HIFU interference elimination using singular value decomposition filtering for

ultrasound guided HIFU.

Euisuk Chung¹, Sunmi Yeo¹, Yeongdae Kim¹, Jihyeok Choi¹, Tai-kyong Song¹ ¹Department of Electronic Engineering, Sogang University, Seoul, Republic of Korea

Background, Motivation and Objective

Ultrasound guided High-Intensity Focused Ultrasound (USgHIFU) is capable of real-time monitoring of the treatment site. However, interferences stemming from the HIFU signal hinder the visualization of internal structure during HIFU treatment. To alleviate this, various methods have been proposed to solve this problem by synchronizing HIFU and imaging sonication sequence or substracting multi-frame images to cancel the HIFU interferences. In this paper, we propose singular value decomposition (SVD) filtering method to eliminate HIFU interference from a single-frame image without synchronization.

Statement of Contribution/Methods

Each scanline signal can be decomposed of orthogonal components by using Hankel SVD. These components' mean frequency can be estimated with autocorrelation, and by removing the frequency component corresponding to the HIFU signal, it is possible to eliminate the ultrasound image interference caused by the HIFU.

To evaluate the performance of the proposed method, an *in vitro* experiments with polyacrylamidebased graphite phantoms were performed using a 1.1-MHz, single-element, spherically focused HIFU transducer (H-102, Sonic Concepts Inc., USA). HIFU signal of 50% duty cycle and 1kHz pulse repetition frequency were generated with a function generator (AFG 3102, Tektronix Inc., USA) followed by a 55-dB RF amplifier (ENIa1040L, Electronic Navigation Industries, USA). A commercial ultrasound imaging system (E-Cube 12R, Alpinion, Republic of Korea) equipped with a convex array transducer (SC1-6, Alpinion, Republic of Korea) was used. The convex array transducer was placed in the central opening of the HIFU transducer for imaging acquisition. The received RF data were offline processed with MATLAB (R2016a, MathWorks, USA).

Results/Discussion

Ultrasound images with and without HIFU sonication and corresponding frequency spectrum are shown in Fig.1. The image with HIFU signal (Fig. 1(b)) is extremely interfered and its frequency component is observed in frequency domain. However, the reconstructed image by the proposed SVD filtering method has a comparable image quality with the interference-free image (Fig.1(a)). Therefore, our proposed method can effectively eliminate the HIFU interference from a single-frame image and achieve real-time ultrasound monitoring during HIFU treatment.



Fig. 1 Monitoring image(top) and 64th scanline frequency spectrum(bottom) of HIFU interference-free(left), HIFU interference (middle), and interference eliminated with proposed method(right)