So you think you can DAS?

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Background, Motivation, and Objective

DAS (delay-and-sum) is the best known and simplest beamforming technique in medical ultrasound imaging. It is fast and easy to program. Although DAS remains the most popular beamformer, there is a persistent craze in the yearly development of alternative beamforming methods (Fig. A). In particular, several studies have focused on adaptive beamformers whose intended purpose is to improve image quality for medical ultrasound. In such investigations, DAS is most often chosen as a reference substandard method. The objective is to give credit back to the DAS by using a proper implementation.

Statement of Contribution/Methods

Image quality returned by DAS is significantly affected by the choice of input parameters. Among these parameters, the *speed of sound* and *f-number* must be properly preset. An unsuitable speed of sound can lead to under- or over-beamforming (Fig. B). To determine the global speed of sound that optimizes lateral resolution, we analyzed the co-occurrence matrix of one real-envelope image. The chosen speed of sound was the one that minimized the correlation statistic (Fig. C), a measure of how correlated a pixel is to its neighbor over the whole image. Note that this process can be performed only once as long as the scan set-ups (tissue and probe) are not modified. Too low an f-number can also affect image quality due to the presence of side lobes. Assuming a rigid baffle and neglecting depth-related attenuation, an appropriate f-number was estimated from the directivity of the array elements (Fig. D). *In vitro* and *in vivo* ultrasound scans confirmed that the *speed of sound* and *f-number* could be optimally preset when generating ultrasound images by DAS.

Results/Discussion

Automated and optimal selection of the input parameters should not be neglected in DAS when compared against adaptive beamformers. To cite a few advantages, DAS 1) is direct and fast as it can be reduced to a mere matrix multiplication of the I/Q signals, 2) preserves information from one frame to another since its input parameters remain unchanged. As previously emphasized in [Rodriguez-Molares et al., 10.1109/ULTSYM.2018.8580101], image improvements reported in adaptive beamforming can be in most cases summarized as grey-level image post-processing. It is thus suggested not to hastily discredit DAS under the pretext of introducing yet another beamforming method.