Tao Hong

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About Me

My research focuses on developing *theoretically* grounded and computationally *efficient* algorithms that enable reliable and efficient AI for imaging science. I aim to bridge data-driven learning with principled modeling to ensure *efficiency*, *interpretability*, *generalizability*, and clinical *trustworthiness* in AI-powered methods.

At the intersection of computational imaging, deep learning, large-scale optimization, and computer vision, my work advances AI-driven imaging algorithms that efficiently and reliably address challenging real-world problems across modalities, including natural image processing (e.g., image super-resolution, deblurring, and inpainting) and biomedical imaging (e.g., MRI, photoacoustic computed tomography, optical diffraction tomography, and Fourier ptychography). I am particularly enthusiastic about cross-domain innovation, in which insights from mathematics, physics, and machine learning converge to advance the next generation of reliable AI systems for imaging science.

Research Interests

- Numerical Optimization and Scientific Computing
- Interpretable/Reliable AI Models for Imaging Science
- Signal Processing, Machine Learning, Computational Imaging, and Inverse Problems

Education

Ph.D. in the Faculty of Computer Science (Direct Track), Technion 2016 - 2021

- Title of thesis: Numerical Optimization and Multigrid Computational Methods with Applications
- Advisors: Prof. Irad Yavneh and Dr. Michael Zibulevsky
- Thesis committee: Irad Yavneh, Michael Zibulevsky, Michael Elad, and Hans De Sterck

Zhejiang University of Technology (ZJUT) 2008 - 2012

- Major: Telecommunications Engineering
- Title of thesis: High-Performance FFT Implementation on FPGA Platforms
- Advisor: Prof. Gang Li

Work Experience

Oden Institute, University of Texas at Austin (UT, Austin) Mar. 2025 - present

Postdoctoral Fellow with Prof. Umberto E. Villa

- Developed computationally and memory-efficient methods for 5D (3D space + time + wavelength) Photoacoustic Computed Tomography (PACT) reconstruction.
- Developed efficient and reliable AI models for PACT, as well as digital phantoms for training and validation.

EECS, University of Michigan (Umich), Ann Arbor Dec. 2021 - Feb. 2025

Postdoctoral Fellow with Prof. Jeffrey A. Fessler and Dr. Luis Hernandez-Garcia

- Developed provable data-driven methods for compressed sensing MRI reconstruction.
- Developed theory-driven methods for optimizing 3D MRI sampling trajectories.
- Developed theory-driven methods for optimizing arterial spin labeling (ASL) and MR fingerprinting (MRF) sequences to achieve fast, simultaneous, and robust quantification of multiple cerebral perfusion parameters.

EPFL, Lausanne, Switzerland Aug. 2019 - Nov. 2019

Visiting Student with Prof. Michael Unser

- Developed efficient multigrid methods for accelerating reconstruction in diffraction tomography, particularly specializing in high refractive-index subjects.
- Developed computationally and memory-efficient mini-batch high-order methods for accelerating reconstruction in 3D optical diffraction tomography.

ZJUT Sep. 2012 - Feb. 2016

Research Assistant with Prof. Gang Li

- Designed low-complexity, robust digital filter structures.
- Optimized sensing matrices for compressed sensing.
- Developed hardware systems for diverse real-world applications.

Honors and Awards

Travel Awards

- 2026 ICERM – Stochastic and Randomized Algorithms in Scientific Computing: Foundations and Applications – long term visitor (Jan. 20 - Apr. 24), Award for Traveling and Lodging, Brown University
- 2025 IPAM – Research Collaboration Workshop, Randomized Numerical Linear Algebra (RNLA), Award for Traveling and Lodging, UCLA
- 2025 ICERM – Scientific Machine Learning for Gravitational Wave Astronomy, Award for Traveling and Lodging, Brown University
- 2024 Computational Imaging Workshop, Award for Traveling and Lodging, IMSI, University of Chicago
- 2023 MTMI workshop, Award for Traveling and Lodging, University of Chicago
- 2023 ICERM – Acceleration and Extrapolation Methods, Award for Traveling and Lodging, Brown University

Scholarships and Awards

- 2014 National Scholarship for Graduate Students, the Ministry of Education, China
- 2014 2nd Class Academic Scholarship of ZJUT
- 2013 2nd Class Academic Scholarship of ZJUT
- 2012 New Graduate Scholarship of ZJUT
- 2011 2nd Class Academic Scholarship of ZJUT
- 2011 1st Prize of the Third National College Students' Mathematical Contest (Zhejiang Province)

Research Experience

Provable, Efficient, Robust, and Reliable Learning Algorithms 2021 - present

- Developed efficient algorithms for learning-based CS MRI reconstruction with convergence guarantees. Supported by *NIH R01 NS112233*.
- Optimized time schedules in ASL-MRF for estimating multiple cerebral perfusion parameters. Supported by *NIH R01 NS112233*.
- Studied uncertainty quantification in learning-based inverse problems and medical foundation models.
- Designed robust and safe AI models for biomedical imaging, resilient to adversarial attacks and robust against corrupted training data.

