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Phase-shift beamforming

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ABSTRACT

Based on the third author's PhD thesis [1] this report investigates further aspects of two dimensional beamforming techniques using a linear array of transducers. Starting with the basic concepts of beamforming a set of fundamental beamforming equations are derived for an arbitrary 3-D array geometry. Given the sensor locations and the source parameters it is possible to electronically steer the beam in any spatial direction in order to transmit and receive ultrasonic signals. In particular, we considered the basic beamforming equation for a linear array of sensors. The effect of array weighting on the beam pattern are examined. An analytical expression for the spatial angular resolution of the beamformer has been derived for small steering angles, and the factors which improve spatial selectivity are discussed. The time delay operation, fundamental for beamforming, has been replaced by the phase-shift, which for the complex-valued signals is equivalent to rotation of signal. This removes limitations on the steering directions inherent for the time-delay beamformers. A simple phase shift beamforming structure is developed. Aiming at highly parallel implementation of the phase-shift beamformer a matrix formulation of its operations has been developed and simulated. Details of MATLAP code required for simulation are described, and graphical results illustrated.