# Zhiyang Fu

## Curriculum Vitae

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## Personal Information

Date of birth: March 6, 1993
Nationality: China

## Summary

- ◇ Ph.D. in Electrical & Computer Engineering with research related to image reconstruction and quantitative parameter mapping of Magnetic Resonance Imaging (MRI)
- ◇ 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 image 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
- ◇ Experience of deep learning based image reconstruction for dedicated breast CT
- ◇ Experience of systematic artifact correction in radial MRI
- ◇ 5+ year experience of Unix/Linux operating system
- ◇ Operation of Siemens MRI scanner user interface for image acquisition
- ◇ Proficient in Python, MATLAB, and PyTorch, familiar with Torch7, Lua, Caffe

## Education

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|---|---|---|
| 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

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|---|---|
| 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) |

## Research Experience

*Graduate Research Assistant at the Dept. of Medical Imaging, University of Arizona*

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.

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.

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.

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.

2020–present **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.

*Graduate Research Assistant at the 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 at the 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

## Publications

### Submitted papers

1. Z. Fu, K. Johnson, M. I. Altbach, and A. Bilgin (2021). Cancellation of streak artifacts using the interference null space (CACTUS) for radial abdominal imaging. *Magnetic Resonance in Medicine*.
2. E. Ahanonu, Z. Fu, R. Philip, D. R. Martin, M. I. Altbach, and A. Bilgin (2022). Deep learning-based slice resolution for improved slice coverage in abdominal T2 mapping. In: *The International Society for Magnetic Resonance in Medicine*.
3. Z. Fu, U. Goerke, K. Johnson, A. Bilgin, and M. I. Altbach (2022). Elliptical Field-of-Views in Radial T2 mapping. In: *The International Society for Magnetic Resonance in Medicine*.
4. Z. Fu, K. Johnson, A. Bilgin, and M. I. Altbach (2022). Streak reduction in radial imaging with CACTUS. In: *The International Society for Magnetic Resonance in Medicine*.
5. B. Toner, Z. Fu, R. Philip, D. R. Martin, M. I. Altbach, and A. Bilgin (2022). The impact of streak-removal on deep learning reconstruction of radial datasets. In: *The International Society for Magnetic Resonance in Medicine*.
6. L. Umapathy, Z. Fu, R. Philip, D. R. Martin, M. I. Altbach, and A. Bilgin (2022). Self-supervised pretraining with Regression and Contrastive loss in MRI. In: *The International Society for Magnetic Resonance in Medicine*.

### 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.

## 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*.

## Activities

- ◇ I have been an ISMRM member&trainee since 2016
- ◇ I reviewed papers for Journal of the Optical Society of America A
- ◇ I reviewed papers for Scientific Reports
- ◇ I reviewed papers for Quantitative Imaging in Medicine and Surgery