ACOUSTICS2008/1414
Simulation and modeling of a new quantitative ultrasound Imaging device using cylindrical crossed beam forming arrays

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Real-time quantitative ultrasound imaging (QUI) produces images of bone properties with the advantages of being non-ionizing, portable and repeatable. A real-time QUI technique has been proposed, based on two 2-D arrays (24x24 transducer elements) to produce a confocal spherical focusing in transmit and receive modes. However, the electronics to manage beam scanning and focusing is complex and remains expensive. To overcome these disadvantages, a new device has been developed, based on two 1-D transducer arrays (72x1 transducer elements) and confocal cylindrical crossed-beam forming. The intersection of two orthogonal cylindrical focus lines replaces the spherical focused beams. Initial results obtained with this approach showed a distortion and a shift of the spectrum in the low frequency range compared to the reference confocal spherical focusing technique. The aim of the study was to explain the observed differences between spherical and cylindrical focusing techniques using numerical simulations of elementary impulse responses calculated in the confocal and reception planes. The orthogonal configuration of the transmit and receive focusing line results in orthogonal curvatures of the transmitted wavefront and receiving aperture, with summation by the receiving aperture of an out-of-phase wavefront. We show that this effect is the major source for the frequency response artifacts.