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Dual apodization technique for improved contrast

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We propose a method to use dual apertures or dual apodization functions to reduce side lobes and clutter for ultrasound imaging. Using a common transmit aperture but different receive apodizations or apertures, we create two point spread functions with very similar main lobes and different sidelobe and clutter signals. Main lobe signals can be distinguished from clutter signals using normalized cross-correlation of the raw radio-frequency data. The normalized cross-correlation coefficient is used as a pixel-by-pixel weighting to pass main-lobe signals and suppress side lobe and clutter signals. Main lobe signals will have a high cross-correlation coefficient near 1 and clutter signals will have coefficients between 0 and -1. Point target simulations show a narrowing of the main beam compared to conventional beamforming at beamwidths -20 dB and lower. Using a 5 MHz 128-element linear array, improvements of contrast-to-noise ratio (CNR) of an anechoic cyst compared to delay and sum beamforming exceed 130% in both simulations and experiments. We also evaluated this method for robustness in the presence of phase aberration. Aberrators ranging from 25-45 ns RMS with correlation lengths of 3-5 mm were used. Here, improvements in CNR also exceed 100% in many cases.