

# Weijie Gan

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## BIOGRAPHY

I am a **fourth-year Ph.D. student from Computer Science** department at **Washington University in St. Louis**, advised by **Dr. Ulugbek Kamilov** and **Dr. Hongyu An**. My research focuses on algorithms designs and theoretical analysis for deep learning-based computational imaging. My research topics include diffusion models, self-supervised representation learning, image reconstruction, image registration, and correction of physical model uncertainty. My work has been shown to deliver real-world impact for various imaging applications, including computational photography, MRI, PET, and ptychography.

**Research Interests:** Computer Vision, Computational Imaging, Medical Imaging, Optimization.

## EDUCATION

<b>Washington University in St. Louis</b> , St. Louis, MO, United States Ph.D. Candidate in Computer Science Advisor: Prof. Ulugbek Kamilov and Prof. Hongyu An	2020.08 - Expected 2024
<b>Washington University in St. Louis</b> , St. Louis, MO, United States M.Sc. in Computer Science	2018.08 - 2020.05
<b>South China University of Technology</b> , Guangzhou, China B.Eng. in Automation & B.Business in Administration (dual-degree)	2014.08 - 2018.05

## WORK EXPERIENCE

<b>Siemens Healthineers</b> , Knoxville, TN, United States Research Intern in the <i>Physics Group of Molecular Imaging</i> Worked with <i>Dr. Jorge Cabello</i> and <i>Dr. Maurizio Conti</i> on a MRI-guided PET reconstruction algorithm based on deep generative models.	2023.05 - 2023.08
<b>Los Alamos National Laboratory (LANL)</b> , Los Alamos, NM, United States Research Intern in the <i>Applied Mathematics and Plasma Physics Group (T-5)</i> Worked with <i>Dr. Brendt Wohlberg</i> on (a) ptychographic image reconstruction algorithm for efficient and high-quality imaging, and (b) contributing on the codebase of <a href="#">Scientific Computational Imaging Code (SCICO)</a> .	2022.05 - 2022.10

## AWARDS

- IEEE CAMSAP Student Paper Award finalist
- AAPM Imaging Best-in-Physics Awards
- Honor PhD (**top 15%**), Department of Computer Science, Washington University in St. Louis, 2021.
- 2019 Fall & 2020 Spring **Master's Fellowship** of Washington University in St. Louis.
- 2019 Fall & 2020 Spring **Engineering School Tuition Scholarship** of Washington University in St. Louis.
- 2015 & 2016 **Annual Third Prize Scholarship** of South China University of Technology.

## RESEARCH SUMMARY

**Learning without Groundtruth for Imaging Inverse Problems**

- Propose DeCoLearn to train DL models exclusively on unregistered noisy measurements by jointly performing image reconstruction and image registration [b7][b10].
- Propose SelfDEQ to *provably* train deep equilibrium model for imaging without ground truth [b5].
- Propose various self-supervised algorithms for imaging that rely on data partition along temporal [b9], spatial [b11], and sampling dimensions [b21][b5][a4].

### Joint Inference of Image and System Unknown

- Propose BC-PnP as a principal framework with theoretical guarantees for blind inverse problems that uses denoisers as priors for both images and system unknowns [b4].
- Propose a novel deep unfolding network for parallel MRI that simultaneously estimates images and coil sensitivity maps [a4][b8].

### Deliver Real-World Impact in Medical and Scientific Imaging

- Develop an algorithm for diagnosis-quality free-breathing 4D MRI reconstruction [b9], licensed by Siemens Healthineers [d1] and facilitating down-streaming tasks of motion correction in PET/MRI [b15] and low-field MRI [b12] systems. Developed an algorithm for fast parallel MRI, achieved  $\times 10$  acceleration without sacrificing performance [a4].
- Develop DL methods for quantitative MRI to reconstruct parameter maps and reduce motion-artifact [a5][b16].
- Develop novel DL algorithms to achieve SOTA performance on: (a) *MR image registration* by using denoisers as priors and implicit neural networks [b3], (b) *ptychographic image reconstruction* by using vision transformer and deep unfolding networks [b1], and (c) *video temporal super-resolution* powered by implicit neural representation [b17].
- Propose to apply dimensionality reduction of system model in deep unfolding and deep equilibrium model to handle the high-dimensional data in imaging [b14][b20].

