

XIAOJIAN XU

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Department of Electrical Engineering and Computer Science ◊ University of Michigan

ABOUT ME

Current research

- My current research pursues to combine computational imaging, optimization, and machine learning (ML) to enable new intelligent imaging technology for various imaging applications including denoising, deblurring, super-resolution, image segmentation, optical microscopy, magnetic resonance imaging (MRI), computed tomography (CT), etc. My research efforts are taking place at two complementary levels: (a) application-oriented projects in collaboration with researchers in medicine, biology, and computer vision; (b) the fundamental and mathematical analysis of imaging.

Research interests

- Computational imaging, Inverse problems, Deep learning, Optimization, Computer vision, Signal processing

EDUCATION

Washington University in St. Louis (WashU), USA 9/2017–8/2022

- 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 time- and memory- efficient 3D image reconstruction methods based on data-driven approaches, especially as applied to denoising/CT/MRI applications with limited measurements and/or training data.
- Designed learning-based image/radiography feature extraction methods with subpixel level (< 125 um) accuracy under heavy photon scattering noise.
- Collaborated on the development of diffusion-model-based image prior for solving phase retrieval problems and the development of the pytorch-based image reconstruction toolbox.

Meta Reality Labs Research (MRLR) 5/2021–8/2021
Research intern with Dr. Brian Wheelwright Seattle (remote)

- Built the ray-tracing model for peripheral display system in Oculus AR/VR devices, solved its display calibration problem, and designed an efficient eye-movement-based camera-to-display mapping for its real-time rendering and view synthesis using neural representation.

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

- Worked on the 3D tomographic imaging problem and developed two distinct methods, model-based optimization and data-driven deep learning, for solving the problem.

AWARDS & HONORS

Honors

- Honored Ph.D student in Computer Science & Engineering department 2021
- Outstanding Graduate Student 2017

Scholarship

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

Others

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

SKILLS

- **Languages:** Python, Matlab, C, Java
- **Skills:** Optimization, Inverse problems, Pytorch, Tensorflow, Deep learning, Linux, TCP/IP

RESEARCH EXPERIENCE

Physics-informed machine learning for imaging 8/2020 – Present

- Developed imaging-model-assisted learning methods such as unsupervised learning, self-supervised and deep unrolling framework for different imaging tasks with various noise corruption challenges.

Integrating physics and deep learning priors for imaging 8/2019 – Present

- Extensively investigated in and developed variants of learning-based iterative algorithms for various imaging tasks by combining the imaging models with the deep-learning priors, in both theory and practice.

Compressed and stochastic algorithms for large-scale imaging 7/2018 – Present

- Investigated in large-scale (dimension-wise and data-wise) imaging problems by 1) developing stochastic/compressed variants of optimization- and learning-based algorithms with convergence guarantee, and 2) designing memory efficient networks.

Other earlier research experience 3/2014 – 6/2017

- Intelligent home system design and development.
- Routing and resource scheduling algorithms for large-scale software defined networks (SDN).

PUBLICATIONS

In preparation (* indicates equal contribution)

- [1] G. Wang, Z. Li, S. Kim, **X. Xu**, J. A. Fessler, "MIRTorCh: A PyTorch-based Differentiable Image Reconstruction Toolbox Developed at University of Michigan", in journal preparation, 2023.
- [2] D. Serino, B. Nadiga, M. Klasky, **X. Xu**, J. A. Fessler, "Hydrodynamic Features to Image Density Mapping Using Generative Models", in journal preparation, 2023.

- [3] 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.
- [4] Z. Li*, **X. Xu***, M. Klasky, J. A. Fessler, "Generalized Coordinate-based Internal Learning for Sparse-view Cone-beam CT Reconstruction", in journal preparation, 2023.
- [5] **X. Xu**, M. Klasky, S. GS; J. Schei, M. McCann, J. Fessler, "Radiography-based Subpixel Feature Extraction under Scatter Corruption", in journal preparation, 2023.
- [6] **X. Xu**, M. Klasky, M. McCann, J. A. Fessler, "Swap-Net: A Memory-Efficient 2.5D Cascade Network for 3D Image Reconstruction", in journal preparation, 2023.

Journals

(* indicates equal contribution)

- [7] 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. (Coming online soon)
- [8] 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. [\[Paper\]](#)
- [9] **X. Xu**, W. Gan, S.V.V.N. Kothapalli, D.A. Yablonskiy, and U.S. Kamilov, "CoRRRECT: A Deep Unfolding Framework for Motion-Corrected Quantitative R2* Mapping", IEEE Trans. on Med. Imag (TMI) (in revision), 2023. [\[Paper\]](#)
- [10] 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 in Biomedicine. 2022:e4883. [\[Paper\]](#)
- [11] **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. [\[Paper\]](#)
- [12] **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. [\[Paper\]](#)
- [13] **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. [\[Paper\]](#)
- [14] 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)

- [15] Z. Li*, J. Hu*, **X. Xu**, L. Shen, and J. A. Fessler, "Poisson-Gaussian Holographic Phase Retrieval with Score-based Image Prior", NeurIPS Workshop on Deep Inverse, 2023. [\[Paper\]](#)
- [16] **X. Xu**, J. Fessler, M. Klasky, S. GS, J. Schei, M. McCann, "An End-to-End Learning Approach for Subpixel Feature Extraction", Optica Imaging Congress 2023. (Coming online soon)
- [17] 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)
- [18] **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%)
- [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

- Invited talk at UCLouvain, Image and Signal Processing Group Seminar, 9/2020
- Invited talk at UMich, Image and Signal Processing Group, 12/2021
- Invited talk at Stanford University, Laboratory of AI in Medicine and Biomedical Physics, 1/2022
- Invited talk at Los Alamos National Lab, 11/2023 (Exp.)
- Invited talk at MSU, Department of Computational Mathematics, Science, and Engineering, 12/2023 (Exp.)
- Invited talk at SIAM Conference on Imaging Science, Deep Learning for Imaging Science, 6/2024 (Exp.)

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 & SUPERVISION EXPERIENCE

(Head) TA for optimization

Assistant Instructor

- ESE 415 Optimization, WashU, 2019 Spring, 2021 Spring
- CSE 534A/ESE 513 Large-Scale Optimization, WashU, 2020 Fall

Students mentoring

7/2018 – Present

Research Mentor

- 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
- Eddie Chandler, "Inhomogeneity correction for MRI", now Ph.D. student at WashU
- 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
- 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
- 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
- Hao Tang, "Adversarially robust classifiers for image reconstruction", now M.S. student at WashU
- 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
- 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
- Fa Long, "Dictionary learning for image restoration", now at Tencent Inc.