Ultrasonic Synthetic-Aperture Interface Imaging

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Abstract— Synthetic-aperture (SA) imaging is a popular method to visualize the reflectivity of an object from ultrasonic reflections. The method yields an image of the (volume) contrast in acoustic impedance with respect to the embedding. Typically, constant mass density is assumed in the underlying derivation. Due to the band-limited nature of the recorded data, the image is blurred in space, which is quantified by the associated point spread function. SA volume imaging is valid under the Born approximation, where it is assumed that the contrast is weak. When objects are large with respect to the wavelength, it is questionable whether SA volume imaging should be the method-of-choice. Herein, we propose an alternative solution that we refer to as SA interface imaging. This approach yields a vector image of the discontinuities of acoustic impedance at the tissue interfaces. Constant wave speed is assumed in the underlying derivation. The image is blurred in space by a tensor, which we refer to as the interface spread function. SA interface imaging is valid under the Kirchhoff approximation, where it is assumed that the wavelength is small compared to the spatial dimensions of the interfaces. We compare the performance of volume and interface imaging on synthetic data and on experimental data of a gelatin cylinder with a radius of 75 wavelengths, submerged in water. As expected, the interface image peaks at the gelatin–water interface, while the volume image exposes a peak and trough on opposing sides of the interface.

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