### PUBLICATION

(\*' indicates equal contribution)

#### Preprinted:

- a1 Z. Zou, J. Liu, S. Shoushtari, Y. Wang, **W. Gan**, U. S. Kamilov. "FLAIR: A Conditional Diffusion Framework with Applications to Face Video Restoration". [arXiv:2311.15445].
- a2 **W. Gan**<sup>\*</sup>, H. Xie<sup>\*</sup>, B. Zhou, X. Chen, Q. Liu, X. Guo, L. Guo, H. An, U. S. Kamilov, G. Wang, and C. Liu. "Dose-aware Diffusion Model for 3D Ultra Low-dose PET Imaging". [arXiv:2311.04248].
- a3 **W. Gan**<sup>\*</sup>, C. Park<sup>\*</sup>, Z. Zou, Y. Hu, Z. Sun, and U. S. Kamilov. "A Structured Pruning Algorithm for Model-based Deep Learning". [arXiv:2311.02003].
- a4 **W. Gan**<sup>\*</sup>, Y. Hu<sup>\*</sup>, C. Ying, T. Wang, C. Eldeniz, J. Liu, Y. Chen, H. An, and U. S. Kamilov, "SPICE: Self-Supervised Learning for MRI with Automatic Coil Sensitivity Estimation." [arXiv: 2210.02584].
- a5 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." [arXiv: 2210.06330].

#### Journal & Conference:

- b1 **W. Gan**, Q. Zhai, M. T. McCann, C. G. Cardona, U. S. Kamilov, and B. Wohlberg. "PtychoDV: Vision Transformer-Based Deep Unrolling Network for Ptychographic Image Reconstruction". IEEE Open J. Signal Process. (**OJSP**), *in press*, 2024.
- b2 Y. Hu, S. V. V. N. Kothapalli, **W. Gan**, A. L. Sukstanskii, G. F. Wu, M. Goyal, D. A. Yablonskiy, U. S. Kamilov, "DiffGEPCI: 3D MRI Synthesis from mGRE Signals using 2.5D Diffusion Model," Proc. Int. Symp. Biomedical Imaging (**ISBI**), *in press*, 2024.
- b3 **W. Gan**<sup>\*</sup>, J. Hu<sup>\*</sup>, Z. Sun, H. An, and U. S. Kamilov. "A Plug-and-Play Image Registration Network". Proc. Int. Conf. Learn. Represent. (**ICLR**), 2024. [acceptance rate: 2250/7304=30.8%]

