

# XIAOJIAN XU

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Department of Electrical Engineering and Computer Science ◊ University of Michigan

## ABOUT ME

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### Current research

- My current research pursues to combine computational imaging, optimization, and machine learning 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), radar, and autonomous driving, etc. My research efforts are taking place at two complementary levels: (a) the fundamental and mathematical aspects of imaging; (b) application-oriented projects in collaboration with researchers in medicine, biology, and computer vision.

### Research interests

- Computational Imaging, Optimization, Deep Learning, Inverse Problems, Computer Vision, Signal Processing

## EDUCATION

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**Washington University in St. Louis (WUSTL), USA** 9/2017–7/2022

- 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

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**University of Michigan** 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** 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** 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

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### 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

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

## RESEARCH EXPERIENCE

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### Model-based deep learning for imaging and vision

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 ([8][9][11][14][16][17][18][19][20][22][24]).

### Learning-based optimization for imaging and vision

8/2020 – 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 ([12][13][19][20][21]).

### 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 variants of optimization- and learning-based algorithms with convergence guarantee, and 2) designing memory efficient networks ([6][14][18][22][25]).

### Some 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

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### 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 Spare-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 Scattering 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, "AWFSD: 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, "CoRECT: 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-Shabli\*, 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. [\[Paper\]](#) [\(Oral\)](#)

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## 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 Artificial Intelligence in Medicine and Biomedical Physics, 1/2022
- Invited talk at MSU, Department of Computational Mathematics, Science, and Engineering, 12/2023 (expected)
- Invited talk at SIAM Conference on Imaging Science (Deep Learning for Imaging Science), 6/2024 (expected)

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## PROFESSIONAL SERVICE

- **Conference reviewer:** ISBI, ICASSP
- **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 Inst and Methods in Physics Research-A (NIM-A), Applied Mathematical Modelling, Optics Communications, Scientific Reports, Signal Processing

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## 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
- Shiqi Xu, "Sparse Fourier ptychographic microscopy", now research scientist at ZEISS

- Eddie Chandler, "Inhomogeneity correction for MRI", now Ph.D student at WUSTL
- Yixuan Luo, "Deep-learning-based image segmentation", now Ph.D student at University of Rochester
- Julia Zeng, "learning-based 3D Image denoising", now at Atlassian
- Michael Kincheloe, "Reinforcement learning for MRI artifacts correction", now B.S. student at WUSTL
- Mingyang Xie, "Accelerated Newton method for CT reconstruction", now Ph.D student at U. Maryland
- Zhixin Sun, "Neural representation for image reconstruction", now Ph.D student at WUSTL
- Weijie Gan, "Fast MRI reconstruction and artifacts correction", now Ph.D student at WUSTL
- Jiarui Xing, "Deep-learning-based image artifacts correction", now Ph.D student at University of Virginia
- Hao Tang, "Adversarially robust classifiers for image reconstruction", now M.S. student at WUSTL
- Ryogo Suzuki, "Unfolding networks for image restoration", now at Rakuten Group, Inc.
- Yukun Li, "Single image denoising", now Ph.D student at Tufts University.
- Fa Long, "Dictionary learning for image restoration", now at Tencent Inc.