High Contrast Preclinical Ultrasound Imaging by Correlating B-mode and Contrast-mode Images

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Background, Motivation and Objective

Contrast-enhanced ultrasound (CEUS) imaging at high frequencies suitable for pre-clinical imaging often suffers from insufficient signal-to-noise ratio (SNR) and contrast-to-tissue ratio. Signal and image processing techniques have been developed to improve the SNR of CEUS. Coherence based approaches have shown promises, including, the recently developed acoustic sub-aperture processing [Stanziola et al, TMI, 2018] where image data from sub-apertures are correlated. However, such processing requires processing of raw data which is often inaccessible to the end users. The coexisting dual mode (B-mode + Contrast-mode) imaging from clinical or preclinical systems provides an opportunity to perform some processing at image domain. In this study, a correlation method was developed to process data at image domain to improve the SNR.

Statement of Contribution/Methods

B-mode and contrast-mode images of a mouse brain were acquired using Visualsonics system Vevo 3100 equipped with the transducer MX250 (frequency bandwidth: 13 - 24 MHz) at a center imaging frequency of 18 MHz. The B-mode data was processed by singular value decomposition (SVD). The SVD thresholds were automatically determined by the point with the largest 2nd derivative of energy with respect to singular value order curves. Then the SVD-filtered B-mode images were cross-correlated with the contrast-mode images for each frame. The assumption of this method is that, if a signal co-exists in the contrast-mode image and SVD-filtered B-mode image, then this signal may be more likely to be the true bubble signal. Thus, the correlation value will be high.

Results/Discussion

Figure (a) and (b) show the summation of total 700 SVD-filtered B-mode image and contrast-mode image, respectively. Figure (c) shows the summation of all the images after the cross-correlation. The SNR was measured in the two blue boxes indicated in each image. The values of SNR are 8.07 dB, 11.01 dB and 13.22 dB respectively in Figure (a-c). This study demonstrates that the cross-correlation of contrast-mode image and SVD-filtered B-mode image can help clinical/preclinical image data to improve SNR. Furthermore, the higher SNR image data can potentially contribute to the super-resolution imaging processing.

