Jiaming Liu

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ABOUT ME

My research focuses on the development of explainable, robust, and efficient frameworks with applications to biomedical and scientific imaging, computational photography, image analysis, and computer vision. Current research efforts are taking place at two complementary levels: (a) establishing theoretical aspects of optimization algorithms for imaging, and (b) developing novel and applicable deep learning methods in specific areas.

Research Interests: Computer Vision, Computational Imaging, Large-scale Optimization, Machine Learning

EDUCATION

Washington University in St. Louis (WUSTL), St. Louis, MO, USA   Aug. 2019 – Expected 2024
Ph.D. student in Electrical & Systems Engineering
Advisor: Prof. Ulugbek Kamilov

WUSTL, St. Louis, MO, USA   Aug. 2017 – Dec. 2018
M.S. in Electrical & Systems Engineering

University of Electronic Science and Technology of China (UESTC), Chengdu, China   Sep. 2013 – Jun. 2017
B.S. in Electronic and Information Engineering

WORK EXPERIENCE

Mitsubishi Electric Research Laboratories (MERL), Cambridge, MA, USA   May. 2023 – Aug. 2023
Research Intern (Remote Bio-signals Reconstruction from Video)
Mentor: Dr. Tim Marks

Lawrence Livermore National Laboratory (LLNL), Livermore, CA, USA   Jun. 2022 – Aug. 2022
Research Intern (Tomographic Imaging in Security)
Mentor: Dr. Rushil Anirudh

Los Alamos National Laboratory (LANL), Los Alamos, NM, USA   Jun. 2021 – Aug. 2021
Research Intern (Model Auto-Calibration for Tomographic Imaging)
Mentor: Dr. Brendt Wohlberg

AWARDS & HONORS

AAPM 2022 Imaging Best-in-Physics Award, NeurIPS 2022 Scholar Award, NeurIPS 2019 Travel Award, WUSTL Dean's Select PhD Fellowship, 2019

RESEARCH EXPERIENCE

(*Indicated by the corresponding publication or preprint shown in the next section.*)

- **Recovery and Robustness Analysis for Model Based Deep Learning**

  - Established theoretical recovery guarantees of *plug-and-play priors* (PnP) for compressive sensing image reconstruction based on monotone operator theory and set-restricted eigenvalue condition (published in [c 5]).

  - Provided robustness analysis for PnP-ADMM on the topic of prior distribution mismatch under nonconvex condition (preprinted in [u 2]). The analysis has been extended to PnP posterior sampling algorithm (preprinted in [u 3]).

- **Efficient Optimization Algorithms for Large-scale and Data-intensive Imaging**

  - Proposed ODER, a first *online deep equilibrium learning* framework with theoretical guarantees for data-intensive imaging modalities that adopts stochastic processing of measurements within an implicit neural network (in [c 4]).
  - Improved reconstruction efficiency by providing various scalable optimization algorithms for large-scale imaging, including block-coordinate and asynchronous distributed variants (in [j 11], [c 14], and [c 9]).

- **Physics Informed Deep Learning Methods**

  - Proposed DOLCE, a new conditional diffusion probabilistic model based framework for limited-angle computational tomography (in [c 1]). This work was performed on LLNL HPC with distributed training.
  - Provided a *coordinate-based internal learning* (CoIL) method for continuously representation of the measurement filed (in [j 5]), inspired by neural representation fields (NeRF).
  - Proposed and analyzed SGD-Net as a new methodology for improving the efficiency of deep unfolding through stochastic approximations of the data-consistency layers (in [j 6]).
  - Proposed RARE algorithm using deep network as regularizer trained for more general artifact-removal on datasets containing only undersampled measurements (in [j 9]).
  - Proposed a novel image reconstruction algorithm (Cal-RED) that enables joint calibration of the measurement operator along with reconstruction of the unknown image (in [c 6]).

SELECTED PUBLICATIONS

('∗' indicates equal contribution.)
Under review

[u 1] Z. Zou∗, **J. Liu**∗, S. Shoushtari, Y. Wang, W. Gan, and U. S. Kamilov, "FLAIR: A Conditional Diffusion Framework with Applications to Face Video Restoration." arXiv:2311.15445, 2023.