- b4 **W. Gan**, S. Shoushtari, Y. Hu, J. Liu, H. An, and U. S. Kamilov, “Block Coordinate Plug-and-Play Methods for Blind Inverse Problems”, Proc. Adv. Neural Inf. Process. Syst. (**NeurIPS**), 2023. [acceptance rate: 3222/12343=26.1%]
- b5 **W. Gan**, C. Ying, P. E. Boroojeni, T. Wang, C. Eldeniz, Y. Hu, J. Liu, Y. Chen, H. An, and U. S. Kamilov, “Self-Supervised Deep Equilibrium Models for Inverse Problems with Theoretical Guarantees and Applications to MRI Reconstruction”, **IEEE Trans. Comput. Imag. (TCI)**, 2023.
- b6 **W. Gan\***, H. Gao\*, Z. Sun, and U. S. Kamilov, “SINCO: A Novel structural regularizer for image compression using implicit neural representations”, Proc. IEEE Int. Conf. Acoustics, Speech and Signal Process. (**ICASSP**), 2023.
- b7 **W. Gan**, Y. Sun, C. Eldeniz, J. Liu, H. An, and U. S. Kamilov, “Deformation-Compensated Learning for Image Reconstruction without Ground Truth”, **IEEE Trans. Med. Imag. (TMI)**, 2022. [impact factor=11.03]
- b8 **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,” Proc. IEEE Int. Conf. Comp. Vis. (**ICCV**) Workshops, 2021.
- b9 **W. Gan\***, C. Eldeniz\*, S. Chen, T. J. Fraum, D. R. Ludwig, Y. Yan, J. Liu, T. Vahle, U. B. Krishnamurthy, U. S. Kamilov, H. An, “Phase2Phase: Respiratory Motion-Resolved Reconstruction of Free-Breathing MRI Using Deep Learning Without a Ground Truth for Improved Liver Imaging,” **Investig. Radiol.**, 2021. [impact factor=10.06]
- b10 **W. Gan**, Y. Sun, C. Eldeniz, H. An and U. S. Kamilov, “Deep Image Reconstruction using Unregistered Measurements without Groundtruth,” Proc. Int. Symp. Biomedical Imaging 2021 (**ISBI**), 2021.
- b11 **W. Gan**, C. Eldeniz, J. Liu, H. An, and U. S. Kamilov, “Image Reconstruction for MRI using Deep CNN Priors Trained without Ground Truth,” Proc. 54th Asilomar Conf. Signals, Systems, & Computers (**Asilomar**), 2020.
- b12 S. Chen, C. Eldeniz, T. J. Fraum, D. R. Ludwig, **W. Gan**, J. Liu, U. S. Kamilov, D. Yang, H. Michael Gach, and H. An. “Respiratory motion management using a single rapid MRI scan for a 0.35 T MRI-Linac system.”, **Medical physics**, 2023.
- b13 C. Park, S. Shoustari, **W. Gan**, and U. S. Kamilov, “Convergence of Nonconvex PnP-ADMM With MMSE Denoisers,” Proc. Int. Workshop on Computational Advances in Multi-Sensor Adaptive Process. (**CAMSAP**) 2023.
- b14 J. Liu, X. Xu, **W. Gan**, S. Shoushtari, U. S. Kamilov, “Online Deep Equilibrium Learning for Regularization by Denoising”, Proc. Adv. Neural Inf. Process. Syst. (**NeurIPS**), 2022.
- b15 S. Chen, T. J. Fraum, C. Eldeniz, J. Mhlanga, **W. Gan**, T. Vahle, U. B. Krishnamurthy, D. Faul, H. M. Gach, M. M. Binkley, U. S. Kamilov, R. Laforest, H. An, “MR-assisted PET respiratory motion correction using deep-learning based short-scan motion fields”, **Magn. Reson. Med. (MRM)**, 2022.
- b16 X. Xu, S. V. V. N. Kothapalli, J. Liu, S. Kahali, **W. Gan**, D. Yablonskiy, and U. S. Kamilov, “Learning-based Motion Artifact Removal Networks for Quantitative R2\* Mapping,” **Magn. Reson. Med. (MRM)**, 2022.
- b17 W. Shangguan, Y. Sun, **W. Gan**, U. S. Kamilov, “Learning Cross-Video Neural Representations for High-Quality Frame Interpolation”, Proc. European Conference on Computer Vision (**ECCV**), 2022.
- b18 M. Xie, J. Liu, Y. Sun, **W. Gan**, B. Wohlberg, and U. S. Kamilov, “Joint Reconstruction and Calibration using Regularization by Denoising,” Proc. IEEE Int. Conf. Comp. Vis. (**ICCV**) Workshops, 2021.
- b19 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.
- b20 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. (TCI)**, 2021.
- b21 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. Top. Signal Process. (JSTSP)**, 2020.

