Xiaojian Xu

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Department of Electrical Engineering and Computer Science ⋄ University of Michigan

ABOUT ME

Current research

- My research is in the area of AI-driven and ML-empowered computational imaging algorithms. My work lies at the intersection of (3D) computational imaging, deep learning, large-scale optimization, image processing, image analysis, and computer vision. I am enthusiastic about combining different domain knowledge to efficiently and robustly solve the real-world challenging computational imaging problems in different imaging systems. My research efforts are taking place at two complementary levels: (1) application-oriented projects in collaboration with researchers in medicine, physics, biology, and computer vision; (2) the fundamental and mathematical analysis of imaging.

Research interests

- Computational imaging/sensing, Deep learning, Generative AI, Foundation models, Image processing, Medical imaging, Machine learning, AI for healthcare, Optimization, Inverse problems, Computer vision, Signal processing, Optical imaging, Biomedical imaging, Dynamic imaging

Skills

- Transformer, Diffusion models, Deep equilibrium models (DEQ), NeRF, CNN, MLP, Pytorch, Tensorflow, Linux, CUDA, Python, Matlab, C, Java, TCP/IP

EDUCATION

Washington University in St. Louis (WashU), USA   *8/2017–8/2022*
- Ph.D. in Computer Science (GPA: 3.87/4.00)
  Advised by Prof. Ulugbek Kamilov

University of Electronic Science and Technology of China (UESTC), China   *9/2014–6/2017*
- M.S. in Communication & Information Engineering (Graduated with honors)
  Advised by Prof. Xingming Li

University of Electronic Science and Technology of China (UESTC), China   *9/2010–6/2014*
- B.S. in Communication Engineering (GPA: 3.89/4.00)

WORK EXPERIENCE

University of Michigan (UMich)   *8/2022–present*
Postdoctoral research fellow with Prof. Jeffrey Fessler   *Ann Arbor*
- Developed an efficient 3D DL network and for various imaging applications.
- Designed a state-of-the-art learning-based feature extraction DL network with subpixel level accuracy.
- Designed a powerful deep learning diffusion-model-based image prior for imaging.
- Collaborated on the development of the pytorch-based medical image reconstruction toolbox (open source).

Meta Reality Labs Research (MRLR)   *5/2021–8/2021*
Research intern with Dr. Brian Wheelwright   *Seattle*
- Programed the end-to-end ray-tracing model for peripheral display system in Oculus AR/VR devices.
- Developed multiple optimization algorithms for solving the display calibration problem in Oculus.
- Designed a novel and efficient eye-movement-based camera-to-display mapping for its real-time rendering and view synthesis using neural representation (NeRF).

Mitsubishi Electric Research Laboratories (MERL) *5/2019–8/2019*
Research intern with Dr. Hassan Mansour *Boston*

- Developed two distinct methods, optimization and deep learning method, for solving the 3D tomographic imaging problem, respectively.

Beingjing Future Tech Co Ltd. *7/2014–10/2017*
Start-up co-founder *Beijing*

- Leaded the software design and development for the smart home system (both Android application and server development).
- Built and designed the communication system and protocols to connect the phone, could server, router and smart devices.

Research Experience

Physics-Informed Machine Learning Algorithms *8/2020 – Present*

- Developed various physics-informed deep learning methods for different imaging tasks. (Representative publication: NeurIPS 2022)
- Extensively investigated and developed variants of learning-based optimization algorithms for various imaging tasks by combining the imaging models with the deep-learning priors, in both theory and practice.

Compressed and Stochastic AI Algorithms for Large-Scale Optimization *7/2018 – Present*

- Developed stochastic/compressed variants of optimization- and deep learning algorithms with convergence guarantee.
- Designed memory-efficient networks architectures for 3D imaging applications.

Other Earlier Research Experience *3/2014 – 6/2017*

- Routing and resource scheduling algorithms for large-scale software defined networks (SDN).

