Zhiyang Fu

Curriculum Vitae

Phone: (520) 360-2133
Email: zyfu@arizona.edu
WWW: http://zhiyang-fu.github.io

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Summary

- ◇ Postdoc in Dept. of Medical Imaging with research on image reconstruction and Monte Carlo simulation of cone-beam Computed Tomography (CT)
- ◇ Ph.D. in Electrical & Computer Engineering with research on image reconstruction and quantitative parameter mapping of Magnetic Resonance Imaging (MRI)
- ◇ Filed two U.S. provisional patent applications on MRI streak reduction and neural field based medical image reconstruction respectively
- ◇ Broad knowledge in Engineering: information theory, detection and estimation in engineering systems, channel coding, and linear and nonlinear optimization
- ◇ Knowledge of digital image processing, medical imaging science and computer vision
- ◇ Knowledge of fundamental theories of machine learning and convolutional neural networks
- ◇ Knowledge of k-space sampling design for non-Cartesian parallel imaging
- ◇ Experience of undergraduate laboratory teaching in Engineering
- ◇ Experience of compressed sensing based image reconstruction for MR parameter mapping
- ◇ Experience of deep learning based image reconstruction for MR parameter mapping and dedicated breast CT
- ◇ Experience of systematic artifact correction in radial MRI
- ◇ Experience of Unix/Linux operating system
- ◇ Operation of Siemens MRI scanner user interface for image acquisition
- ◇ Proficient in Python, MATLAB, and PyTorch, familiar with TensorFlow, Torch7, Lua, Caffe

Education

2010–2014	B.Sc. in Optical Engineering	Zhejiang University
2014–2017	M.Sc. in Electrical & Computer Engineering	Univeristy of Arizona
2017–2021	Ph.D. in Electrical & Computer Engineering	University of Arizona

- ◇ Co-advisors: Prof. Ali Bilgin and Prof. Maria I. Altbach
- ◇ GPA 4.0/4.0
- ◇ Minor in College of Optical Science
- ◇ Dissertation: Supervised and Self-supervised Learning for Accelerated Medical Imaging

Graduate Coursework

ECE 559	Fundamentals of Optics for Electrical Engineers
ECE 503	Probability and Random Processes for Engineering Applications
OPTI 637	Principles of Image Science
OPTI 536	Introduction to Image Science
SIE 545	Fundamentals of Optimization
OPTI 636	Noise in Imaging Systems
ECE 501B	Advanced Linear Systems Theory
OPTI 638	Advanced Medical Imaging
ECE 639	Detection and Estimation in Engineering Systems
ECE 529	Digital Signal Processing
ECE 637	Channel Coding
ECE 532	Digital Image Analysis

ECE 523 Engineering Applications of Machine Learning and Data Analytics
ECE 578 Fundamentals of Computer Networks
CSC 577 Introduction to Computer Vision
CS 231n Convolutional Neural Networks for Visual Recognition
(Stanford course, self-taught online)

Experience

Postdoctoral Research Associate, Dept. of Medical Imaging, University of Arizona

2022-present **Design innovative tomographic imaging systems and develop advanced image reconstruction techniques for breast CT**
- Collabration with Advanced Breast-CT GmbH (Erlangen, Germany) for denoising photon counting CT images using deep learning
- Collabration with Prof. Ge Wang research team (Rensselaer Polytechnic Institute) for breast CT dose reduction using Denoising Diffusion Probabilistic Models (DDPM)
- Developed a self-supervised learning approach (based on Self2Self with Dropout) for dedicated breast CT denoising (clinical data acquired with Koning prototype scanner, Koning Corporation, West Henrietta, NY).
- Developed a neural field based learning approach for dedicated breast CT with short-scan and offset-detector geometry.

Filed Tech Lauch Arizona Patent UA23-154 – Attenuation Field Network for Image Reconstruction and *US Provisional Patent Application No. 63/522,658 – Attenuation Field Network for Image Reconstruction*

Data Science Fellows, Data Science Institute, University of Arizona

2022-2023 **Program for training and mentoring in data science**
Supervised by Nirav Merchant and Maliaca Oxnam.
Phase I (junior fellows): training and learning activities in data and project management, open science and reproducibility, research collaboration, and professional communication.
Phase II (senior fellows): apply knowledge to research projects, provide data science workshops/webinars, and serve as peer mentors and resources for the community.

