混合成像系统实验室
Hybrid Imaging System Lab (HISLab)

上海科技大学
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Ki-GAN: Knowledge Infusion Generative Adversarial Network for Photoacoustic Image Reconstruction *in vivo*

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Outline

1. Background
2. Methodology
3. Experiments and Results
4. Conclusion

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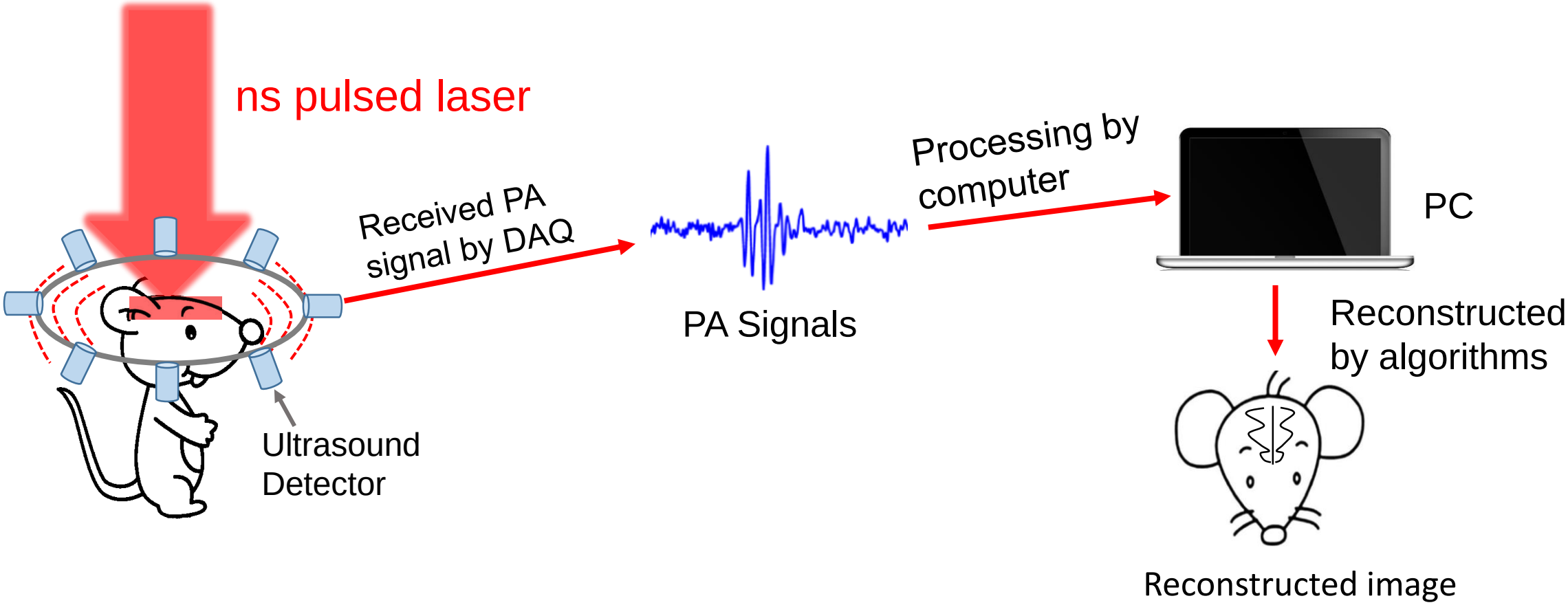
Background

The photoacoustic (PA) effect is the physical basis for PAT

Light illumination, Light absorption, Temperature rise, Thermoelastic expansion, Ultrasonic emission



