3-D Vector Velocity Estimation with Row-Column Addressed Arrays

The concept of 2-D row-column (RC) addressed arrays for 3-D imaging have shown to be an interesting alternative to 2-D matrix array, due to the reduced channel count. However, the properties for RC arrays to estimate blood velocities have never been reported, which is of great importance for a clinical implementation of this type of array. The aim of this study is, thus, to develop a technique for estimating 3-D vector flow with a RC array using the transverse oscillation (TO) method. The properties are explored both in a simulation study and with a prototype probe for experimental use. In both setups, a 124 channel 2-D RC array with integrated apodization, pitch = 270 µm and a center frequency of 3.0 MHz was used. The performance of the estimator was tested on a simulated vessel (Ø = 12 mm) with a parabolic flow profile and a peak velocity of 1 m/s. Measurements were made in a flowrig (Ø = 12 mm) containing a laminar parabolic flow and a peak velocity of 0.54 m/s. Data was sampled and stored on the experimental ultrasound scanner SARUS. Simulations yields relative mean biases at (- 1.1%, -1.5%, -1.0%) with mean standard deviations of σ were (8.5%, 9.0%, 1.4%) % for (vx, vy, vz) from a 3-D velocity vector in a 15° rotated vessel with a 75° beam-to-flow angle. In the experimental setup with a 90° beam-to-flow angle, the relative mean biases were (-2.6%, -1.3% , 1.4%) with a relative standard deviation of (5.0%, 5.2%, 1.0%) for the respective transverse, lateral and axial velocity component.