

Sparse Random Aperture for Multiangle High Frame Rate Volumetric Imaging

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Background, Motivation and Objective

High frame rate volume imaging (HFRVI) provides researchers access to high-quality images as well as very high temporal information. Despite its potential, HFRVI remains challenging to implement due to the high cost of the equipment. The purpose of this study was to develop algorithms using random apertures that would allow the use of a matrix array with 1024 elements using a Vantage system with 256 channels (V-256MUX). We compared the image quality and frame rate (FR) to acquisition with a multisystem 1024 channels system (V-1024MSC).

Statement of Contribution/Methods

A phantom was manufactured consisting of a top string parallel to the x axis, a lower string parallel to the y axis and a pin at a lower depth placed off axis. Two multiangle algorithms using random sparse apertures with 256 elements were developed and tested using the V-256MUX: 2D compounding with 2 angles (20° and 10°) revolved around the z axis (2D-2Ang, 17 transmits); 2D compounding with an inward spiral pattern starting at 20° and converging to a diverging wave (0°) after 2 revolutions (2D-Spl, 10 transmits). For comparison, images were also acquired with the V 256 with synthetic transmit and receive using diverging waves (DW-Flash). Finally, the multiangle scripts were also implemented in the V-1024MSC using the full matrix aperture.

Results/Discussion

Figure 1 shows the transverse plane at 3 depths (A-O) (top and bottom strings and pin) for the different scripts. In all cases, the main lobe presented the same width, however, the main-lobe-to-side-lobe (MLTSL) level differed between scripts. Panels P, Q, R and S, show the point spread function (dB) for the strings (at each axis) and for the pin (both axes). The DW-Flash had the lowest mean MLTSL of 20.8 dB with a frame rate (FR) of 630 Hz. The random aperture scripts presented mean MLTSL of 22.3 dB and 22.0 dB and FR's of 149 and 253 Hz for the 2D-2Ang and 2D-Spl. The algorithms on the V-1024MSC presented a mean MLTSL of 29.1 and 28.9, respectively, with max FR's of 597 and 1014 Hz for the same scripts.

This study demonstrated the use of random sparse apertures for HFRVI while maintaining MLTSL comparable to the MSC. Moreover, the spiral algorithm showed to have similar MLTSL results for the V-256MUX and the V-1024MSC to the 2-angle script with a significant lower number of transmits (i.e. 17 Tx Vs. 10 Tx), therefore improving the frame rate.

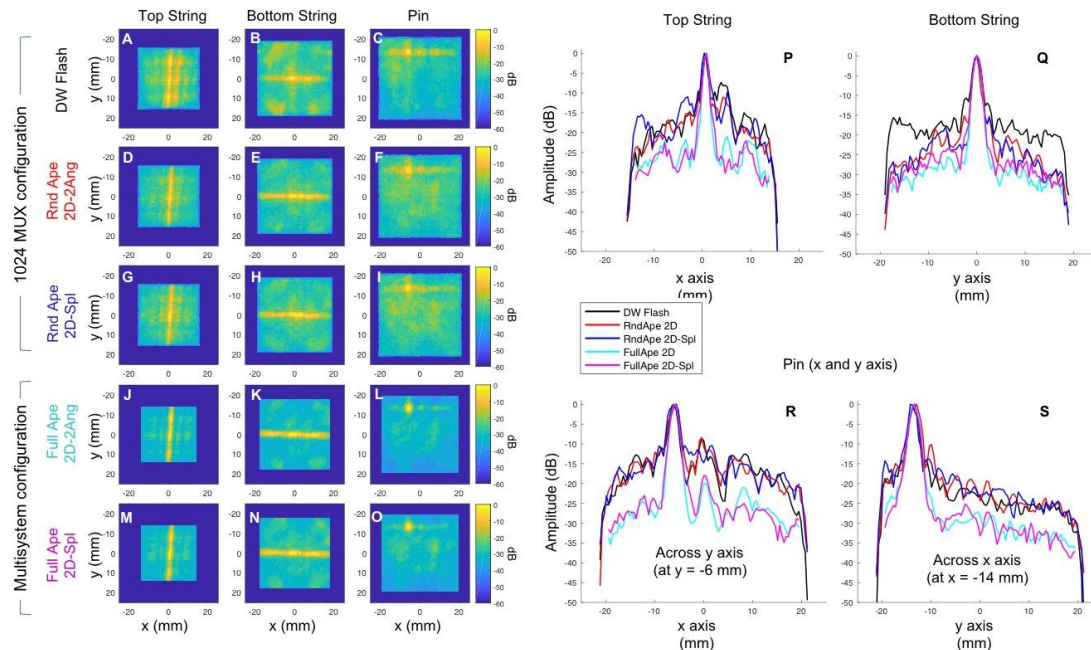


Figure 1. Panels A-O show the transverse planes for the different scripts at 3 depths (top, bottom string and pin). Panels P-S show the point spread function (dB) for the strings (P and Q) and for the pin (R and S).