Awards & Honors

Honors

- Honored Ph.D student in Computer Science & Engineering Department, WashU *2021*
- Outstanding Graduate Student, UESTC *2017*

Scholarship

- Graduate Student First-Rank Academic Scholarship, UESTC *2016*
- Graduate Student Second-Rank Academic Scholarship, UESTC *2015*
- Graduate Student First-Rank Academic Scholarship, UESTC *2014*
- National Inspirational Scholarship, UESTC *2013*
- People's First-Rank Scholarship, UESTC *2012*
- National Inspirational Scholarship, UESTC *2011*

Others

- Third-prize of 'Internet+' Entrepreneurship Competition in Sichuan Province *2016*
- Great Award of Intelligent City Technology Competition, UESTC *2016*
- Award of Hackathon Programming Competition, UESTC *2015*
- Second Prize of Electronic Design Competition, UESTC *2011*

Publications

Highlights *(* indicates equal contribution)*

[1] **X. Xu***, J. Liu*, W. Gan, S. Shoushtari, and U. S. Kamilov, "Online Deep Equilibrium Learning for Regularization by Denoising", Advances in Neural Information Processing Systems 35 (NeurIPS 2022): 25363-25376. [Paper] (Acceptance rate of 25.6%)

[2] Z. Li*, J. Hu*, **X. Xu**, L. Shen, and J. A. Fessler, "Poisson-Gaussian Holographic Phase Retrieval with Score-based Image Prior", NeurIPS Workshop, 2023. [Paper](Recent work on diffusion models)

In preparation *(* indicates equal contribution)*

[3] **X. Xu**, M. Klasky, M. McCann, J. A. Fessler, "Swap-Net: A Memory-Efficient 2.5D Cascading Network for 3D Image Reconstruction", in journal preparation, 2023.

[4] **X. Xu**, M. Klasky, S. GS; J. Schei, M. McCann, J. A. Fessler, "Radiography-based Subpixel Feature Extraction under Scatter Corruption", in journal preparation, 2023.

[5] **X. Xu***, Z. Li*, J. A. Fessler, "Generalized Coordinate-based Internal Learning for Sparse-view Dynamic Cone-beam CT Reconstruction", in journal preparation, 2023.

[6] G. Wang, Z. Li, S. Kim, **X. Xu**, J. A. Fessler, "MIRTorch: An Open Source PyTorch-based Differentiable Image Reconstruction Toolbox", in journal preparation, 2023.

[7] D. Serino, B. Nadiga, M. Klasky, **X.Xu**, J. A. Fessler, "Hydrodynamic Features to Image Density Mapping Using Generative Models", in journal preparation, 2023.

[8] S. De, M. Klasky, O. Korobkin, **X. Xu**, J. A. Fessler, "Determination of Crush Model, Equation of State, and Hydrodynamic Properties using Aluminium Flyer Plate Impact Simulations", in journal preparation, 2023.

Journals *(* indicates equal contribution)*

[9] A. Benfenati, P.Cascarano, U. S. Kamilov, **X. Xu**, "Constrained Regularization by Denoising with Automatic Parameter Selection", IEEE Signal Process. Lett. (SPL) (under review), 2023. [Paper]

[10] Z. Li*, J. Hu*, **X. Xu**, L. Shen, and J. A. Fessler, "Accelerated Wirtinger Flow with Score-based Diffusion Image Prior for Poisson-Gaussian Holographic Phase Retrieval", IEEE Trans. on Comp. Imag. (TCI) (under review), 2023. [Paper]

[11] **X. Xu**, W.Gan, S.V.V.N. Kothapalli, D.A. Yablonskiy, and U.S. Kamilov, "CoRRECT: A Deep Unfolding Framework for Motion-Corrected Quantitative R2* Mapping", Magnetic Resonance in Medicine (MRM) (under review), 2023. [Paper]

