

# Christopher Sandino

PH.D. STUDENT · AI RESEARCHER

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## Summary

I am a Ph.D. candidate in the department of electrical engineering at Stanford University. My research interests include developing and applying signal processing & artificial intelligence methods to imaging problems. I am seeking an internship position for summer 2020 doing applied AI research. References are available upon request.

## Education

### Stanford University

PH.D. ELECTRICAL ENGINEERING

Stanford, CA

2015 - Present

M.S. ELECTRICAL ENGINEERING

2015 - 2017

### University of Southern California

B.S. ELECTRICAL ENGINEERING

Los Angeles, CA

2011 - 2015

GPA: 3.85/4.00, Magna Cum Laude

## Work Experience

### General Electric Healthcare

Menlo Park, CA

AI/ML RESEARCH INTERN

Summer 2018

- Designed, implemented, and trained novel neural network architectures to reconstruct heart MRI videos from rapidly acquired measurements (achieved **12X faster** scan times) using Python/TensorFlow
- Built containerized DL reconstruction prototype to run seamlessly and efficiently on any GE MRI scanner
- Tested and deployed DL reconstruction on multiple scanners at Lucile Packard Children's Hospital where it is being used on patients every week
- Presented work at two international conferences (SCMR, ISMRM), and published patent on proposed method

### National Institutes of Health

Bethesda, MD

RESEARCH INTERN

Summer 2014

- Implemented and tested efficient curve fitting tools in C++/OpenMPI for online estimation of magnetic tissue parameters from MRI data
- Worked with team of engineers and clinicians to deploy tissue parameter estimation tools at over 30 clinical sites worldwide
- Developed a novel method for high accuracy tissue parameter estimation by leveraging self-derived noise statistics
- Presented work at an international conference (ISMRM), and published two journal papers

## Research Projects

### Deep learning-based reconstruction of rapidly acquired cardiac MRI data

Stanford + General Electric

CO-ADVISED BY JOSEPH CHENG & SHREYAS VASANAWALA

2017 - Present

- Developed novel convolutional neural network (CNN) architecture based on separable 3D convolutions to enhance the performance of deep video restoration tasks
- Integrated novel convolutional layers into reconstruction network developed at GE, enabling higher quality heart MRI reconstructions
- Iterated on network architecture, data acquisition, and training procedures based on clinician and MRI technologist feedback
- Presented work at two machine learning workshops (NeurIPS, BayLearn) and submitted one journal paper (MRM)

### Automatic detection of degraded image quality for smart MRI operator feedback

Stanford University

ADVISED BY SHREYAS VASANAWALA

2015 - Present

- Designed and trained machine learning classifiers to detect motion artifacts from abdominal MR images with 85% accuracy
- Mentored two undergraduate Caltech students who extended this project to use more complex models (CNNs) to detect other types of artifacts with higher accuracy
- Under my supervision, my mentees submitted two abstracts to international conferences (ISMRM 2020, ISBI 2020)

### Comprehensive & motion-robust MR imaging techniques for pediatric applications

Stanford University

ADVISED BY SHREYAS VASANAWALA

2015 - Present

- Designed and implemented novel data acquisition schemes on GE scanners for motion-robust 4-D MR imaging
- Implemented a memory-efficient reconstruction method parallelized across multiple GPUs to process large-scale (>100GB) raw data using Python/CuPy
- Presented work at two international conferences (ISMRM 2018 & 2019)

# Skills

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<b>Programming Languages</b>	Python, C, C++, Shell, Matlab, LaTeX, HTML
<b>Frameworks</b>	TensorFlow, PyTorch, CuPy, Google Cloud, Docker, OpenMPI
<b>Spoken Languages</b>	English, Spanish

