Synthetic aperture ultrasound Fourier beamformation using virtual sources

An efficient Fourier beamformation algorithm is presented for multistatic synthetic aperture ultrasound imaging using virtual sources (FBV). The concept is based on the frequency domain wavenumber algorithm from radar and sonar and is extended to a multi-element transmit/receive configuration using virtual sources. Window functions are used to extract the azimuth processing bandwidths and weight the data to reduce sidelobes in the final image. Field II simulated data and SARUS measured data are used to evaluate the results in terms of point spread function, resolution, contrast, SNR, and processing time. Lateral resolutions of 0.53 mm and 0.66 mm are obtained for FBV and DAS on point target simulated data. Corresponding axial resolutions are 0.21 mm for FBV and 0.20 mm for DAS. The results are also consistent over different depths evaluated using a simulated phantom containing several point targets at different depths. FBV shows a better lateral resolution at all depths, and the axial and cystic resolutions of -6 dB, -12 dB and -20 dB are almost the same for FBV and DAS. To evaluate the cyst phantom metrics, three different criteria of Power Ratio (PR), Contrast Ratio (CR), and contrast to noise ratio (CNR) have been used. Results show that the algorithms have a different performance in the cyst center and near the boundary. FBV has a better performance near the boundary, however, DAS is better in the more central area of the cyst. Measured data from phantoms are also used for evaluation. The results confirm the applicability of FBV in ultrasound and 20 times less processing time in comparison with DAS is attained. Evaluating the results over a wide variety of parameters and having almost the same results for simulated and measured data demonstrates the ability of FBV in preserving the quality of image as DAS, while providing a more efficient algorithm with 20 times less computations.

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