ULTRASONIC WAVEFRONT COHERENCE IN THE PRESENCE OF ABERRATION

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The coherence of pulse-echo wavefronts in the presence of aberration has been investigated experimentally. In the investigation, a 3.0 MHz two-dimensional array system with a pitch of 0.6×0.6 mm^2 was used to acquire pulse-echo data at $f/1.2$ from a point reflector and from a region of random scattering each through a water path and through a path that included a tissue-mimicking aberration phantom. Measurements were made for two different phantoms: a strong aberrator (rms arrival time fluctuation of 70 ns and FWHM correlation length of 7 mm) and a weak aberrator (rms fluctuation of 40 ns and correlation length of 8 mm). For the aberration path, data were acquired with and without aberration correction on transmit. Aberration correction included time-shift compensation alone and with backpropagation. The temporal-spatial correlation function in the receive aperture was computed and the full width of the 0.8 maximum (FW@0.8M) Cartesian dimensions used to describe the coherence. The FW@0.8M spatial dimension for the point reflector data through an aberrating path was 4.2 mm and 6.6 mm for the strong and weak aberrator, respectively. For a water path through which the point reflector spatial coherence was determined mostly by the element directivity, the FW@0.8M was 23.4 mm. The FW@0.8M widths for random scattering were 3.0 mm, 4.2 mm, and 11.4 mm for the strong aberrator, the weak aberrator, and the water path, respectively. The coherence width was restored, for example, to 17.4 mm by time-shift compensation for the point reflector with strong aberration. The coherence width for random scattering with strong aberration was restored, for example, to 6.6 mm by backpropagation with time-shift compensation on transmit and receive. The coherence obtained through an aberrating path using geometric focussing on transmit was not improved by aberration correction on receive. The results indicate that the coherence of scattering is significantly decreased by aberration and restoration of coherence requires compensation of aberration on transmit as well as on receive.

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