# Publications

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## JOURNAL PAPERS

- **Sandino CM**, Lai P, Vasanaawala SS, Cheng JY: Accelerating cardiac cine MRI using a deep learning-based ESPIRiT reconstruction. arXiv:1911.05845 [eess.SP]. Submitted to Magnetic Resonance in Medicine.
- MO Malave, CA Baron, SP Koundinyan, **Sandino CM**, F Ong, JY Cheng, DG Nishimura: Reconstruction of Undersampled 3D Non-Cartesian Image-Based Navigators for Coronary MRA Using an Unrolled Deep Learning Model. Magnetic Resonance in Medicine. 2020.
- **Sandino CM**, Cheng JY, Chen F, Mardani M, Pauly JM, Vasanaawala SS: Compressed Sensing: From Research to Clinical Practice with Deep Neural Networks. IEEE Signal Processing Magazine, 2020.
- Yuan J, Hu Y, Menini A, **Sandino CM**, Sandberg J, Sheth V, Moran CJ, Alley MT, Lustig M, Hargreaves BA, Vasanaawala SS: Near-silent distortionless DWI using magnetization-prepared RUFIS. Magnetic Resonance in Medicine, 2019.
- Looby K, Herickhoff CD, **Sandino CM**, Zhang T, Vasanaawala SS, Dahl JJ: Unsupervised clustering method to convert high-resolution magnetic resonance volumes to three-dimensional acoustic models for full-wave ultrasound simulations. Journal of Medical Imaging, 2019.
- **Sandino CM**, Kellman P, Arai AE, Hansen MS, Xue H: Myocardial  $T_2^*$  mapping: Influence of noise on precision and accuracy. Journal of Cardiovasc Magn Reson. 2015.
- Kellman P, Xue H, Spottiswoode BS, **Sandino CM**, Hansen MS, Abdel-Gadir A, Treibel TA, Rosmini S, Mancini C, Bandettini WP, McGill L, Gatehouse P, Moon JC, Pennell DJ, Arai AE: Free-breathing  $T_2^*$  mapping using respiratory motion corrected averaging. Journal of Cardiovasc Magn Reson. 2015.

## CONFERENCE & WORKSHOP PRESENTATIONS

- **Sandino CM**, F Ong, Vasanaawala SS: Deep subspace learning: Towards fast and scalable neural networks for high-dimensional MRI reconstruction. In Proceedings of the ISMRM Workshop on Data Sampling & Image Reconstruction. Sedona, AZ, United States. 2020.
- Ma J, Nakarmi U, Kin CYS, **Sandino CM**, Cheng JY, Syed AB, Wei P, Pauly JM, Vasanaawala SS: Diagnostic Image Quality Assessment and Classification in Medical Imaging: Opportunities and Challenges. IEEE International Symposium on Biomedical Imaging. Iowa City, IA. 2020. (Pre-print arXiv:1912.02907)
- **Sandino CM**, Lai P, Vasanaawala SS, Cheng JY: DL-ESPIRiT: Improving robustness to SENSE model errors in deep learning-based reconstruction. In Proceedings of the 27th Annual Meeting of ISMRM in Montreal, Quebec, Canada. 2019. **Awarded Magna Cum Laude.**
- **Sandino CM**, Ong F, Cheng JY, Lustig M, Alley MT, Vasanaawala SS: High spatiotemporal resolution cones 4D flow using memory-efficient iterative reconstruction. In Proceedings of the 27th Annual Meeting of ISMRM in Montreal, Quebec, Canada. 2019. **Awarded 3rd best abstract by MR Flow Study Group.**
- Zeng DY, **Sandino CM**, Nishimura DG, Vasanaawala SS, Cheng JY: Reinforcement learning for online undersampling pattern optimization. In Proceedings of the 27th Annual Meeting of ISMRM in Montreal, Quebec, Canada. 2019. **Awarded Magna Cum Laude.**
- Malave MO, Koundinyan S, **Sandino CM**, Ong F, Cheng JY, Nishimura DG: Accelerated 3D Non-Cartesian Reconstruction with Deep Learning. In Proceedings of the 27th Annual Meeting of ISMRM in Montreal, Quebec, Canada. 2019.
- He JJ, **Sandino CM**, Zeng DY, Vasanaawala SS, Cheng JY: Deep predictive modelling of dynamic contrast-enhanced MRI data. In Proceedings of the 27th Annual Meeting of ISMRM in Montreal, Quebec, Canada. 2019.
- He JJ, **Sandino CM**, Vasanaawala SS, Cheng JY: Deep phase unwrapping of 2D phase-contrast data. In Proceedings of the 27th Annual Meeting of ISMRM in Montreal, Quebec, Canada. 2019. **Awarded 2nd best abstract by MR Flow Study Group.**
- Bush A, **Sandino CM**, Ramachandran S, Alley MT, Vasanaawala SS: Multi-Echo Flow-encoded Rosette (MELROSE) enables velocity and  $T_2^*$  assessment of both extravascular tissue and intravascular blood for motion robust, quantitative cardiovascular blood flow and oxygenation mapping. In Proceedings of the 27th Annual Meeting of ISMRM in Montreal, Quebec, Canada. 2019.
- Yuan J, Hu Y, Menini A, **Sandino CM**, Sandberg J, Alley MT, Lustig M, Hargreaves B, Vasanaawala SS: Silent Distortionless DWI. In Proceedings of the 27th Annual Meeting of ISMRM in Montreal, Quebec, Canada. 2019.
- Moran CJ, Cheng JY, **Sandino CM**, Alley MT, Daniel B, Carl M, Hargreaves B: Double Echo Steady State (DESS) Cones for Motion-Robust Steady-State Diffusion-Weighted Imaging. In Proceedings of the 27th Annual Meeting of ISMRM in Montreal, Quebec, Canada. 2019.
- **Sandino CM**, Lai P, Vasanaawala SS, Cheng JY: Deep reconstruction of dynamic magnetic resonance imaging data using separable 3D convolutions. BayLearn: Bay Area Machine Learning Symposium. Facebook. Menlo Park, CA. 2018.
- **Sandino CM**, Lai P, Janich MA, Brau ACS, Vasanaawala SS, Cheng JY: ESPIRiT with deep priors: Accelerating 2D cardiac CINE MRI beyond compressed sensing. In Proceedings of the 22nd Annual Meeting of SCMR in Bellevue, WA, United States. 2019.
- **Sandino CM**: Enabling faster cardiac MRI exams via deep learning-based image reconstruction. University of Utah, Imaging Elevated Symposium. Salt Lake City, UT. 2018. **Invited Talk.**

