Effective and versatile software beamformation toolbox - DTU Orbit (17/10/2019)

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Delay-and-sum array beamforming is an essential part of signal processing in ultrasound imaging. Although the principles are simple, there are many implementation details to consider for obtaining a reliable and computational efficient beamforming. Different methods for calculation of time-delays are used for different waveforms. Various inter-sample interpolation schemes such as FIR-filtering, polynomial, and spline interpolation can be chosen. Apodization can be any preferred window function of fixed size applied on the channel signals or it can be dynamic with an expanding and contracting aperture to obtain a preferred constant F-number. An effective and versatile software toolbox for off-line beamformation designed to address all of these issues has been developed. It is capable of exploiting parallelization of computations on a Linux cluster and is written in C++ with a MATLAB (Math Works Inc.) interface. It is an aid to support simulations and experimental investigation of 3D imaging, synthetic aperture imaging, and directional flow estimation. A number of parameters are necessary to fully define the spatial beamforming and some parameters are optional. All spatial specifications are given in 3D space such as the physical positions of the transducer elements during transmit and receive and the positions of the points to beamform. The points of focus are defined as a collection of lines each having an origin, a direction, a distance between points and a length. The transducer, the points to beamform, and the apodization are defined as individual objects and a combination of these define the actual beamforming. Once the beamforming is defined, the time-delays and apodization values for every combination of transmit elements, receive elements and focus points can be calculated and stored in lookup-tables (LUT). Parametric beamforming can also be applied where calculations are done by demand, thus, reducing the storage demand dramatically. On a standard PC with a Pentium 4, 2.66 GHz processor running Linux the toolbox can beamform 100,000 points in lines of various directions in 20 seconds using a transducer of 128 elements, dynamic apodization and 3rd order polynomial interpolation. This is a decrease in computation time of at least a factor of 15 compared to an implementation directly in MATLAB of a similar beamformer.

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