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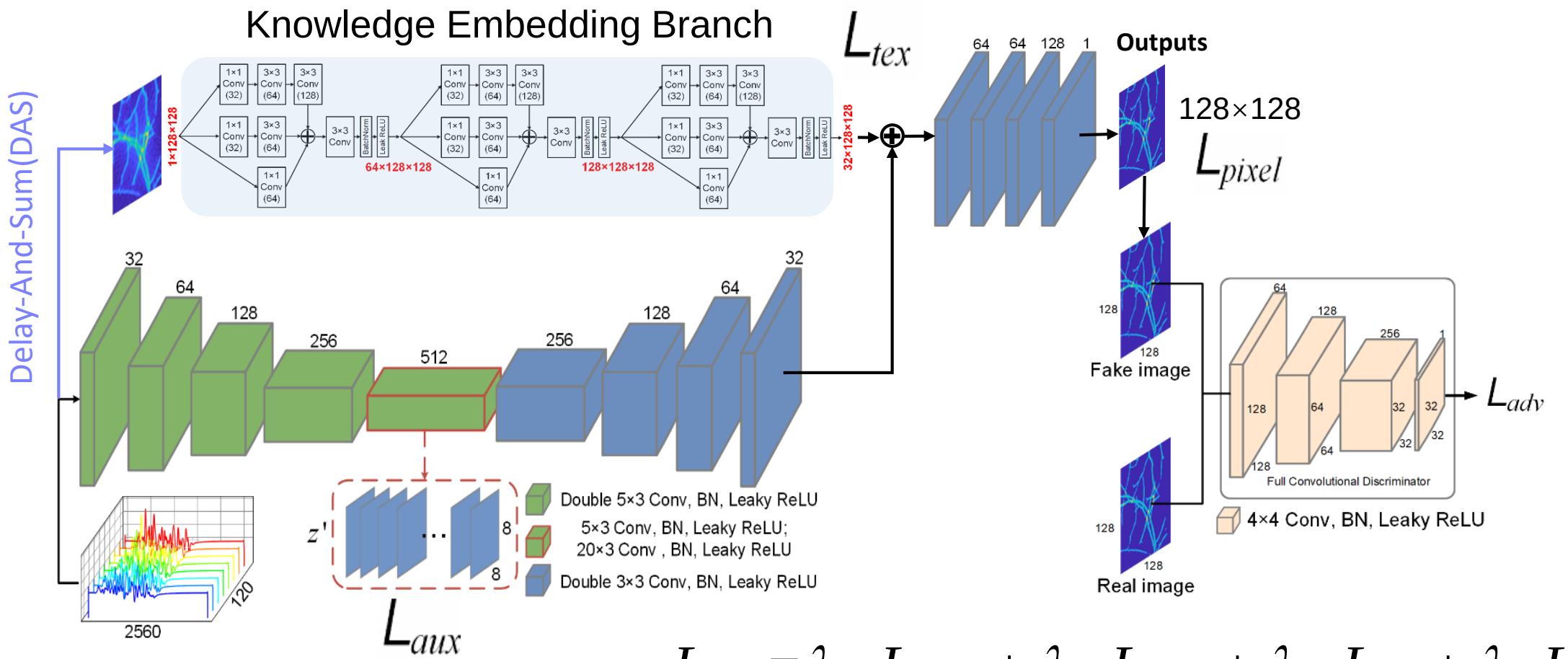
Knowledge Infusion-GAN



$$L_{total} = \lambda_{adv} L_{advG} + \lambda_{pix} L_{pixel} + \lambda_{aux} L_{aux} + \lambda_{tex} L_{tex}$$

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Experiments

- The sample is placed in the 38.4×38.4 mm region;
- 120 transducers are placed around the target as a circle;
- The MATLAB toolbox k-Wave is used to generate the training data;
- Full-sampled and sparse-sampled data are used to validate our method;
- *In-vivo* data are also validated in our method.