- **Sandino CM**, Cheng JY, Alley MT, Carl M, Vasanaawala SS: Accelerated abdominal 4D flow MRI using 3D golden-angle cones trajectory. In Proceedings of the 26th Annual Meeting of ISMRM in Paris, France. 2018. **Awarded Magna Cum Laude**.
- Koundinyan S, Malave MO, Cheng JY, **Sandino CM**, Nishimura DG: Improved design and reconstruction of 3D image based navigators for coronary MR angiography. In Proceedings of the 26th Annual Meeting of ISMRM in Paris, France. 2018.
- **Sandino CM**, Dixit N, Vasanaawala SS, Cheng JY: Deep convolutional neural networks for accelerated dynamic magnetic resonance imaging. NeurIPS Medical Imaging Workshop. Long Beach, CA, United States. 2017.
- **Sandino CM**, Dixit N, Vasanaawala SS, Cheng JY: Deep convolutional neural networks for accelerated 3-D cardiac CINE image reconstruction. In Proceedings of the ISMRM Workshop on Machine Learning. Pacific Grove, CA, United States. 2018. **Honorable Mention for Best Poster**.
- **Sandino CM**, Alley MT, Cheng JY, Hargreaves BA, Vasanaawala SS: Feasibility of non-contrast-enhanced cardiovascular 4D flow MRI using a balanced SSFP approach. In Proceedings of the 25th Annual Meeting of ISMRM in Honolulu, HI, United States. 2017.
- **Sandino CM**, Cheng JY, Alley MT, Vasanaawala SS: Precision weighted least-squares phase unwrapping of abdominal 4D flow MRI data. In Proceedings of the ISMRM Workshop on Quantitative MR Flow. San Francisco, CA, United States. 2017.
- **Sandino CM**, Kellman P, Hansen MS, Arai AE, Xue H: Estimation of error maps for evaluating precision of myocardial T2\* mapping techniques In Proceedings of the 23rd Annual Meeting of ISMRM in Toronto, Ontario, Canada. 2015.

## Patents & Disclosures

- **Sandino CM**, Lai P, Cheng JY, Vasanaawala SS: Methods and systems for magnetic resonance image reconstruction using an extended sensitivity model and a deep neural network. Licensed by GE Healthcare, Siemens Healthineers.
- Chen F, **Sandino CM**, Cheng JY, Pauly JM, Vasanaawala SS: Method for estimating systematic imperfections in medical imaging systems with deep learning. Licensed by GE Healthcare, Siemens Healthineers.
- He JJ, **Sandino CM**, Vasanaawala SS, Cheng JY: Method for correction of phase-contrast magnetic resonance imaging data using a neural network. Licensed by GE Healthcare.

## Honors & Awards

- 2018-19 **Magna Cum Laude Award**, International Society for Magnetic Resonance in Medicine
- 2016 **Graduate Research Fellowship**, National Science Foundation
- 2016 **Training in Biomedical Imaging & Instrumentation (TBI2) Fellowship**, National Institutes of Health
- 2015 **EE Departmental Fellowship**, Stanford University
- 2015 **Discovery Scholar**, University of Southern California
- 2014 **Tau Beta Pi Member**, University of Southern California

## Extracurricular Activities

### Radiology Trainee Council

Stanford University

ELECTRICAL ENGINEERING LIAISON

2017-2019

- Planned and coordinated events between electrical engineering and radiology research groups
- Organized weekly research presentations, social events, and the annual radiology retreat

### Enhancing Diversity in Graduate Education (EDGE)

Stanford University

MEMBER

2017-2019

- Mentored first-year electrical engineering and computer science graduate students from under-represented groups