Efficient Numerical Algorithms for Large-Scale Problems 2016 - present

- Developed computational/memory efficient high-order/subspace/randomized methods with convergence guarantees tailored for 3D optical diffraction tomography and 5D dynamic photoacoustic computed tomography image reconstruction. Supported by *ERC Advanced Grant GlobalBioIm* and *NIH R01 EB034261*.
- Studied generalized acceleration techniques that accelerate iterative methods without incurring additional computational cost. Supported by *Israel Science Foundation No. 1639/19*.
- Explored hybrid strategies that integrate numerical optimization with multigrid methods to advance large-scale scientific computing. Supported by *Israel Science Foundation No. 1639/19*.
- Optimized sensing matrices and dictionary learning techniques to enhance imaging systems.

Other Earlier Research Experience 2010 - 2016

- Studied robust digital filter structures against finite word-length effects with state-space methods, demonstrating that well-designed structures can preserve performance with only 4-bit coefficient representations — a key for *efficient AI deployment*. Supported by NSFC.
- Developed hardware systems on FPGA, MC51 microcontroller, and ARM platforms, implementing applications such as signal generation, traffic light management, and interactive museum explanation devices.

Publications

Journals (__ indicates corresponding author)

[22] **Tao Hong**, Zhaoyi Xu, Jason Hu, and Jeffrey A. Fessler, "On adapting randomized Nyström preconditioners to accelerate variational image reconstruction," *To appear in IEEE Transactions on Computational Imaging*, 2025. [link][pdf][code]

[21] **Tao Hong**, Xiaojian Xu, Jason Hu, and Jeffrey A. Fessler, "Provable preconditioned plug-and-play approach for compressed sensing MRI reconstruction," *IEEE Transactions on Computational Imaging*, vol. 10, pp. 1476 - 1488, Oct. 2024. [link][pdf][code]

[20] **Tao Hong**, Luis Hernandez-Garcia, and Jeffrey A. Fessler, "A complex quasi-Newton proximal method for image reconstruction in compressed sensing MRI," *IEEE Transactions on Computational Imaging*, vol. 10, pp. 372 - 384, Feb. 2024. [link][pdf][code]

[19] **Tao Hong** and Irad Yavneh, "On adapting Nesterov's scheme to accelerate iterative methods for linear problems," *Numerical Linear Algebra with Applications*, e2417, Mar. 2022. [link] [pdf][code]

[18] **Tao Hong**, Irad Yavneh, and Michael Zibulevsky, "Solving RED with weighted proximal methods," *IEEE Signal Processing Letters,* vol. 27, pp. 501-505, Mar. 2020. [link] [pdf] [slides][code]

[17] **Tao Hong**, Yaniv Romano, and Michael Elad, "Acceleration of RED via vector extrapolation," *Journal of Visual Communication and Image Representation,* vol. 63, Aug. 2019. [link] [pdf][code]

[16] **Tao Hong**, Xiao Li, Zhihui Zhu, and Qiuwei Li, "Optimized structured sparse sensing matrices for compressive sensing," *Signal Processing,* vol. 159, pp. 119-129, Jun. 2019. [link] [pdf]

[15] **Tao Hong** and Zhihui Zhu, "Online learning sensing matrix and sparsifying dictionary simultaneously for compressive sensing," *Signal Processing*, vol. 153, pp. 188-196, Dec. 2018. [link][pdf][code]

[14] **Tao Hong** and Zhihui Zhu, "An efficient method for robust projection matrix design," *Signal Processing*, vol. 143, pp. 200-210, Feb. 2018. [link][pdf][code]

[13] **Tao Hong**, Huang Bai, Sheng Li, and Zhihui Zhu, "An efficient algorithm for designing projection matrix in compressive sensing based on alternating optimization," *Signal Processing,* vol. 125, pp. 9-20, Aug. 2016. [link][code]

Preprints and Under Review

[12] **Tao Hong**, Jenil Shah, Luke Lozenski, Refik Cam, Mark Anastasio, and Umberto Villa, "A low-rank promoting image prior for accurate estimation of tumor perfusion rates in dynamic contrast-enhanced photoacoustic tomography", *submitted to SPIE Imaging*, 2025.

[11] **Tao Hong**, Umberto Villa, and Jeffrey A. Fessler, "A convergent generalized Krylov subspace method for compressed sensing MRI reconstruction with gradient-driven denoisers," *submitted to IEEE Transactions on Computational Imaging*, 2025. [link][pdf]

[10] **Tao Hong**, Zhaoyi Xu, Se Young Chun, Luis Hernandez-Garcia, and Jeffrey A. Fessler, "Convergent complex quasi-Newton proximal methods for gradient-driven denoisers in compressed sensing MRI reconstruction," *submitted to IEEE Transactions on Computational Imaging after Major Revision*, 2025. [link][pdf][website][code]

[9] **Tao Hong**, Zhaoyi Xu, Jason Hu, and Jeffrey A. Fessler, "On adapting randomized Nyström preconditioners to accelerate variational image reconstruction," *submitted to IEEE Transactions on Computational Imaging after Major Revision*, 2025. [link][pdf][code]