#### Abstract:

- c1 M. David, Y. Yuan, A. Bacon, A. Movva, S. Shah, B. Lang, **W. Gan**, I. Berke, U. S. Kamilov, S. Lake, “Machine Learning Approaches To Segment And Cluster Cells Of The Cartilage And Capsule In Rat Elbow Histology Sections.” *Osteoarthritis and Cartilage* 31 (2023): S55-S56.

- c2 S. Chen, C. Eldeniz, T. J. Fraum, D. Ludwig, **W. Gan**, U. S. Kamilov, D. Yang, and H. An, “Respiratory Motion Detection and Reconstruction Using CAPTURE and Deep Learning Phase2Phase Network for a 0.35 T MRI-LINAC System,” Ann. Meeting American Association of Physicists in Medicine (**AAPM 2022**) (Washington, DC, 10-14 July), p. 66527, 2022. [**Best-in-Physics Award in Imaging**]
- c3 S. Chen, **W. Gan**, C. Eldeniz, U. S. Kamilov, T. J. Fraum, H. An, “DL-MOTIF: Deep Learning Based Motion Transformation Integrated Forward-Fourier Reconstruction for Free-Breathing Liver DCE-MRI”, Proceedings of the 30th Annual Meeting of the **ISMRM**, pp. 3469, 2022.
- c4 P. E. Boroojeni, P. Commean, C. Eldeniz, **W. Gan**, G. Skolnick, K. Patel, U. S. Kamilov, H. An, “Rapid high-resolution cranial bone MRI using deep-learning prior image reconstruction”, Proceedings of the 30th Annual Meeting of the **ISMRM**, pp. 2440, 2022.
- c5 S. Chen, C. Eldeniz, **W. Gan**, U. S. Kamilov, T. Fraum, H. An, “Forward-Fourier Motion-Corrected Reconstruction for Free-Breathing Liver DCE-MRI”, Proceedings of the 29th Annual Meeting of the **ISMRM**, pp. 0128, 2021.
- c6 S. Chen, C. Eldeniz, **W. Gan**, U. S. Kamilov, D. Yang, M. Gach, H. An, “Respiratory Motion Detection and Reconstruction Using CAPTURE and Deep Learning for a 0.35 T MRI-LINAC System: An Initial Study”, Proceedings of the 29th Annual Meeting of the **ISMRM**, pp. 4254, 2021.
- c7 J. Liu, C. Eldeniz, Y. Sun, **W. Gan**, S. Chen, H. An, U. S. Kamilov, “RED-N2N: Image reconstruction for MRI using deep CNN priors trained without ground truth”, Proceedings of the 28th Annual Meeting of the **ISMRM**, pp. 0993, 2020.
- c8 C. Eldeniz, **W. Gan**, S. Chen, J. Liu, U. S. Kamilov, H. An, “Phase2Phase: Reconstruction of free-breathing MRI into multiple respiratory phases using deep learning without a ground truth”, Proceedings of the 28th Annual Meeting of the **ISMRM**, pp. 0807, 2020.

#### Patent:

- d1 H. An, U. S. Kamilov, **W. Gan**, C. Eldeniz, and J. Liu, “Systems and Methods of Reconstructing Magnetic Resonance Images using Deep Learning,” US Patent App. 17/079,177, 29 2021.
- d2 U. S. Kamilov, H. An, Y. Hu, J. Liu, C. Eldeniz, **W. Gan**, and Y. Chen, “Self-supervised joint image reconstruction and coil sensitivity calibration in parallel mri without ground truth.” US. Patent App. 17/968,541, 2023

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#### PRESENTATION & TALK

- p1 “SINCO: A Novel structural regularizer for image compression using implicit neural representations”, Asilomar 2023, Pacific Grove, CA, USA.
- p2 “Deep Learning Method for Accelerated Magnetic Resonance Imaging (MRI) without Groundtruth”, WashU Imaging Sciences Pathway (ISP) Retreats 2021, Virtual.
- p3 “Deep Image Reconstruction using Unregistered Measurements without Groundtruth”, Proc. Int. Symp. Biomedical Imaging (ISBI), 2021, Virtual.
- p4 “Image reconstruction for MRI using deep CNN priors trained without ground truth”, Proc. 54th Asilomar Conf. Signals, Systems, & Computers (Asilomar), 2020, Virtual.

