ZATION SYMPOSIUM

;ING, Stephen W. Smith,
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ER, R.L. Goldberg,[1] S.W.
rsity, Durham, NC 27706

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G ELEMENTS, Emad S.
Computer Science, The

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6.5 EFFECT ON J_0 NONDIFFRACTING BEAM OF DELETING CENTRAL ELEMENTS OF J_0 ANNULAR ARRAY TRANSDUCER, J-y. Lu and J. F. Greenleaf, Biodynamics Research Unit, Department of Physiology and Biophysics, Mayo Clinic and Foundation, Rochester, MN 55905.

A J_0 Bessel ultrasonic nondiffracting annular array transducer was developed, and its beam characteristics [1] and pulse-echo imaging capability [2] were studied. Although the nondiffracting beam has the advantage of large depth of field, the high intensity of the central lobe of the beam causes possible skin heating which limits acoustic power transmitted and depth of the beam into biological soft tissue. This problem could be solved if the central elements of the nondiffracting transducer could be deleted.

We report both computer simulation and experiment of nondiffracting pulse-echo responses of a point scatterer in water when 1, 2, and 3 central elements of our 10-element, 50-mm diameter nondiffracting transducer were turned off, respectively. The results show that after $Z/D \geq 1.0$, where Z and D are the distance away from the transducer and the diameter of the transducer, respectively, the differences between lateral pulse-echo responses produced by the nondiffracting transducer with no element and up to three elements missing are negligible. Therefore, a pulse-echo imaging system where the nondiffracting beam is used in transmitting, signal-to-noise ratio could be increased by about 12 dB if three central elements of the nondiffracting transducer are inactivated (according to the J_0 Bessel function, the pressure amplitude of the third lobe of the nondiffracting beam is about 25% that of the main lobe).

This work was supported in part by NIH grant CA43920.

[1] Lu, J-y and Greenleaf, J.F. *IEEE Trans Ultrason Ferroelec. Freq. Cont. UFFC-37*, 438-447, (1990.)

[2] Lu, J-y and Greenleaf, J.F., *Ultrasound Med Biol* (In press).

6.6 DIFFRACTION-FILTER-FREE PULSE-ECHO MEASUREMENTS FOR FOCUSSED TRANSDUCERS, Raoul Mallart and Mathias Fink, Laboratoire Ondes et Acoustique, Université Paris 7 - ESCPI, 10, rue Vauquelin , 75005 Paris France and Laboratoires d'Electronique Philips, 22, avenue Descartes, 94453 Limeil-Brevannes, France.

The use of ultrasound pulse-echo signals for the estimation of quantitative tissue parameters is complicated by the transducer field effect. When estimating ultrasound attenuation or backscatter, diffraction effects introduce a bias due to their depth dependent filtering behavior. In these measurements, the naive plane wave assumption cannot be used. The diffraction effects related to the finite aperture of the transducer are to be taken into consideration and corrected for. These effects cause the propagating pulse spectrum to vary with range and therefore mask the effects of attenuation or backscatter. These effects are strongest when the transducer is focussed in transmit and receive modes (as, for example, with concave transducers). The problem of the correction of the bias induced by these diffraction effects is generaly recognized. Most correction techniques consist in a calibration of the diffraction effect that takes into consideration the echographic signal backscattered by a random medium. Spectral analysis of these signals over moving windows leads to the concept of diffraction filter.

A careful study of the pressure field scattered by a random medium shows that for any transmitting aperture, the diffraction filter disapears when the receiver is small enough. This effect is valid even for a focussed transmitting aperture. It is independent of size and focal length and central frequency. Besides, the diffraction filter disapearance is also observed in aberrating media. A similar effect is also observed in incoherent (phase insensitive) pulse-echo processing. To take advantage of this property, multielements transducers are required.

These results are backed by experimental data obtained on a tissue mimicking phantom with a linear array working at 3.0 MHz working in transmit and receive modes. They also explain some results obtained by Johnston and Miller in backscatter estimation with their phase insensitive 2D pseudo-array (*IEEE UFFC-33*, pp.713-721).

The possibility of eliminating the diffraction filter without giving up focussing in transmission casts renewed interest on the use of incoherent (phase insensitive) pulse-echo processing for the measurement of quantitative parameters with ultrasound.

6.7 FRONT-END FOR ECHOGRAPHIC IMAGE PROCESSING, J.M. Thijssen,[1] J.T.M. Verhoeven,[1] B.J. Oosterveld,[1] F. Hottier,[2] O. Farabet[2] and L. Bartoletti[2], [1]Biophysics Laboratory, Institute of Ophthalmology, University Hospital, Nijmegen, The Netherlands and [2]Laboratiore d'Electronique Philips (LEP), Limeil-Brévannes, France.

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