

# XIAOJIAN XU

[[Homepage](#)] [[Google Scholar](#)] [[Github](#)] [[Twitter](#)]

✉ xiaojianxu@wustl.edu ☎ +1 314-203-8568

## 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 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, Deep Learning, Inverse Problems, Optimization, Computer Vision

## 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*

*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*

*Boston*

- Investigated in 3D tomographic imaging problems and solved them with both model- and learning-based methods on both simulated and experimental data.

## RESEARCH EXPERIENCE

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**Model-based deep learning for imaging**

8/2020 – Present

- Working on provable model-based unfolding networks and learning prior assisted methods in medical imaging
- Working on macroscopic-magnetic-field-inhomogeneities-corrected MRI image reconstruction

**Plug-and-Play priors (PnP) and Regularized by denoising (RED)**

8/2018 – Present

- 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.

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

7/2018 – Present

- Developed compressed proximal algorithms for stochastic optimization problems and was the first to prove the convergence.
- Developed the stochastic variant of the PnP-ADMM algorithm for large-scale optimization and proved its 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.

### **Model and learning combined methods for image reconstruction**

3/2018 – 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.

### **Some earlier research experience**

3/2014 – 6/2017

- Development of Intelligent Home System.
- Design routing and resource scheduling algorithms for large-scale network SDN.

## **LIST OF PUBLICATIONS**

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### *Preprints*

- **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>
- 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)

- **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.
- **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.
- **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.
- 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.
- 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.
- **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.

- 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.
- **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 (expected)

## 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** 1/2019–Present  
*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