[u 2] S. Shoushtari∗, **J. Liu**∗, E. P. Chandler, M. S. Asif, and U. S. Kamilov, "Prior Mismatch and Adaptation in PnP-ADMM with a Nonconvex Convergence Analysis." arXiv:2310.00133, 2023.

[u 3] M. Renaud, **J. Liu**, V. De Bortoli, A. Almansa, and U. S. Kamilov, " Plug-and-Play Posterior Sampling under Mismatched Measurement and Prior Models." arXiv:2310.03546, 2023.

Journal

[j 1] Z. Zou∗, **J. Liu**∗, B. Wohlberg, and U. S. Kamilov, "Deep Equilibrium Learning of Explicit Regularization Functionals for Imaging Inverse Problems." **IEEE Open J. Signal Process.**, vol 4, pp. 390-398, 2023.

[j 2] **J. Liu**, R. Hyder, M.S. Asif, and U.S. Kamilov, "Chapter 3 - Optimization Algorithms for MR Reconstruction." Advances in Magnetic Resonance Technology and Applications, vol 7, pp. 59–72, 2022.

[j 3] S. Shoushtari, **J. Liu**, Y. Hu, and U. S. Kamilov, "Deep Model-Based Architectures for Inverse Problems under Mismatched Priors." **IEEE J. Sel. Areas Inf. Theory.**, pp. 1–1, 2022.

[j 4] Z. Zhang, **J. Liu** and D. Yang, U.S. Kamilov, and G. Hugo, "Best in Physics (Imaging): Deep Learning-Based Motion Compensation for 4D-CBCT Reconstruction." **Medical Physics**, vol 49, 2022.

[j 5] Y. Sun, **J. Liu**, M. Xie, B. Wohlberg, and U. S. Kamilov, "CoIL: Coordinate-Based Internal Learning for Tomographic Imaging." **IEEE Trans. Comput. Imag.**, vol 7, pp. 1400-1412, 2021.

[j 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 Trans. Comput. Imag.**, vol 7, pp. 598-610, 2021.

[j 7] Z. Wu, Y. Sun, A. Matlock, **J. Liu**, L. Tian, and U. S. Kamilov, "SIMBA: Scalable Inversion in Optical Tomography using Deep Denoising Priors." **IEEE J. Sel. Topics Signal Process.**, pp. 1–1, 2020.

[j 8] 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.

[j 9] **J. Liu**, Y. Sun, C. Eldeniz, W. Gan, H. An, and U. S. Kamilov, "RARE: Image Reconstruction using Deep Priors Learned without Ground Truth." **IEEE J. Sel. Topics Signal Process.**, pp. 1–1, 2020.

[j 10] C. Eldeniz, W. Gan, S. Chen, T. J. Fraum, D. R. Ludwig, Y. Yan, **J. Liu**, T. Vahle, U. B. Krishnamurthy, U. S. Kamilov, and H. An, "Phase2Phase: Respiratory Motion-Resolved Reconstruction of Free-Breathing Magnetic Resonance Imaging Using Deep Learning Without a Ground Truth for Improved Liver Imaging," **Invest. Radiol.**, 2021.

[j 11] Y. Sun*, **J. Liu***, and U. S. Kamilov, "Block Coordinate Regularization by Denoising." **IEEE Trans. Comput. Imag.**, vol 6, pp. 908-921, 2020.

[j 12] M. Torop, S. Kothapalli, Y. Sun, **J. Liu**, S. Kahali, D. A. Yablonskiy, and U. S. Kamilov, "Deep Learning using a Biophysical Model for Robust and Accelerated Reconstruction of Quantitative, Artifact-free and Denoised R_2^* Images," **Magn. Reson. Med.**, vol 84, pp. 2932-2942, 2020.

[j 13] G. Song, Y. Sun, **J. Liu**, and U. S. Kamilov, "A New Recurrent Plug-and-Play Prior Based on the Multiple Self-Similarity Network." **IEEE Signal Process. Lett.**, vol.27, pp. 451-455, 2020.

