3:30

1pBB9. Radiation impedance of a finite circular piston vibrating normal to an isotropic viscoelastic half-space with application to medical diagnosis. Xiangling Zhang, Thomas J. Royston (Univ. of Illinois at Chicago, Chicago, IL 60607), Hussein A. Mansy, and Richard H. Sandler (Rush Medical College, Chicago, IL 60612)

In a recent study [J. Acoust. Soc. Am. **106**, 3678–3686 (1999)], a new analytical solution was developed and validated experimentally for the problem of surface wave generation on a linear viscoelastic half-space by a rigid circular disk located on the surface and oscillating normal to it. The results of that study suggested that, for the low audible frequency range, some previously reported values of shear viscosity for soft biological tissues may be inaccurate. Those values were determined by matching radiation impedance measurements with theoretical calculations reported previously [J. Acoust. Soc. Am. **23**, 707–714 (1951)]. In the current study, the new derivation is extended to the calculation of radiation impedance. Comparisons are made with prior theory and experiments to determine which theory is more accurate and what range of values for shear viscosity is more accurate. Measurement of skin surface radiation impedance has been studied by a few researchers for rapid, nonintrusive diagnosis of a variety of specific medical ailments. It is hoped that the developments reported here will advance these techniques and also provide insight into related diagnostic methods, such as sonoelastic imaging and other methodologies that utilize disease-related variations in soft tissue viscoelastic properties. [Work supported by a grant from the Whitaker Foundation.]

3:45

1pBB10. Bessel beams of finite amplitude in absorbing media. Kevin B. Cunningham and Mark F. Hamilton (Dept. of Mech. Eng., Univ. of Texas, Austin, TX 78712-1063)

The profile of a Bessel beam is $J_0(\rho)$, where J_0 is the zeroth-order Bessel function and ρ is a dimensionless distance from the axis. The beam propagates without diffraction, a property that has stimulated interest in connection with medical ultrasound imaging. Previous analyses of second-harmonic generation in Bessel beams are limited to lossless media. Du, Zhang, and Zhu [*Proc. 14th Intl. Symp. Nonlin. Acoust.*, edited by R. J. Wei (Nanjing U.P., Nanjing, 1996), pp. 189–194] showed that the beam profile of the second harmonic in the near field is given approximately by $J_0^2(\rho)$. Ding and Lu [Appl. Phys. Lett. **68**, 608 (1996)] obtained $J_0(2\rho)$ for the far field. We provide a more general analysis of second-harmonic generation, first by investigating solutions for lossless propagation in greater detail, and second by including absorption. It is shown that the far-field beam profile is $J_0(2\rho)$ only for very small values of a characteristic absorption parameter. As the absorption parameter increases, the beam profile evolves toward a distribution given approximately (i.e., away from minima) by $J_0^2(\rho)$. Numerical results are presented for higher harmonics and for waveform distortion in a Bessel beam that forms a shock. [Work supported by ONR.]

4:00

1pBB11. Adaptive transmit focusing by numerical backpropagation of ultrasonic waveforms. James C. Lacefield and Robert C. Waag (Dept. of Elec. and Comput. Eng., Univ. of Rochester, Rochester, NY 14627, lacefiel@ece.rochester.edu)

Physical aspects of adaptive transmit-focusing algorithms that model an inhomogeneous medium as a time-shift screen distant from the aperture are described. Exact restoration of an ideal focus by numerical backpropagation of a time-shifted field to the aperture followed by physical propagation of transmitted waveforms requires an aperture that is sampled at greater than twice the highest spatial frequency in the field and occupies an area larger than the nonzero region of the field. Time-shift screens that are estimated from backpropagated pulse–echo data include oscillations at outer sample positions. The oscillations are caused by edge waves diffracted from the aperture boundary. Simulations performed using point-reflector data acquired through a distributed aberration phantom with a two-dimensional array system demonstrate that nonidealities from spatially windowed data increase the peripheral energy of the compensated focus compared to the ideal case at levels below −20 dB. Omission of the outer time-shift estimates and apodization of the time-shifted field reduce the significance of these nonidealities. For biomedical applications in which pulse distortions more severe than simple time shifts are observed, compensated foci produced using the backpropagation method nevertheless exhibit lower peripheral energy than foci produced after time-shift compensation in the aperture.

4:15

1pBB12. The application of a material parameter extraction algorithm to MRI-based displacement measurements. Anthony J. Romano, Joseph A. Bucaro (Naval Res. Lab., Washington, DC 20375-5350), and Richard L. Ehman (Mayo Clinic and Foundation)

A novel algorithm based on the variational formulation is presented for the determination of the material parameters $(\lambda+2\mu)/\rho$ and μ/ρ throughout inhomogeneous media given volumetric displacement information. The performance of the inversion algorithm is subsequently investigated when applied to measured displacement data throughout an inhomogeneous test phantom. The vector displacement components throughout the test phantom subject to monochromatic shear excitation measured in time using MRI (Magnetic Resonance Imaging) were temporally Fourier transformed to extract the components of monochromatic excitation, and the data were delivered to the inversion algorithm. A sequence of studies is presented on the basis of subsequent wavenumber filtering, polarization selection, and variation in the size of the volume elements of resolution. The resulting performance is assessed and recommendations for future efforts are discussed. [Work supported by ONR and NIH.]

4:30

1pBB13. Increasing field of view of high frame rate ultrasonic imaging. Jian-yu Lu and Shiping He (Ultrasound Lab., Dept. of Bioeng., The Univ. of Toledo, Toledo, OH 43606, jilu@eng.utoledo.edu)

A high frame rate imaging method has been developed recently based on the theory of limited diffraction beams for medical diagnosis. This method constructs images in a direction normal to the transducer surface. In this report, the high frame rate method is extended so that it will not only construct images in the normal direction, but also in any oblique directions. This increases the image construction area because images from several oblique angles can be combined. A new equation has been derived for this extension. A computer simulation was performed. Results show that the field of view of images constructed with the extended method is increased from about 15.74 deg to about 96.57 deg with a linear array of a width (foot print) of about 18.288 mm after combining images from only seven angles (the depth of the images is assumed to be 66.12 mm). This work is significant because a large field of view with a small transducer footprint is desirable for high frame rate heart imaging. [Work supported in part by Grant No. HL60301 from NIH.]