Rui Luo

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I. Summary

I am an M.S. candidate at the School of Biomedical Engineering, ShanghaiTech University. I am experienced in non-Cartesian MRI techniques, including gradient waveform design and image reconstruction. My techniques can be integrated with a wide range of traditional MRI applications for enhanced performance, such as quantitative MRI and real-time MRI.

Keywords– MRI, non-Cartesian, method development, engineering, pulse sequence, reconstruction.

II. Research

Though non-Cartesian MRI is efficient in data acquisition, there are several barriers to overcome before widespread clinical adoption. My M.S. research focuses on addressing those barriers, including currently inefficient gradient waveform design and sampling density compensation.

Real-Time Gradient Waveform Design for Arbitrary k-Space Trajectories

Non-Cartesian MRI is known for its highly efficient sampling. However, its gradient waveform design is still time-consuming and remains a barrier to clinical adoption. In this work, I propose a general-purpose, highly efficient method reducing **90%** of the computation time and **99%** of the slew-rate error simultaneously compared to the baseline method. Specifically, the computation time fits within the acquisition window, which enables real-time gradient waveform design. This work offers new possibilities for trajectory design and enables adaptive scanning. Currently, this work is under revision at *IEEE Transactions on Biomedical Engineering*. The preprint is available at https://arxiv.org/abs/2507.21625.

Sampling Density Compensation using Fast Fourier Deconvolution

Another drawback to the clinical translation of non-Cartesian MRI is its relatively slow and complex reconstruction. An important step in non-Cartesian reconstruction is the sampling density compensation. In this work, I proposed a method that reduces the time to derive a 3D density compensation function from tens of minutes to tens of seconds (**1-2 orders of magnitude** improvement) without sacrificing reconstruction quality. We plan to submit this work to *IEEE Transactions on Signal Processing*. The preprint is available at https://arxiv.org/abs/2510.14873.

In summary, I aim to make non-Cartesian MRI not only efficient, but also practical and reliable. Future publications are expected to concentrate on optimizing a wide range of traditional MRI applications with my non-Cartesian techniques, and also on the new challenges and possibilities introduced by these techniques.

III. Collaboration

I collaborated with researchers both intra-group and inter-group, ranging from clinical studies to deep-learning methods development. Here are two representative works:

Zero-shot INMR for Ultra-high Temporal Resolution Dynamic MRI

This work employs an Implicit Neural Manifold Representation (INMR) neural network to reconstruct real-time cardiac image series. I contributed my non-Cartesian pulse sequence from my own work. Currently this work has been accepted for publication at *AAAI*.

ASL-CMR detects CMD in diabetic mice: a multi-imaging modality comparison

This work compares the diagnostic performance of ASL-CMR versus TTDE in detecting coronary microvascular dysfunction (CMD) in different types of diabetes. I served as the sequence programmer in this work. Specifically, I helped to maintain an ASL pulse sequence on a 9.4T Bruker Scanner (BioSpec 94/20). This work has been published at *ISMRM* (https://archive.ismrm.org/2025/1028_MyimsuQ38.html).

IV. Experience

September 2025, Reviewer, *IEEE Transactions on Medical Imaging*

I independently reviewed one manuscript for *IEEE Transactions on Medical Imaging* via ScholarOne, and my comment was adopted as the primary concern in the decision letter. I think this experience is highly valuable because through this experience I learned the priorities of each role during a publication process - by reading the official *"Instructions to Reviewers"* as well as *"Instructions to AEs"*. This experience makes the reactions from reviewers or editors predictable to me before I submit a paper, a revision, or a review.

Fall 2024, Teaching Assistant, *Principles of Magnetic Resonance Imaging*

I independently designed the final project, including sampling simulation and compressed sensing reconstruction of non-Cartesian MRI, and mentored 33 students by helping them connect the Fourier transform with the principle of MRI. Given the positive feedback from the students, this experience gives me great confidence to be a good teacher.

V. Education

2023 - present M.S. (Biomedical Engineering) at ShanghaiTech University (GPA: 3.92/4.00)

Major Courses:

Algorithms **(A+)**, Principles of MRI **(A)**, Medical Image Processing **(A)**
Medical Imaging Sensor Design **(A)**, MRI System Design **(A)**

2018 - 2022 B.S. (Automation) at Shandong University (GPA: 81.31/100)

Awards:

National **1st** prize in Smart Car Competition (acoustic group, 2020)
National **2nd** prize in Smart Car Competition (delivery group, 2021)
Provincial **1st** prize in Smart Car Competition (optical group, 2019)

*** For reference, one national 3rd prize of such competition qualifies a student for recommendation to graduation schools.**

VI. Skills

Pulse sequence design (non-Cartesian MRI),
Image reconstruction (non-Cartesian MRI),
Python (with C++ backend / GPU acceleration) / MATLAB / C++ / CUDA programming,
Academic writing and publishing,
Numerical optimization (CG, ADMM, etc.),
Deep-learning (UNet, Transformer, etc.),
Circuit design and embedded programming.