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#### PROFESSIONAL SERVICES

##### Professional societies:

- IEEE Student Member and IEEE Signal Processing Society Student Member (2020 - present).
- The International Society for Magnetic Resonance in Medicine (ISMRM), Graduate Trainee (2020 - present).

##### Journal Reviewer:

- BMC Medical Imaging

- **Scientific Report**
- IEEE Transaction on Medical Imaging (**TMI**), Distinguished Reviewer 2022-2023
- IEEE Transaction on Computational Imaging (**TCI**)
- IEEE Transaction on Image Processing (**TIP**)
- IEEE Transactions on Circuits and Systems for Video Technology (**TCSVT**)

#### Conference Reviewer/PC:

- International Conference on Learning Representations (**ICLR 2024**)
- Conference on Neural Information Processing Systems (**NeurIPS 2023**), Top Reviewer 2023
- IEEE CVF Computer Vision and Pattern Recognition Conference (**CVPR 2023/2024**)
- European Conference on Computer Vision (**ECCV 2024**)
- Asian Conference on Computer Vision (**ACCV 2024**)
- IEEE CVF International Conference on Computer Vision (**ICCV 2023**)
- IEEE CVF International Conference on Computer Vision Workshop (**ICCVW 2021**)
- IEEE International Symposium on Biomedical Imaging (**ISBI 2021/2022/2023/2024**)
- IEEE International Conference on Acoustics, Speech and Signal Processing (**ICASSP 2022/2023/2024**)
- International Conference on Machine Learning (**ICML 2022**)
- IEEE International Conference on Image Processing (**ICIP 2022/2023**)
- International Symposium on Computational Sensing (**ISCS 2023**)

#### MEDIA COVERAGE

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- m1 “New deep learning method boosts MRI results without requiring new data.” by Beth Miller, Newsroom of the WashU Source, 7 September 2021, <https://source.wustl.edu/2021/09/new-deep-learning-method-boosts-mri-results-without-requiring-new-data/>.
- m2 “New deep learning method boosts MRI results without requiring new data” by Beth Miller, Medical Press, 7 September 2021, [https://medicalxpress.com/news/2021-09-deep-method-boosts-mri-results.html?src\\_id=alt](https://medicalxpress.com/news/2021-09-deep-method-boosts-mri-results.html?src_id=alt)
- m3 “A single MRI scan can manage respiratory motion” by Tami Freeman, PhysicsWorld, 19 Jul 2022, <https://physicsworld.com/a/a-single-mri-scan-can-manage-respiratory-motion/>.

#### TEACHING SERVICE

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##### As Course Teaching Assistant:

- ESE 415 Optimization, WashU. 2021 Spring & 2022 Spring & 2023 Spring
- ESE 513/CSE 534A Large-Scale Optimization for Data Science, WashU. 2021 Fall & 2022 Fall & 2023 Fall

#### STUDENT SUPERVISION

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##### Co-advised with Prof. Ulugbek Kamilov:

- Harry, Gao (Undergrad student), achievement: [b6].
- Yuan, Yangpeng (Undergrad student, now at Duke), achievement: [c1].
- Hu, Yuyang (MS student, now Ph.D. at WashU), achievement: [a4].
- Ian, Hudson (MS student, now at Microsoft)
- Huang, Nan (MS student)
- Jing, Dian (MS student)
- Siu, Vincent (Undergrad student)
- Park, Chicago (Undergrad student), achievement: [a3].
- James, H. Tillman (Undergrad student)
- Hu, Junhao (MS student, now Ph.D. at WashU), achievement: [b3].