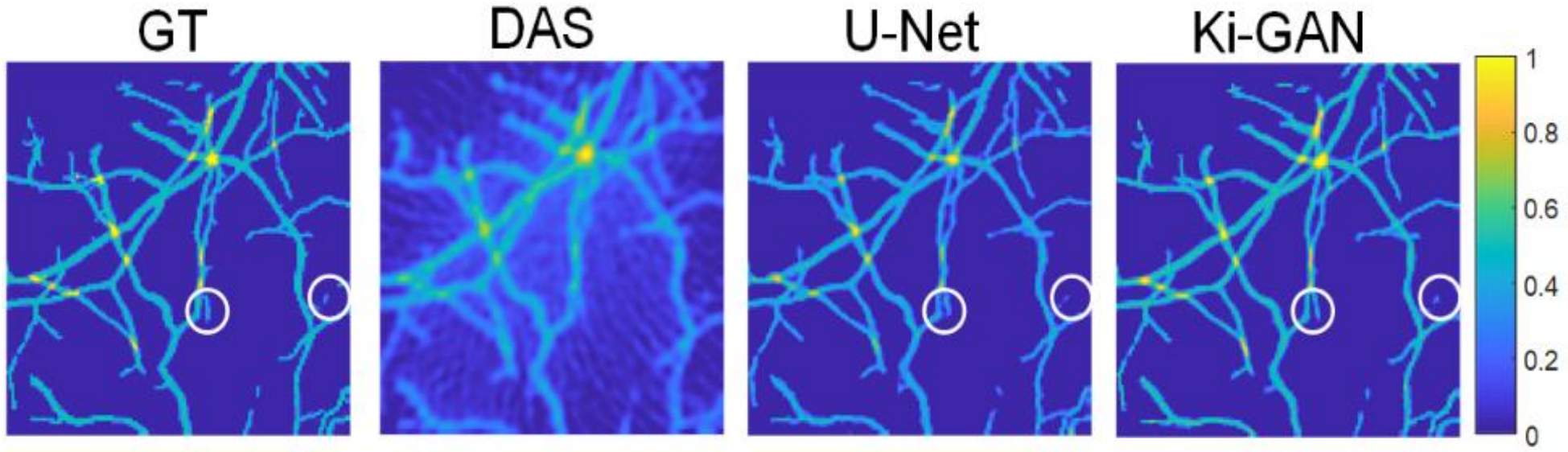
Results

Ablation study

Table 1. Evaluation results of different models for the test sets (full-sampled data). U-Net[1]: input the signals and resize to concatenation, U-Net[2]: input the result of DAS, AE#1: Auto-Encoder, AE#2: AE#1 with PSSIK, AE#3:AE#2 with Image Feature Supervision, AE#4: AE#3 with Embedded Certified Knowledge.

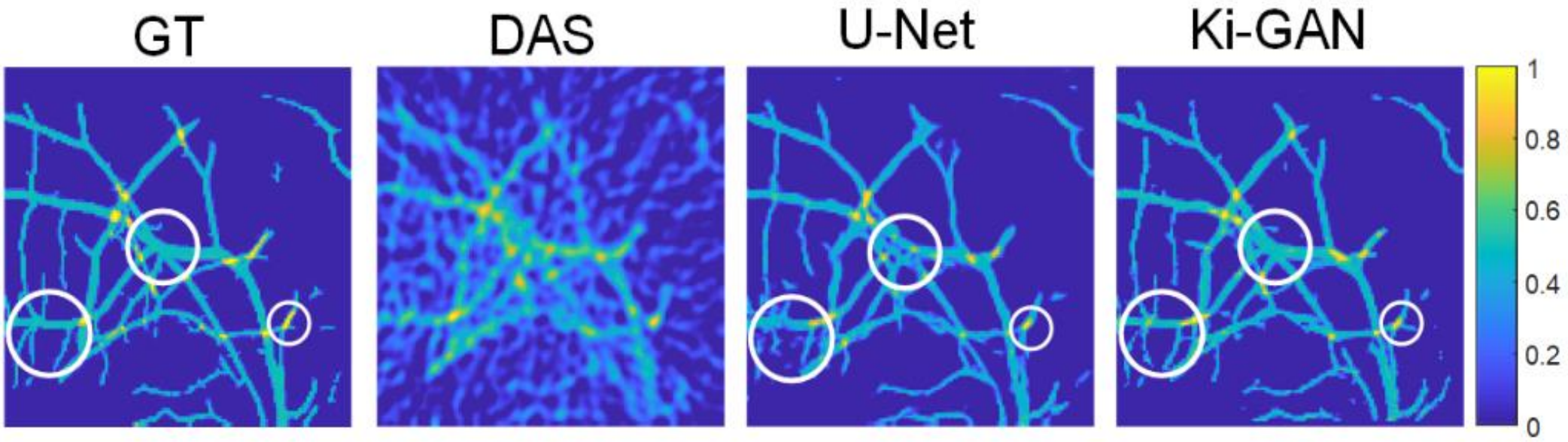
	DAS	U-Net[1]	U-Net[2]	AE#1	AE#2	AE#3	AE#4	Ki-GAN
SSIM	0.2159	0.6453	0.8749	0.6519	0.6818	0.6931	0.9123	**0.9285**
PSNR	15.6176	18.4519	24.0175	18.7033	19.1193	19.1529	24.8951	**25.5115**
SNR	1.6386	4.3237	10.1285	4.7243	5.1403	5.1739	10.6161	**11.5324**