Graduate Research Assistant, Dept. of Medical Imaging, University of Arizona

2020–2021 **Beamforming based streak cancellation for radial abdominal imaging**
To eliminate the commonly occurred streaking artifacts due to gradient nonlinearities in radial abdominal imaging; modeled these streaks as interference to the signal using a low-dimensional subspace; cancellation of streaks using the interference null space; showed improved reconstruction quality and T2 estimation accuracy.

Filed Tech Lauch Arizona Patent UA21-119 – System and Method for Streak Reduction in MRI, *US Provisional Patent Application No. 63/176,696*, and *US Patent Application No. 17/659,712*

2018–2020 **Deep learning reconstruction for dedicated breast computed tomography**
In collabration with Prof. Andrew Karellas and Prof. Srinivasan Vedantham
To reduce radiation dose in breast CT to a level that may be suitable for breast cancer screening, designed a multi-slice residual dense network for sparse-view breast CT data; Quantitatively illustrated significantly reduced MSE and bias compared to FDK method.

2018–2020 **Multi-task learning for T1/T2 mapping**

(1) Designed a multi-input ResNet for MR parameter mapping where data acquired to estimate one parameter can be used to enhance the reoncstruction of another at extremely high undersampling rate.
(2) Evaluated the use of relaxation signal model driven constraints in deep learning based MR parameter mapping; Showed these subspace constraints can be incorporated either as pre-processing step or into the loss function to improve accuracy and sensitivity of MR parameter estimations.

2017–2020 **Deep learning reconstruction for accelerated MR parameter mapping**
Demonstrated feasibility of deep learning based approaches for accelerated MR parameter mapping; Constructed a multi-scale ResNet that yields accurate parameter maps with reconstruction times several orders of magnitude faster than model-based compressed sensing methods.

2015–2016 **1D GRAPPA in the k_z direction for non-Cartesian k-space sampling**
To accelerate k-space acquisition with slice parallel imaging, formulated and implemented a 1D GRAPPA algorithm in the k_z direction for 3D non-Cartesian k-space sampling, e.g. stack-of-stars.

Graduate Research Assistant, Dept. of Electrical & Computer Engineering, University of Arizona

2014–2015 **Independent research with Prof. Mark A. Neifeld on image reconstruction of X-ray CT Imaging**
Implemented both linear algorithms including Principal Component Analysis (PCA) based denoising and Wiener filtering, and non-linear methods including (fast) Iterative Soft-Thresholding Algorithm (ISTA) and Chambolle's Total Variation (TV) minimization for CT image reconstruction

Graduate Teaching Assistant, Dept. of Electrical & Computer Engineering, University of Arizona

2014–2015 **Taught the laboratory section of *ECE 351C Electronic Circuits***
Prepared step-by-step laboratory instructions and trained undergraduate students for operating electronic test equipment and building electronic circuits

Awards

2018 ISMRM *Magna Cum Laude* Merit Award
2018 University of Arizona *GPSC Travel Grant*
2020 AAPM *Imaging Blue Ribbon ePoster*
2021 ISMRM *Magna Cum Laude* Merit Award
2022 University of Arizona *CRTEC Travel Award*
2023 Fully3D 2023 *Trainee Travel Award*

Activities

- I have become an AAPM Junior member in March, 2022
- I have been an ISMRM member&trainee from 2016 to 2022
- I reviewed abstracts for ISMRM 2022 and ISBI 2023
- I reviewed papers for *Medical Physics*, *Scientific Reports*, *Physics in Medicine & Biology*, *Quantitative Imaging in Medicine and Surgery*, *Machine Learning: Science and Technology*, and *Journal of the Optical Society of America A*