[12] S. Kahali, S.V.V.N. Kothapalli, **X. Xu**, U. S. Kamilov, and D. A. Yablonskiy, "Deep-Learning-Based Accelerated and Noise-Suppressed Estimation (DANSE) of quantitative Gradient Recalled Echo (qGRE) MRI metrics associated with Human Brain Neuronal Structure and Hemodynamic Properties", NMR Biomed. 2023 May;36(5):e4883. doi: 10.1002/nbm.4883. Epub 2022 Dec 18. PMID: 36442839.[Paper]

[13] **X. Xu**, S. V. V. N. Kothapalli, S. Kahali and U. S. Kamilov, and D. A. Yablonskiy, "Learning-based motion artifact removal networks for quantitative R2* mapping", Magnetic Resonance in Medicine (MRM), vol. 88, no. 1, pp. 106–119, 2022. [Paper]

[14] **X. Xu**, Y. Sun, J. Liu, B. Wohlberg, and U. S. Kamilov, "Provable Convergence of Plug-and-Play Priors with MMSE Denoisers", IEEE Signal Process. Lett. (SPL), vol. 27, pp. 1280–1284, 2020. [Paper]

[15] **X. Xu***, Y. Sun*, Z. Wu*, B. Wohlberg, and U. S. Kamilov, "Scalable Plug-and-Play ADMM With Convergence Guarantees", IEEE Trans. on Comp. Imag. (TCI), vol. 7, pp. 849–863, 2021. [Paper]

[16] J. Liu, Y. Sun, W. Gan, **X. Xu**, B. Wohlberg, and U. S. Kamilov, "SGD-Net: Efficient Model-Based Deep Learning with Theoretical Guarantees", IEEE Trans. on Comp. Imag. (TCI), vol. 7, pp. 598–610, 2021. [Paper]

Conferences *(* indicates equal contribution)*

[17] **X. Xu**, J. Fessler, M. Klasky, S. GS, J. Schei, M. McCann, "An End-to-End Learning Approach for Subpixel Feature Extraction", Imaging Systems and Applications 2023. [Paper]

[18] Z. Li, **X. Xu**, J. Hu, J. A. Fessler, Y. Dewaraja, "Reducing SPECT Acquisition Time by Predicting Missing Projections with Single-Scan Self-Supervised Coordinate-based Learning", Journal of Nuclear Medicine, June 2023, 64 (supplement 1) P1014. [Paper] (Oral)

[19] Y. Hu, J. Liu, **X. Xu**, and U. S. Kamilov, "Monotonically Convergent Regularization by Denoising", 2022 IEEE International Conf. on Image Processing (ICIP), Bordeaux, France, 2022, pp. 426-430. [Paper]

[20] **X. Xu***, A. H. Al-Shabili*, I. Selesnick, and U. S. Kamilov, "Bregman Plug-and-Play Priors", 2022 IEEE International Conf. on Image Processing (ICIP), Bordeaux, France, 2022, pp. 241-245. [Paper]

[21] **X. Xu**, J. Liu, Y. Sun, B. Wohlberg, and U. S. Kamilov, "Boosting the Performance of Plug-and-Play Priors via Denoiser Scaling", in 54th Asilomar Conf. on Signals, Systems, and Computers (ACSSC), 2020, pp. 1305–1312. [Paper] (Oral)

[22] J. Liu, Y. Sun, W. Gan, **X. Xu**, B. Wohlberg, and U. S. Kamilov, "Stochastic Deep Unfolding for Imaging Inverse Problems", in IEEE Int. Conf. Acoustics, speech and signal process (ICASSP), 2021, pp. 1395–1399. [Paper]

[23] **X. Xu**, O. Dhifallah, H. Mansour, P. T. Boufounos, and P. V. Orlik, "Robust 3D Tomographic Imaging of the Ionospheric Electron Density", in 2020 IEEE Int. Geoscience and Remote Sensing Symposium (IGARSS), 2020, pp. 437–440. [Paper] (Oral)

