A TWO-DIMENSIONAL AMPLITUDE-STEERED ARRAY FOR REAL-TIME VOLUMETRIC ACOUSTIC IMAGING

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ABSTRACT

Real-time volumetric ultrasound imaging is difficult due to problems with array construction and due to the slow speed of data collection. In 1976, a linear amplitude-steered array was introduced that uses reduced electronics to steer a monofrequency beam. The current study examines how the linear amplitude-steered array can be extended to a two-dimensional array operating over a broad range of frequencies to be used for a real-time volumetric imaging system. First, the properties of the linear amplitude-steered array are studied, showing that there is a tradeoff between axial and lateral resolution, unique to this array, that depends on the length of the array. Second, various time-frequency distributions are surveyed for use in creating an image from a single received signal. Next, the concepts of imaging with a linear array are extended to imaging a volume with a two-dimensional amplitude-steered array. The array design is presented, and it is shown that targets can be localized by using the frequency separation of the amplitude-steered array in the vertical direction and conventional phased array beamsteering in the horizontal direction. Several methods for displaying the data are presented, with projection images offering computational savings. Nonlinear propagation is also discussed, demonstrating that although frequency of the received signal is equated with position, nonlinear generation of harmonics does not cause the appearance of false targets in the images. Experimental data are compared with simulations to validate the simulations of the array operation.

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