Conference

[c 1] **J. Liu**, R. Anirudh, J. J. Thiagarajan, S. He, K. A. Mohan, U. S. Kamilov, and H. Kim, "DOLCE: A Model-Based Probabilistic Diffusion Framework for Limited-Angle CT Reconstruction." **ICCV 2023**, [**Acceptance rate: 2160/8088 = 27%**].

[c 2] W. Gan, S. Shoushtari, Y. Hu, **J. Liu**, H. An, and U. S. Kamilov "Block Coordinate Plug-and-Play Methods for Blind Inverse Problems." **NeurIPS 2023**, [**Acceptance rate: 3218/12343 = 26%**].

[c 3] T. Kerepecky, **J. Liu**, X.W. Ng, D.W. Piston, and U.S. Kamilov, "Dual-Cycle: Self-Supervised Dual-View Fluorescence Microscopy Image Reconstruction using CycleGAN." Proc. IEEE Int. Conf. Acoustics, Speech and Signal Process. (**ICASSP 2023**).

[c 4] **J. Liu***, X. Xu*, W. Gan, S. Shoushtari, and U. S. Kamilov, "Online Deep Equilibrium Learning for Regularization by Denoising." **NeurIPS 2022**, [**Acceptance rate: 2665/10411 = 26%**].

[c 5] **J. Liu**, M. S. Asif, B. Wohlberg, and U. S. Kamilov, "Recovery Analysis for Plug-and-Play Priors using the Restricted Eigenvalue Condition." **NeurIPS 2021**, [**Acceptance rate: 2371/9122 = 26%**].

[c 6] M. Xie*, **J. Liu***, Y. Sun, W. Gan, B. Wohlberg, and U. S. Kamilov, "Joint Reconstruction and Calibration using Regularization by Denoising with Application to Computed Tomography." **ICCV Workshop 2021 [Oral]**.

[c 7] W. Gan, Y. Hu, C. Eldeniz, **J. Liu**, Y. Chen, H. An, and U. S. Kamilov, "SS-JIRCS: Self-Supervised Joint Image Reconstruction and Coil Sensitivity Calibration in Parallel MRI without Ground Truth," **ICCV Workshop 2021**.

[c 8] **J. Liu**, Y. Sun, W. Gan, X. Xu, B. Wohlberg, and U. S. Kamilov, "Stochastic Deep Unfolding for Imaging Inverse Problems." Proc. IEEE Int. Conf. Acoustics, Speech and Signal Process. (**ICASSP 2021**).

[c 9] Y. Sun, **J. Liu**, Y. Sun, B. Wohlberg, and U. S. Kamilov, "Async-RED: A Provably Convergent Asynchronous Block Parallel Stochastic Method using Deep Denoising Priors." **ICLR 2021**, [**Spotlight: 114/2997 = 4%**].

[c 10] W. Gan, Y. Sun, C. Eldeniz, **J. Liu**, H. An, and U. S. Kamilov, "Deep Image Reconstruction using Unregistered Measurements without Groundtruth," Proc. Int. Symp. Biomedical Imaging 2021 (**ISBI 2021**), pp. 1531-1534.

[c 11] W. Gan, C. Eldeniz, **J. Liu**, H. An, and U. S. Kamilov, "Image Reconstruction for MRI using Deep CNN Priors Trained without Groundtruth," **Proc. 54th Asilomar Conf. Signals, Systems, & Computers**, 2020.

[c 12] X. Xu, **J. Liu**, Y. Sun, B. Wohlberg, and U. S. Kamilov, "Boosting the Performance of Plug-and-Play Priors via Denoiser Scaling." Proc. 54th Asilomar Conf. Signals, Systems, & Computers, 2020.

[c 13] **J. Liu**, Y. Sun, and U. S. Kamilov, "Infusing Learned Priors into Model-Based Multispectral Imaging." IEEE International Workshop on Computational Advances in Multi-Sensor Adaptive Processing (**CAMSAP 2019**).

[c 14] Y. Sun, **J. Liu**, and U. S. Kamilov, "Block Coordinate Regularization by Denoising." **NeurIPS 2019**, [**Acceptance rate: 1428/6743 = 21%**].