[24] J. Liu, Y. Sun, **X. Xu**, and U. S. Kamilov, "Image Restoration Using Total Variation Regularized Deep Image Prior", in 2019 IEEE Int. Conf. Acoustics, speech and signal process (ICASSP), 2019, pp. 7715–7719. [Paper]

[25] **X. Xu** and U. S. Kamilov, "SignProx: One-bit Proximal Algorithm for Nonconvex Stochastic Optimization", in IEEE Int. Conf. Acoustics, speech and signal process (ICASSP), Brighton, UK, May 2019, pp. 7800–7804. [Paper] (Oral)

INVITED TALKS

• UCLouvain, Image and Signal Processing Group Seminar	*9/2020*
• UMich, Image and Signal Processing Group	*12/2021*
• Stanford University, Laboratory of AI in Medicine and Biomedical Physics	*1/2022*
• Los Alamos National Lab	*11/2023*
• MSU, Department of Computational Mathematics, Science, and Engineering	*12/2023*
• SIAM Conference on Imaging Science, Deep Learning for Imaging Science	*5/2024*

PROFESSIONAL SERVICE

- **Conference reviewer**: ISBI, ICASSP, CVPR
- **Journal reviewer**: IEEE Transactions on Image Processing (TIP), IEEE Transactions on Computational Imaging (TCI), IEEE Transactions on Medical Imaging (TMI), IEEE Signal Processing Letters (SPL), IEEE Open Journal of Signal Processing (OJSP), Signal, Image and Video Processing, Nuclear Instruments and Methods in Physics Research-A (NIM-A), Applied Mathematical Modelling, Optics Communications, Scientific Reports, Signal Processing

TEACHING EXPERIENCE

(Head) Teaching Assistant
- ESE 415 Optimization, WashU, 2019 Spring, 2021 Spring
- CSE 534A/ESE 513 Large-Scale Optimization, WashU, 2020 Fall

STUDENT MENTORING

Undergraduates *7/2018 – Present*
- Eddie Chandler, "Inhomogeneity correction for MRI", now Ph.D. student at WashU
- Julia Zeng, "learning-based 3D image denoising", now at Atlassian
- Michael Kincheloe, "Reinforcement learning for MRI artifacts correction", now B.S. student at WashU
- Mingyang Xie, "Accelerated Newton method for CT reconstruction", now Ph.D. student at UMD

- Hao Tang, "Adversarially robust classifiers for image reconstruction", now M.S. student at WashU
- Gustavo Gratacós, "Image restoration with patch-wise sparse learning", now Ph.D. student at WashU
- Jhoan S. Hernandez, "Convolutional sparse learning", now M.S. student at Howard University

Graduates   *7/2018 – Present*
- Ziyun Li, "Coordinate-based internal learning for medical imaging" (ongoing), now M.S. student at UMich
- Jason Hu, "Phase retrieval with score-based image priors" (ongoing), now Ph.D. student at UMich
- Yixuan Luo, "Deep-learning-based image segmentation", now Ph.D. student at UR
- Zhixin Sun, "Neural representation for image reconstruction", now Ph.D. student at WashU
- Yongcheng Song, "Focal-plane regression for autofocus", now at COMAC
- Weijie Gan, "Fast MRI reconstruction and artifacts correction", now Ph.D. student at WashU
- Jiaming Liu, "Total variation regularized deep image prior", now Ph.D. student at WashU
- Jiarui Xing, "Deep-learning-based image artifacts correction", now Ph.D. student at UVA
- Ryogo Suzuki, "Unfolding networks for image restoration", now at Rakuten Group, Inc.
- Yukun Li, "Single image denoising", now Ph.D. student at Tufts University
- Shiqi Xu, "Sparse Fourier ptychographic microscopy", now research scientist at ZEISS
- Fa Long, "Dictionary learning for image restoration", now at Tencent Inc.