Results



Full-sampled data
120 channels

Results

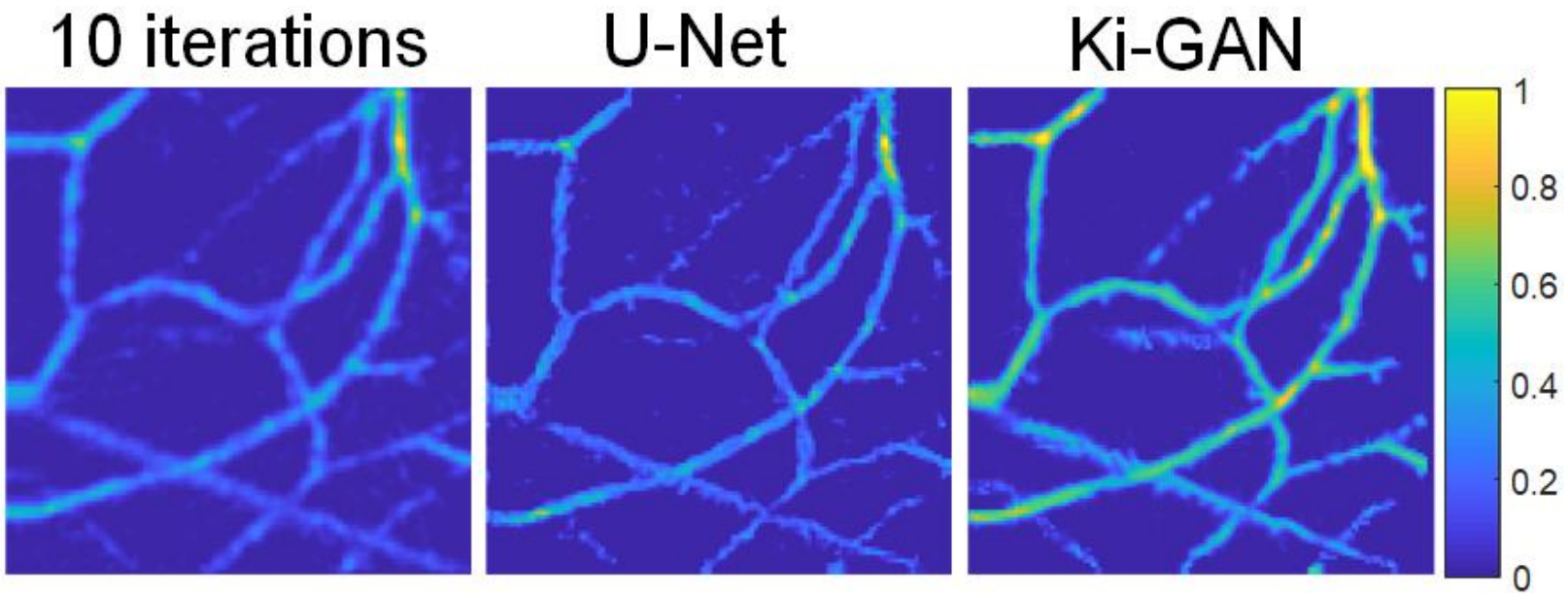


Sparse-sampled data
40 channels

Table 2. Evaluation results of different models for the test sets (sparse-sampled data).

	DAS	U-Net	Ki-GAN
SSIM	0.1842	0.8174	**0.8617**
PSNR	15.5123	21.348	**22.7398**
SNR	1.5333	7.4689	**8.7607**

Results



The vessel imaging of rat thigh.
(120 channels)

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Conclusion

- The artifacts are essential to sparse-view photoacoustic tomography for conventional algorithms;
- We proposed Ki-GAN to reconstruct the PA image by infusing knowledge, and combine the conventional reconstruction with deep learning;
- This approach fills the gap between existing direct-processing and post-processing methods;
- A main texture come from the KEB; The latent features come from Auto-Encoder.

Thank you!

LAB website

www.hislab.cn

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Full paper