[8] **Tao Hong**, Thanh-an Pham, Irad Yavneh, and Michael Unser, "A mini-batch quasi-Newton proximal method for constrained total variation nonlinear image reconstruction," *submitted to SIAM Journal on Imaging Sciences*, 2025. [link][pdf][poster][code]

[7] **Tao Hong**, Thanh-an Pham, Eran Treister, and Michael Unser, "Diffraction tomography with Helmholtz equation: Efficient and robust multigrid-based solver," *In preprint.* [link][pdf]

[6] **Tao Hong**, Irad Yavneh, and Michael Zibulevsky, "Merging multigrid optimization with SESOP," *In preprint.* [link][pdf][slides]

Conference Proceedings and Abstracts

[6] **Tao Hong**, Luis Hernandez-Garcia, and Jeffrey A. Fessler, "Fast double stochastic proximal method for CS-MRI reconstruction with multiple wavelets", ISMRM, 2024. Abstract

[5] **Tao Hong**, Luis Hernandez-Garcia, and Jeffrey A. Fessler, "Complex quasi-Newton proximal methods for the image reconstruction in compressed sensing MRI", ISMRM, 2023. Abstract

[4] **Tao Hong**, Huang Bai, Yabin Wei, Jie Yang, and Zhihui Zhu, "Sparse two-dimensional FIR digital filters design using FISTA", *Image and Signal Processing (CISP), 2014 IEEE 7th International Congress on,* pp. 815-819, Oct. 2014.

[3] **Tao Hong**, Huang Bai, Sheng Li, Chaogeng Huang, and Liping Chang, "A new method for design allpass filters with equiripple group delay errors," *Industrial Electronics and Applications (ICIEA), 2014 IEEE 9th Conference on*, pp. 1024-1028, Jun. 2014.

[2] **Tao Hong**, Chaogeng Huang, Gang Li, and Yongching Lim, "A Hessenberg-based input balanced realization for all-pass systems," *Information, Communications and Signal Processing (ICICS) 2013 IEEE 9th International Conference on,* pp. 1-5, Dec. 2013.

[1] **Tao Hong**, Si Tang, Gang Li, Xiongxiong He, and Liping Chang,"All-pass based efficient and robust structures for finite precision implementation of digital filters," *Control Conference (CCC), 2013 IEEE 32nd Chinese*, pp. 4517-4522, Jul. 2013.

Teaching Experience

Teaching Assistant

- Graduate course *Advanced Signal Processing* (ZJUT, Fall 2013, taught by Prof. Gang Li, 48 hours).
- Graduate course *Signal Analysis* (ZJUT, Spring 2013, taught by Prof. Gang Li, 32 hours).
- Undergraduate course *Signal and System* (ZJUT, Spring 2012, taught by Prof. Gang Li, 64 hours).

Student Mentoring

- David Frey (Sep. 2024 - present, main advisor: Dr. Douglas Noll) PhD in Umich BME, Topic: 3D dynamic MRI reconstruction.
- Jason Hu (Sep. 2022 - present, main advisor: Dr. Jeffrey Fessler) PhD in Umich EECS, Topic: Diffusion models in inverse problems. (publications: [10] [22])
- Jenil Shah (Mar. 2025 - Aug. 2025, main advisor: Dr. Umberto Villa) Master in UT Austin CSEM program, Thesis title: *Low rank-based image reconstruction methods for dynamic contrast enhanced multispectral optoacoustic tomography.* (publication: [13])

Invited Talks

- 2026 Virginia Tech, Mathematics Department Seminar
- 2024 UT Austin, Oden Institute, OPTIMUS center
- 2024 SIAM Conference on Imaging Science, Advanced Approaches in Inverse Problems and Applications
- 2024 Chinese University of Hong Kong, Mathematics Department Seminar
- 2024 Nanjing University, Mathematics Department Seminar
- 2024 Southeast University, Mathematics Department Seminar
- 2023 Zhejiang University, College of Control Science and Engineering Seminar
- 2023 Xi'an Jiaotong–Liverpool University, Mathematics Department Seminar
- 2023 ShanghaiTech University, School of Information Science and Technology Seminar
- 2021 University of Michigan, Ann Arbor, Image and Signal Processing Group and fMRI Lab
- 2021 Rice University, Computational Imaging Lab
- 2021 Duke University, Computational Optics Lab
- 2021 Caltech, Computational Cameras
- 2019 EPFL, Biomedical Imaging Group

Professional Service

Journal Reviewers: SIAM Journal on Imaging Sciences, SIAM Journal on Scientific Computing, IEEE Open Journal of Signal Processing, IEEE Signal Processing Letters, IEEE Trans. Signal Processing, IEEE Trans. Computational Imaging, IEEE Trans. on Biomedical Engineering, IEEE Trans. Circuits and Systems for Video Technology, IEEE Trans. CAS-II, Journal of Computational and Applied Mathematics, Magnetic Resonance in Medicine, Signal Processing, Digital Signal Processing

Conference Reviewers: ICICS, ICIEA, ISBI, CPAL, and others.

Membership: IEEE