

# XIAOJIAN XU

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Department of Computer Science and Engineering ♦ Washington University in St. Louis

## 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), 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, Image Processing

## EDUCATION

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**Washington University in St. Louis (WUSTL)**, St. Louis, MO, USA 9/2017–6/2022 (*expected*)

- Ph.D student in Computer Science (GPA: 3.87/4.00), advised by Dr. Ulugbek Kamilov

**University of Electronic Science and Technology of China (UESTC)**, Chengdu, China 9/2014–6/2017

- M.Eng in Communication & Information Engineering (Graduated with Honors)

**University of Electronic Science and Technology of China (UESTC)**, Chengdu, China 9/2010–6/2014

- B.Eng in Communication Engineering (GPA: 3.89/4.00)

## WORK EXPERIENCE

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**Facebook Reality Labs Research (FRLR)** 5/2021–8/2021

*Research intern with Dr. Brian Wheelwright* Seattle (*remote*)

- Simulated the end-to-end peripheral display system (lens-lets and display LED array included) in Oculus and implemented a corresponding efficient ray-tracing model for the system, all from scratch.
- Solved the display calibration problem with the simulated display system and ray tracing model by designing various optimization strategies.
- Designed a novel deep-learning-based (neural representation) method for the challenging pupil-movement-based camera-to-display mapping in the virtual reality (VR) system, which achieved real-time rendering capability (0.3 sec) without losing visual quality.

**Mitsubishi Electric Research Laboratories (MERL)** 5/2019–8/2019

*Research intern with Hassan Mansour* Boston

- Investigated in 3D tomographic imaging problems challenged by noise corruption, data acquisition and problem model establishment.
- Established the whole system for data acquisition, and solved the problem by proposing two distinct methods, model-based optimization and data driven deep learning.

## RESEARCH EXPERIENCE

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**Model-based deep learning for imaging and vision** 8/2020 – *Present*

- Working on provable model-based unfolding networks for medical imaging application and computer vision tasks with various noise corruption (Gaussian, Poisson, etc) challenges.
- Developed imaging-model-assisted unsupervised, self-supervised and supervised learning methods for different imaging tasks such as denoising, deblurring, MRI, CT.

**Learning-based optimization for imaging and vision** 8/2020 – *Present*

- Conducted different image reconstruction tasks (e.g. deblurring, super-resolution, Poisson/Gaussian denoising, compressive sensing, phase retrieval, MRI, CT, etc.) by combining the physical models together with the deep learning priors, e.g. the model-based unrolling networks and learning-involved optimization.
- Extensively investigated in the variants of Plug-and-Play priors (PnP) and Regularized by denoising (RED) approaches for various imaging tasks (both theory and practice).
- Conducted the first mathematical analysis of plug-and-play priors (PnP) framework for minimum mean squared error (MMSE) denoisers. This result provides new insights into usage of deep-learning denoisers in PnP.
- Designed a practically efficient denoiser scaling technique that can greatly boost the performance of PnP algorithms under deep-learning priors by explicitly adjusting the amount of PnP regularization.
- Developed the stochastic variant of the PnP-ADMM algorithm for large-scale optimization and proved its convergence.

#### **Compressed and stochastic algorithms for large-scale imaging**

7/2018 – Present

- Developed the stochastic variant of iterative PnP and unfolding networks for large scale imaging application with convergence guarantee.
- Developed compressed proximal algorithms for stochastic optimization problems and was the first to prove the convergence.

#### **Learning-based magnetic resonance imaging (MRI) and quantitative-MRI (qMRI)**

7/2018 – Present

- Developed both supervised and self-supervised deep-learning-based methods for motion artifact removal in qMRI mapping.
- Investigated the application of reinforcement learning, neural representation and sparse representation in fast MRI reconstruction.
- Working on macroscopic-magnetic-field-inhomogeneities-corrected MRI image reconstruction

#### **Some earlier research experience**

3/2014 – 6/2017

- Development of whole intelligent home system.
- Designed routing and resource scheduling algorithms for large-scale network SDN.

### **LIST OF PUBLICATIONS**

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#### **Preprints**

- [1] **X. Xu** et al., “Learning-based Motion Artifact Removal Networks (LEARN) for Quantitative  $R_2^*$  Mapping,” arXiv:2109.01622 [eess], Sep. 2021, [Online]. Available: <http://arxiv.org/abs/2109.01622>
- [2] 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,” bioRxiv, 2021, doi: 10.1101/2021.09.10.459810.

#### **Published**

(\* indicates equal contribution)

- [3] **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., vol. 27, pp. 1280–1284, 2020.
- [4] **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, 2020, pp. 1305–1312.
- [5] **X. Xu\***, Y. Sun\*, Z. Wu\*, B. Wohlberg, and U. S. Kamilov, “Scalable Plug-and-Play ADMM With Convergence Guarantees,” IEEE Transactions on Computational Imaging, vol. 7, pp. 849–863, 2021.
- [6] 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 Transactions on Computational Imaging, vol. 7, pp. 598–610, 2021.
- [7] 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.

- [8] **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.
- [9] 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.
- [10] **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.

## INVITED TALKS

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- SIAM Conference on Imaging Science, 07/2020
- UCLouvain, Image and Signal Processing Group Seminar, 09/2020
- Asilomar Conference on Signals, Systems, and Computers, 10/2021

## REVIEWER EXPERIENCE

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- **Conferences:** ISBI, ICASSP
- **Journals:** IEEE Transactions on Image Processing (TIP), IEEE Transactions on Computational Imaging (TCI), Optics Communications

## TEACHING & SUPERVISION EXPERIENCE

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### (Head) TA for Optimization

2019–2020

*Assistant Instructor*

*St. Louis*

- Worked as an assistant instructor for course "Optimization" and "Large-Scale Optimization for Data Science" for four semesters. Developed and held weekly tutorial lectures and occasional guest lectures, hold office hours, answer questions online, design homework and exams.

### Students supervision

7/2018–Present

*Research Supervisor*

*St. Louis*

#### Current students

- Eddie Chandler, "Inhomogeneity correction for MRI", *now B.S. student at WUSTL*
- Yixuan Luo, "Deep-learning-based image segmentation", *now M.S. student at WUSTL*
- Michael Kincheloe, "Reinforcement learning for MRI artifacts correction". *now B.S. student at WUSTL*

#### Previous students

- Zhixin Sun, "Neural representation for MRI reconstruction", *coming Ph.D student at WUSTL*
- Weijie Gan, "Fast MRI reconstruction and artifacts correction", *now Ph.D student at WUSTL*
- Jiarui Xing, "Deep-learning-based MRI artifacts correction", *now Ph.D student at University of Virginia*
- Shiqi Xu, "Sparse Fourier ptychographic microscopy", *now Ph.D student at Duke University*
- Hao Tang, "Adversarially robust classifiers for image reconstruction", *now M.S. student at WUSTL*
- Ryogo Suzuki, "Unfolding networks for image restoration", *now at Rakuten, Japan*
- Yukun Li, "Single image denoising", *now at Baidu Inc.*
- Fa Long, "Dictionary learning for image restoration", *now at Tencent Inc.*

## SKILLS

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

## AWARDS & HONORS

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### Honors

- Honored Ph.D student in Computer Science & Engineering department (WUSTL) 2021

### 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
- Outstanding Graduate Student 2015
- Second Prize of Electronic Design Competition in UESTC 2011