, frozen, sectioned, and mounted on a glass slide. Whenever possible, an adjoining slice was obtained and subjected to conventional light microscopy analysis, including the use of the appropriate stain. In all cases, acoustical microscopy (of unstained tissue) was equally diagnostic to conventional methods. Acoustical images of thick (100 $\mu$m) tissue sections demonstrate the feasibility of using this technology on an in-vivo basis.

**0729 Measurements of Ultrasonic Pulse Arrival Time Differences Produced by Abdominal Wall Specimens**

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The influence of propagation medium inhomogenecities on pulsatile ultrasonic fields has been investigated experimentally. The study employed a special curved transducer to produce a hemispherical wave pulse and a linear array to measure the resulting field along a line in a plane. Translation of the array in the elevation direction yielded data over a two-dimensional aperture. Time delay across the aperture was calculated by adding delay differences obtained by crosscorrelating signals on adjacent elements and noting the position of the crosscorrelation peaks. Received waveforms were shifted an amount given by the difference between the actual arrival time and a calculated geometric delay to isolate arrival time differences due to propagation path inhomogenecities. Waveform and time delay difference plots as well as histograms and statistics derived from them for propagation through a water path and for propagation through five specimens of human abdominal wall indicate that arrival time fluctuations in the presence of human abdominal wall specimens are significantly greater than for a water path and that degradation in focussing through human abdominal wall can be expected in ultrasonic imaging systems which operate in the low megahertz range and employ a relatively large aperture.

**0701 Time Domain Velocity Measurement System**

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A system based on a new method of velocity measurement has been developed. The novel approach involves the real time tracking of speckle features along the beam direction. This time domain method determines the range of individual speckle peaks storing each range digitally with 20ns resolution. Translation between successive interrogations is computed by range subtraction. The velocity of the peaks can then be derived by knowledge of the pulse repetition frequency. The advantages over Doppler include lower susceptibility to aliasing, high sensitivity to low velocities, and potential angle independent flow measurements. The method is computationally less intensive than correlation approaches although it makes use of the same phenomenon, namely the speckle pattern produced by the blood. The mean spatial frequency of speckle is the same as the resolution of the system. Consequently the method operates at the maximum resolution permitted by the imaging system used. A system to realize

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