A row-column array for tissue anisotropy estimation using acoustic radiation force induced displacements

Huaiyu Wu, Md. Murad Hossain, Caterina M. Gallippi, Xiaoning Jiang

Background, Motivation and Objective

Degree of anisotropy (DoA) in mechanical properties is clinically relevant for tissue pathology of muscles, kidney, and breast, etc. We have previously shown that DoA is reflected by the ratio of acoustic radiation force impulse (ARFI)-induced peak displacement (PD) achieved when the long axis of a spatially asymmetric ARF PSF is aligned along versus across the material's axis of symmetry. However, with traditional linear array, a mechanical 90^o degree rotation is required, which will induce misalignment errors. Although fully sampled matrix array is a possible solution, the fabrication procedure is complicated and expensive. Therefore, in this work, a row-column array is developed to enable electronic aperture rotation with low cost and simple electrode connections, demonstrating the concept of DoA evaluation without mechanical rotation of an array.

Statement of Contribution/Methods

The row-column array contains 3×64 elements with a total dimension of 15 mm×15 mm×0.28 mm corresponding to a central frequency of 5 MHz. In the x-direction, the array has 64 elements with a pitch size of 230 µm and a kerf size of 30 µm. In the y-direction, the array has 3 columns with an element width of 5 mm. The orthogonal pushing beam can be realized by x-group pushing beam in which 5 rows in x-direction are fired together and the y-pushing beam in which center column in y-direction is fired. To validate the performance of the array, the loop sensitivity of each element was tested with a pulser/receiver (5900PR, Panametrics Inc., Waltham, MA). Also, the pressure output and the beam profile were measured with a hydrophone (Onda HNA-0400, Onda Co., Sunnyvale, CA, USA). Then, a custom phantom was prepared, and a multichannel research imaging system (Verasonics Vantage 256, Kirkland, WA, USA) was used to drive the array and acquire the peak displacement.

Results/Discussion

The pulse-echo test of the single element has shown 86.5 ± 5.3 mV with 1 µJ excitation and the central frequency is 5.2 MHz with a -6 dB bandwidth of 46.7%. The measured pressure output with a distance of 10 mm is 0.81 MPa under an excitation of 60 Vpp. The -6 dB beam profile has shown a region of 2.1 mm × 12.1 mm in *x*-direction and 1.9 mm × 12.5 in the *y*-direction, respectively. Peak displacement was around 0.35 µm in a 12 kPa Young's moduli phantom with a 100-cycles pushing pulse and excitation voltage of 60 Vpp. These results demonstrate the feasibility of using a row-low array for ARFI imaging.

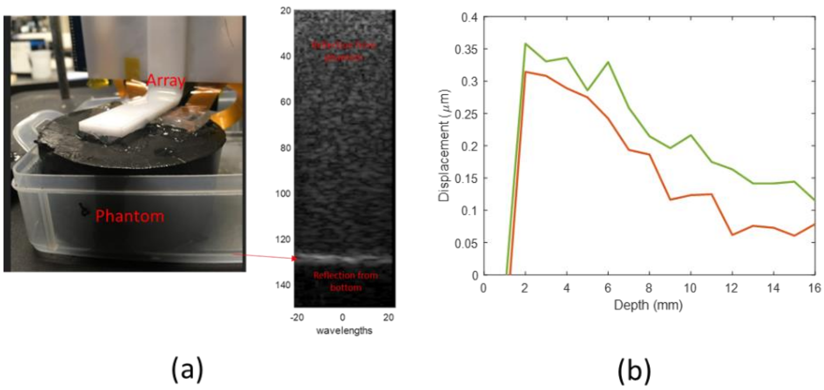

Figure 1. (a) Experiment setup and B-mode imaging of the phantom. (b) Displacement measurement of the phantom under excitations