Investigation of Transverse Oscillation Method

Conventional ultrasound scanners can only display the axial component of the blood velocity vector, which is a significant limitation when vessels nearly parallel to the skin surface are scanned. The transverse oscillation method (TO) overcomes this limitation by introducing a transverse oscillation and an axial oscillation in the pulse echo field. The theory behind the creation of the double oscillation pulse echo field is explained as well as the theory behind the estimation of the vector velocity. A parameter study of the method is performed, using the ultrasound simulation program Field II. A virtual linear array transducer with center frequency 7 MHz and 128 active elements is created, and a virtual blood vessel of radius 6.4 mm is simulated. The performance of the TO method is found around an initial point in the parameter space. The parameters varied are: flow angle, transmit focus depth, receive apodization, pulse length, transverse wave length, number of emissions, signal to noise ratio, and type of echo canceling filter used. Using the experimental scanner RASMUS, the performance of the TO method is evaluated. An experimental flowrig is used to create laminar parabolic flow in a blood mimicking fluid and the fluid is scanned under different flow-to-beam angles. The relative standard deviation on the transverse velocity estimate is found to be less than 10% for all angles between 50 deg. and 90 deg. Furthermore the TO method is evaluated in the flowrig using pulsatile flow which resembles the flow in the femoral artery. The estimated volume flow as a function of time is compared to the volume flow derived from a conventional axial method at an flow-to-beam angle of 60 deg. It is found that the method is highly sensitive to the angle between the flow and the beam direction. Also the choice of echo canceling filter affects the performance significantly.

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