Publications

Journal papers

1. M. B. Keerthivasan, M. Saranathan, K. Johnson, Z. Fu, C. C. Weinkauf, D. R. Martin, A. Bilgin, and M. I. Altbach (Mar. 2019). An efficient 3D stack-of-stars turbo spin echo pulse sequence for simultaneous T2-weighted imaging and T2 mapping. *Magnetic Resonance in Medicine* **82**(1). PMID: 30883879, 326–341.
2. Z. Fu, S. Mandava, M. B. Keerthivasan, Z. Li, K. Johnson, D. R. Martin, M. I. Altbach, and A. Bilgin (Nov. 2020). A multi-scale residual network for accelerated radial MR parameter mapping. *Magnetic Resonance Imaging* **73**. PMID: 32882339; PMCID: PMC7580302, 152–162.
3. Z. Fu, H. W. Tseng, S. Vedantham, A. Karellas, and A. Bilgin (Dec. 2020a). A residual dense network assisted sparse view reconstruction for breast computed tomography. *Scientific Reports* **10**(1). PMID: 33273541; PMCID: PMC7713379.
4. Z. Li, Z. Fu, M. Keerthivasan, A. Bilgin, K. Johnson, J.-P. Galons, S. Vedantham, D. R. Martin, and M. I. Altbach (June 2021). Rapid high-resolution volumetric T1 mapping using a highly accelerated stack-of-stars Look Locker technique. *Magnetic Resonance Imaging* **79**. PMID: 33722634; PMCID: PMC8107135, 28–37.
5. Z. Fu, K. Johnson, M. I. Altbach, and A. Bilgin (May 2022). Cancellation of streak artifacts in radial abdominal imaging using interference null space projection. *Magnetic Resonance in Medicine* **88**(3). PMID: 35608238, 1355–1369.
6. Z. Fu, H. W. Tseng, A. Karellas, and S. Vedantham (xxx 2023). Dedicated cone-beam breast CT with short-scan and offset-detector geometry: An attenuation field network reconstruction. *Nature Machine Intelligence* **xx**(x). Prepared; In submission.
7. H. W. Tseng, Z. Fu, A. Karellas, and S. Vedantham (xxx 2023). Radiation dose reduction using half x-ray pulse width with unsupervised deep-learning technique for dedicated breast CT. *Medical Physics* **xx**(x). Prepared; In submission.

Conference papers

1. Z. Fu, Z. Li, M. B. Keerthivasan, D. R. Martin, M. I. Altbach, and A. Bilgin (Apr. 2017). T1 and T2 Mapping using Highly Accelerated Radial Data Acquisition and Alternating Direction Method of Multipliers. In: *International Society for Magnetic Resonance in Medicine*.
2. Z. Fu, S. Mandava, M. B. Keerthivasan, D. R. Martin, M. I. Altbach, and A. Bilgin (June 2018a). A Multi-Scale Deep ResNet for Radial MR Parameter Mapping. In: *International Society for Magnetic Resonance in Medicine*. **Oral Presentation**.
3. Z. Fu, S. Mandava, M. B. Keerthivasan, D. R. Martin, M. I. Altbach, and A. Bilgin (Oct. 2018b). MR Parameter Mapping using Sequential Multi-Contrast Acquisitions and Multi-Input Multi-Scale ResNet. In: *ISMRM Workshop on Machine Learning, Part II*.
4. Z. Fu, S. Mandava, Z. Li, D. R. Martin, M. I. Altbach, and A. Bilgin (May 2019). Deep parameter mapping with relaxation signal model driven constraints. In: *International Society for Magnetic Resonance in Medicine*.
5. Z. Fu, H.-W. Tseng, S. Vedantham, A. Karellas, and A. Bilgin (Dec. 2019). Deep Learning-driven Sparse-view Reconstruction for Radiation Dose Reduction in Dedicated Breast CT: quantitative Evaluation. In: *Radiology Society of North America*. **Oral Presentation**.
6. Z. Fu, D. R. Martin, M. I. Altbach, and A. Bilgin (Aug. 2020). Multi-objective Deep Learning for Joint Estimation and Detection Tasks in MRI. In: *International Society for Magnetic Resonance in Medicine*.
7. Z. Fu, H. W. Tseng, S. Vedantham, A. Karellas, and A. Bilgin (July 2020b). Dedicated Breast CT: Comparative Evaluation of Multi-Scale Residual Dense Network and Residual Encoder-Decoder Network for Deep Learning-Driven Sparse-View Reconstruction. In: *American Association of Physicists in Medicine*. **Oral Presentation**.
8. E. Ahanonu, Z. Fu, M. I. Altbach, and A. Bilgin (May 2021). Improved Slice Coverage in Inversion Recovery Radial Balanced-SSFP using Deep Learning. In: *International Society for Magnetic Resonance in Medicine*. **Oral Presentation**.

