Real-Time 3-D Echocardiography

This talk presents a method of four-dimensional (4-D) (3-D + Time) space–frequency analysis for directional denoising and enhancement of real-time three-dimensional (RT3D) ultrasound and quantitative measures in diagnostic cardiac ultrasound. Expansion of echocardiographic volumes is performed with complex exponential wavelet-like basis functions. These functions offer good localization in time and frequency and decompose a signal into distinct patterns of oriented harmonics, which are invariant to intensity and contrast range. Level-Set segmentation is carried out on denoised data after adaptive thresholding of transform coefficients. This process attenuates speckle noise while preserving cardiac structure. The superiority of 4-D over 3-D analysis for decorrelating additive white noise and multiplicative speckle noise on a 4-D phantom volume expanding in time is demonstrated. Quantitative validation, computed for contours and volumes, is performed on in vitro balloon phantoms. Clinical application of this spaciotemporal analysis tool are reported for 12 patient cases providing measures of left ventricular volumes and ejection fraction.

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