10:50

2aBB7. Calibration of a two-dimensional array system for ultrasonic aberration correction. James C. Lacefield, Daniel B. Phillips, and Robert C. Waag (Dept. of Elec. and Computer Eng., Univ. of Rochester, Rochester, NY 14627-0126)

Two procedures for electronic compensation of array spatial and temporal nonidealities are compared. The motivations for array calibration are to account for signal variations due to differences in the impulse responses of the elements and to reduce beam degradation caused by nonideal element directivities. Both methods calculate inverse filters to equalize the signal at each element. One approach equalizes the array response to a planar reflector, while the other equalizes the response at a specified focal point. The point calibration method reduces the standard deviation of arrival time fluctuations in the measured wave front from a point reflector from 21 to 2 ns and reduces the standard deviation of energy level fluctuations from 2.5 to 1.7 dB. However, the point method also diverts more energy outside the main peak of the focused beam, which causes the −10-dB peripheral energy ratio to increase from 0.30 to 0.32. Point calibration of the receive aperture is nevertheless desirable for aberration correction using backpropagation followed by time-shift compensation because the fidelity of the correlation algorithm is dependent upon unbiased measurement of the echo wave front at the receive aperture.

11:05

2aBB8. Comparison of high-frame rate and delay-and-sum imaging methods. Jian-yu Lu and Anjun Liu (Ultrasound Lab., Dept. of Bioengineering, The Univ. of Toledo, Toledo, OH 43606, jilu@eng.utoledo.edu)

Recently, a high-frame rate imaging method has been developed with limited diffraction beams to construct either two-dimensional (2-D) or three-dimensional (3-D) images (up to 3750 frames or volumes/s for biological soft tissues at a depth of about 200 mm). In this talk, the new method is compared with the conventional delay-and-sum (dynamic focusing) method. Both computer simulation and experiment results show that the quality of images constructed with the two methods are virtually identical when the maximum Axicon angle of X waves in the high-frame rate method is approaching to 90 degrees. Theoretical analysis is carried out to confirm the results. This is significant because the high-frame rate method requires thousands of times less computations while achieving the same high-imaging quality as the conventional delay-and-sum method. [This work was supported in part by grant HL 60301 from the National Institutes of Health.]

11:20

2aBB9. High-frequency dependence of the backscatter coefficient on selected bovine tissues from 10–30 MHz. Subha Maruvada, Kirk K. Shung, and Shyh-Hau Wang (Grad. Prog. in Acoust. and The Bioengineering Prog., University Park, PA 16802)

Very high-frequency diagnostic ultrasonic imaging operates at frequencies of 20 MHz and higher. Thus it is critical to obtain data on ultrasonic attenuation and scattering in this frequency range. At high frequencies, it is not feasible to make scattering measurements with unfocused transducers due to their decreased sensitivity, therefore focused transducers are needed. Using the standard substitution method to calculate the backscatter coefficient, as is used with unfocused transducers, yields erroneous results for focused transducers. The assumption that the reflected echo from a perfect reflector in the far field can be calculated as though the transducer acted like a point source is not valid for focused transducers. A method is presented for focused transducers where the flat reflector is substituted by a particulate reference medium whose backscatter coefficient is well known and documented, in this case, a red cell suspension. Results between focused and unfocused transducers match closely between 10 and 20 MHz. The backscatter coefficient for bovine tissues has been well documented between 1 and 10 MHz. These measurements have been extended to 30 MHz. The frequency dependence of backscatter on bovine tissues will be presented in the range 10–30 MHz and compared to previous results.

11:35

2aBB10. Assessing arterial stenoses by tracking turbulence with Doppler ultrasound. Megan M. Miller, Christy K. Holland (Dept. of Radiol., M.L. 0742, Univ. of Cincinnati, Cincinnati, OH 45219-2316, Christy.Holland@uc.edu), and Peter J. Disimile (Univ. of Cincinnati, Cincinnati, OH 45267-0700)

When a stenosis, or narrowing, causes a significant area reduction of a blood vessel, turbulence in the post-stenotic jet can be detected with Doppler ultrasound distal to the stenosis. A technique is investigated for assessing the severity of a stenosis, defined as the pressure drop across the lesion, by extracting the streamwise turbulence intensity (or the normalized square root of the velocity variance) from the Doppler ultrasound in an arterial flow model. The model consists of an optically and acoustically transparent polyurethane tube that mimics femoral artery compliance, a pump capable of continuous and pulsatile flow, 10-μm glass spheres as an ultrasound and laser scatterer, and both blunt and rounded inlet stenoses. The flow field through three axisymmetric, Plexiglas stenoses with diameter reductions from 60% to 95% mH were investigated with an ATL HDI 3000 using the L7-4 linear array in Doppler mode (1.0-mm spatial pulse length) and a Dantec two-color 55X laser Doppler anemometer (0.7-mm major axis). To validate the ultrasound technique, correlation of Doppler ultrasound and laser Doppler anemometry flow measurements was examined. The correlation of the peak velocity, the maximum turbulence intensity, and the pressure drop across each stenosis was also investigated. This Doppler ultrasound technique could be sensitive to more subtle alterations in hemodynamics and therefore could aid early detection of atherosclerosis.

11:50

2aBB11. Backward propagation algorithms for image reconstruction: Signal processing, algorithm architecture, and applications. Hua Lee (Dept. of Elec. and Computer Eng., Univ. of California, Santa Barbara, CA 93106)

Traditionally, image reconstruction algorithms were developed, following the design and configurations of the data-acquisition systems. So, the algorithms are typically special-purpose and system-specific. Consequently, there is a lack of consistency in terms of algorithm architecture, organization, and performance. In this paper, we present a unified framework for algorithm design and development. This allows us to implement image reconstruction for various data-acquisition configurations including active or passive sensing, linear or circular receiving apertures, CW or wideband illumination, and monostatic or bistatic formats, based on a single theoretical framework in an organized manner. The computation schemes for both linear and circular apertures will be discussed in detail. The layered backward propagation technique, as the main processing modality, provides the flexibility for dynamic updating for changes of propagation parameters. In addition, we illustrate parallel processing and recognition as integrated components for the algorithm structure. The presentation includes the theoretical background on signal processing for image formation, and overview of algorithm architecture for various configurations, a discussion on computation complexity and commonality, and several applications.