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Deep Learning based Speed of Sound Reconstruction for Sparse-View Ultrasound Computed Tomography

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***Abstract*— This paper introduces U-Net for solving the speed of sound reconstruction on sparse view ultrasound computed tomography. It is trained and validated on the ellipse simulation dataset and in vitro experiment dataset. Both qualitative and quantitative results show a significant improvement in the speed of sound reconstruction for sparse views.**

***Clinical Relevance*— This will speed up the process of ultrasound transmission computed tomography of the breast.**

I. INTRODUCTION

Ultrasound computed tomography (USCT) has recently attracted extensive interest for breast cancer diagnosis as a non-invasive imaging modality. Speed of sound and attenuation are presumed to be specific for breast cancer. The ray-based theory has been widely used for USCT speed of sound (SOS) reconstruction. Comparatively speaking, it's stable and computationally efficient, however, it still takes a long time to reconstruct. A reduced number of measurements can increase the measurement speed and reduce system costs, but it also inevitably lowers image quality.

In this paper, the deep learning method is utilized to improve the SOS reconstruction for sparse view USCT, so that it approaches the image quality of dense views.

II. METHODS

We use the U-Net (Fig. 1) to implement the mapping from sparse view to dense view SOS reconstruction results. Images reconstructed by using 256 projections were taken as a reference, whereas images reconstructed with a fraction of sensors were considered as inputs of the network. The network trained on 500 ellipses simulation images and 500 in vitro experiment rat organ images.

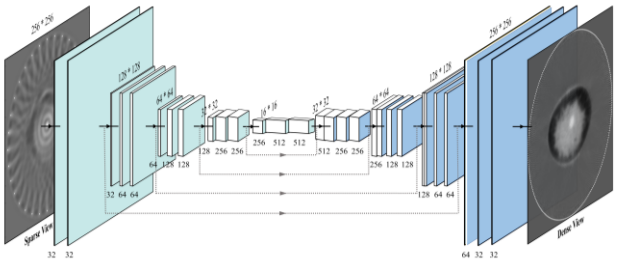

Figure 1. Neural Network Structure.

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III. RESULTS

Fig. 2 shows the results from the in vitro rat organ dataset. We obtain the reconstruction results using the deep learning model for 8, 16, 32, 64, 128 views. It confirms that the proposed method consistently outperforms the original bent-ray method at all view down-sampling factors.

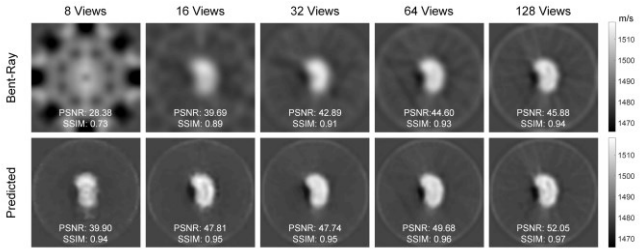

Figure 2. SOS images of rat kidney by bent-ray algorithm (Top) and proposed network (Bottom) under different numbers of elements array.

By comparing the quantitative evaluation metrics, it is clear that 16-views are capable of producing a reconstructed image similar to that obtained with 256-views, suggesting that the proposed model is capable of reconstructing the speed of sound images from extremely sparse conditions. With the increase of the input views, the quality of the reconstructed images begins to improve with different views.

IV. DISCUSSION & CONCLUSION

In this paper, we proposed a deep learning framework to enhance the SOS reconstruction for sparse view ultrasound computed tomography. Therefore, this will allow for lowering scanning costs, improving image quality and speeding up the imaging process for USCT.

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