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# Feasibility study on USCT for brain imaging to estimate artifacts and image distortion caused by bone propagation

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We are trying to image inside the skull with USCT with the goal of examination of acute stroke during the emergency conveyance. For transcranial USCT, attenuation and phase distortion after the pass through the skull would degrade its imaging performance. The purpose of this study is to establish the reconstruction method for the transcranial USCT through the process of a frequency optimization and an artifact cancellation to recover the energy attenuation and the focus quality, respectively.

## (2) Material and Methods

To investigate the artifacts caused by skull and evaluate the point spread function of the transcranial USCT, we obtained the data with k-Wave simulation in which the ring-shaped area simulating the skull and the point scatter were set inside the ring-array transducer with a diameter of 10 cm, an element number of 256. The frequency of transmitted pulse was 1.6 MHz. The image was reconstructed by using a synthetic aperture imaging method [X.Qu et al, J. Med. Ultrasonics, 43, 2016] for two models as shown in Fig (a), (d). In experiments, a wire set in the ABS (acrylonitrile butadiene styrene) ring-shaped skull phantom was imaged by a 1024-ch ring array with diameter of 10 cm connecting with Verasonics system to validate simulation results.

## (4) Discussion and Conclusion

Fig (e) shows the echo data obtained from the model in Fig (a). Transmitted wave curve was broken unlike the case without skull, which caused artifacts. We succeeded in cancelling these artifacts by taking the mode of signal values. Future studies will focus on image reconstruction method in which refraction is taken into consideration and finding the optimum frequency of transmitted pulse. Furthermore, more realistic model of skull in geometry and acoustic properties will be investigated.

## (3) Results

The reconstructed image is shown in Fig (b). The estimated position for the scatter positioned at (10.5 mm, 10.5 mm) was (10.7 mm, 10.7 mm) and half width was 1.89 mm. In addition, artifacts were cancelled as shown in Fig (c) by taking the mode (maximum value in the histogram) of signal values instead of taking the sum of signal values in synthetic aperture imaging method. Fig (f) shows the reconstructed image obtained for more realistic model which has cancellous bone as shown in Fig (d). In experiments, the signal from the wire with diameter of 2mm was able to be detected with ring-shaped skull phantom, however the signal intensity of the same diameter in the simulation was not enough to be imaged after reconstruction process.

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