9. Z. Fu, M. I. Altbach, and A. Bilgin (May 2021). Cancellation of streak artifacts using the interference null space (CACTUS) for radial abdominal imaging. In: *International Society for Magnetic Resonance in Medicine*. **Oral Presentation**.
10. Z. Li, Z. Fu, and M. I. Altbach (May 2021). High spatial and temporal resolution rapid 3D IR-radFLASH pulse sequence for T1 mapping in the brain. In: *International Society for Magnetic Resonance in Medicine*.
11. E. Ahanonu, Z. Fu, R. Philip, D. R. Martin, M. I. Altbach, and A. Bilgin (May 2022). Deep learning-based slice resolution for improved slice coverage in abdominal T2 mapping. In: *The International Society for Magnetic Resonance in Medicine*.
12. Z. Fu, U. Goerke, K. Johnson, A. Bilgin, and M. I. Altbach (May 2022). Elliptical Field-of-Views in Radial T2 mapping. In: *The International Society for Magnetic Resonance in Medicine*.
13. Z. Fu, K. Johnson, A. Bilgin, and M. I. Altbach (May 2022). Streak reduction in radial imaging with CACTUS. In: *The International Society for Magnetic Resonance in Medicine*.
14. Z. Fu, H. W. Tseng, A. Karellas, and S. Vedantham (July 2022a). Low-dose Cone-beam Dedicated Breast CT: Self-supervised Denoising From Single Image. In: *American Association of Physicists in Medicine*.
15. Z. Fu, H. W. Tseng, A. Karellas, and S. Vedantham (July 2022b). Short-scan Cone-beam Dedicated Breast CT: Self-supervised Denoising From Single Image. In: *American Association of Physicists in Medicine*.
16. B. Toner, Z. Fu, R. Philip, D. R. Martin, M. I. Altbach, and A. Bilgin (May 2022). The impact of streak-removal on deep learning reconstruction of radial datasets. In: *The International Society for Magnetic Resonance in Medicine*.
17. L. Umapathy, Z. Fu, R. Philip, D. R. Martin, M. I. Altbach, and A. Bilgin (May 2022). Self-supervised pretraining with Regression and Contrastive loss in MRI. In: *The International Society for Magnetic Resonance in Medicine*.
18. Z. Fu, H. W. Tseng, and S. Vedantham (July 2023a). An attenuation field network reconstruction for cone-beam breast CT with a laterally-shifted detector in short scan. In: *American Association of Physicists in Medicine*. **Oral Presentation**.
19. Z. Fu, H. W. Tseng, and S. Vedantham (July 2023b). An attenuation field network reconstruction using short-scan and offset-detector data for cone-beam breast CT. In: *American Association of Physicists in Medicine*. **Oral Presentation**.
20. T. C. Larsen, H. W. Tseng, R. Trinate, Z. Fu, A. Karellas, and S. Vedantham (July 2023). Joint Optimization of X-Ray Spectrum and Scintillator Thickness Used in the Detector for Microcalcification Detector in Dedicated Cone-Beam Breast CT. In: *American Association of Physicists in Medicine*. **Oral Presentation**.
21. R. Trinate, H. W. Tseng, T. C. Larsen, Z. Fu, and S. Vedantham (July 2023). Objective Physics-Based Image Quality Characterization of a Low-Noise,High-Resolution, Dedicated Cone-Beam Breast CT using an Offset Detector. In: *American Association of Physicists in Medicine*. **Oral Presentation**.
22. H. W. Tseng, Z. Fu, J.-T. A. Chang, H.-H. S. Chow, and S. Vedantham (July 2023). Patient-Specific Mean Glandular Dose from a High-Resolution Dedicated Cone-Beam Breast CT System with Offset Detector. In: *American Association of Physicists in Medicine*.
23. H. W. Tseng, Z. Fu, and S. Vedantham (July 2023). Radiation Dose Reduction in Cone-Beam Breast CT Using Shorter X-Ray Pulse-Width with a Self-Supervised Deep Learning Algorithm. In: *American Association of Physicists in Medicine*.