Fast simulation of non-linear pulsed ultrasound fields using an angular spectrum approach - DTU Orbit (22/12/2018)

**Fast simulation of non-linear pulsed ultrasound fields using an angular spectrum approach**

A fast non-linear pulsed ultrasound field simulation is presented. It is implemented based on an angular spectrum approach (ASA), which analytically solves the non-linear wave equation. The ASA solution to the Westervelt equation is derived in detail. The calculation speed is significantly increased compared to a numerical solution using an operator splitting method (OSM). The ASA has been modified and extended to pulsed non-linear ultrasound fields in combination with Field II, where any array transducer with arbitrary geometry, excitation, focusing and apodization can be simulated. The accuracy of the nonlinear ASA is compared to the non-linear simulation program – Abersim, which is a numerical solution to the Burgers equation based on the OSM. Simulations are performed for a linear array transducer with 64 active elements, focus at 40 mm, and excitation by a 2-cycle sine wave with a center frequency of 5 MHz. The speed is increased approximately by a factor of 140 and the calculation time is 12 min with a standard PC, when simulating the second harmonic pulse at the focal point. For the second harmonic point spread function the full width error is 1.5% at 6 dB and 6.4% at 12 dB compared to Abersim.

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