[c 15] Z. Wu, Y. Sun, **J. Liu**, and U. S. Kamilov, "Online Regularization by Denoising with Application to Phase Retrieval." **ICCV Workshop 2019**, [**Oral**].

[c 16] **J. Liu**, Y. Sun, X. Xu, and U. S. Kamilov, "Image Restoration using Total Variation Regularized Deep Image Prior." Proc. IEEE Int. Conf. Acoustics, Speech and Signal Process. (**ICASSP 2019**), pp. 7715-7719.

PATENTS

[1] "Self-Supervised Joint Image Reconstruction and Coil Sensitivity Calibration in Parallel MRI Without Ground Truth," with U. S. Kamilov, H. An, Y. Hu, W. Gan, C. Eldeniz, and Y. Chen (pending)

[2] "Systems and Methods of Reconstructing Magnetic Resonance Images using Deep Learning," with H. An, U. S. Kamilov, W. Gan, and C. Eldeniz (pending)

TECHNICAL SKILLS

- Proficient with programming languages: Java, Python, C Programming, Matlab.

- Proficient with deep learning frameworks: Pytorch/Pytorch Lightning, TensorFlow, and Jax.

- Five years of experience in computer vision, deep learning, optimization, inverse problems and medical imaging.

- Fluency in imaging modality: image deconvolution, compressive sensing, and tomography.

APPLICABLE COURSEWORK

- *Sparse Modeling for Imaging and Vision*
- *Machine Learning*
- *Probability and Stochastic Process*
- *Biological Imaging Technology*
- *Algorithms for Nonlinear Optimization*
- *Mathematics of Imaging Science*
- *Digital Signal Processing*
- *Topology*
- *Optimization*
- *Partial Differential Equation*
- *Digital Image Processing*

PROFESSIONAL SERVICES

Reviewer for journals

Neurocomputing, Neural Computing and Applications (**NCAA**), Optical Communication, IEEE Transactions on Image Processing (**TIP**), IEEE Transactions on Signal Processing (**TSP**), International Journal of Intelligent Systems (**IJIS**), IEEE Transactions on Computational Imaging (**TCI**), IEEE Transactions on Neural Networks and Learning Systems (**TNNLS**), Applied Mathematical Modelling, Scientific Reports.

Reviewer for conferences

International Conference on Machine Learning (**ICML**), International Conference on Learning Representations (**ICLR**), Neural Information Processing Systems (**NeurIPS**), IEEE/CVF Computer Vision and Pattern Recognition Conference (**CVPR**), IEEE International Conference on Acoustics, Speech and Signal Processing (**ICASSP**), IEEE International Conference on Image Processing (**ICIP**), IEEE International Symposium on Biomedical Imaging (**ISBI**), IEEE/CVF International Conference on Computer Vision (**ICCV / ICCV Workshop**).

Others

Student Member, IEEE Signal Processing Society (2019-present)

TEACHING SERVICE

As Course Teaching Assistant:

- ESE 415 Optimization, Wash U. 2020 Spring, 2021 Spring.

- CSE 534 Large-Scale Optimization, Wash U. 2020 Fall, 2021 Fall, 2022 Fall.

SUPERVISED STUDENTS

Current Students (Co-advised with Prof. Kamilov):

- Yubo Wang (B.S. ESE), *Now Ph.D student at WUSTL*
- Zihao Zou (M.S. ESE), *Now M.S. student at WUSTL*
- Marien Renaud (M.S. ESE), *Now Ph.D student at Institut de Mathématiques de Bordeaux (IMB)*

Former Students (Co-advised with Prof. Kamilov):

- Zichen Zhang (M.S. ESE), *Now M.S. student at WUSTL*
- Guangyu Meng (M.S. CSE), *Now Ph.D student at Uni. of Notre Dame*
- Jialu Wang (B.S. CSE) *Now B.S. student at WUSTL*
- Peter Ming (B.S. CSE), *Now in Google*
- Max Trop (M.S. CSE), *Now Ph.D student at Northeastern U.*
- Mingyang Xie (B.S. CSE), *Now Ph.D student at University of Maryland*
- Ziwen Wang (B.S. CSE), *Now M.S. student at WUSTL*