Master's project

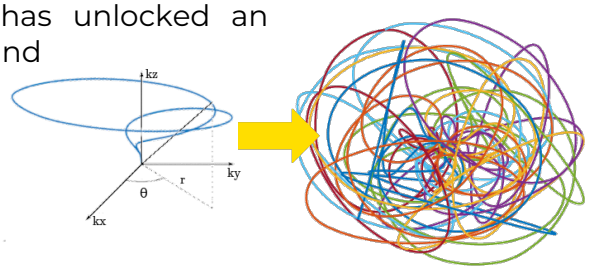
Deep Learning image reconstruction of cones free-running cardiac MRI

Location: CHUV Biopole (Vennes station), Lausanne

Dates/Duration: Sept 26 to Fev-March 27

Background

Magnetic resonance imaging (MRI) is the modality of choice in diagnosing and monitoring many cardiac diseases. Unfortunately, clinical imaging of the moving heart has been often limited to 2D, which holds back the full potential of this impactful technology. Our group in Lausanne has spearheaded a novel 3D cardiac MRI method: the free-running framework[1]. Free-running has unlocked an unprecedented panel of anatomical, functional and hemodynamical biomarkers. Nevertheless, free-running acquisitions remain long, and image reconstruction is tedious.



Project Description

To overcome this challenge, a more efficient k-space trajectory has been proposed based on cone-shaped sampling rather than straight radial lines[2]. While this cone trajectory allows faster acquisitions, it further complicates image reconstruction. A recent machine-learning image reconstruction for free-running has been developed in house that simplifies the reconstruction process and improves the final images[3]. Adapting this framework to the cones would join the best of both worlds: a faster acquisition paired with a simplified image reconstruction framework.

To implement this adaptation in the free-running framework, **this work will combine cutting-edge MRI signal processing, machine-learning image reconstruction and MRI experimentation to reach an impactful clinical application**.

Candidates will be able to familiarize themselves with both the technical (i.e. MR signal and machine-learning) and biophysical (imaging of the heart) aspects of the project. Initial development and simulation will be performed in MATLAB or Python followed by optimization in phantoms and healthy adult volunteers.

Location

This Master's project will take place in the Department of Radiology at the Lausanne University Hospital (CHUV) and the University of Lausanne (UNIL) in Switzerland under the supervision of Dr. Stanislas Rapacchi and Dr. Jerome Yerly as part of the research team of Prof. Matthias Stuber. You will be part of a group of ~20 engineers and physicists working in the CHUV Biopole, in close collaboration with our clinical partners in Radiology and Cardiology. Our group has access to 4 state-of-the-art clinical MRI scanners, including our latest high-end low-field MRI system, and you will actively collaborate with Siemens Healthcare.

References

[1]L. Di Sopra, D. Piccini, S. Coppo, M. Stuber, and J. Yerly, “An automated approach to fully self-gated free-running cardiac and respiratory motion-resolved 5D whole-heart MRI,” Magn Reson Med, vol. 82, no. 6, pp. 2118–2132, 2019, doi: 10.1002/mrm.27898.

[2]M. Nicoletti, J. Yerly, A. C. Ogier, M. Stuber, and S. Rapacchi, “ID#: 2210464 - Dual Echo TIme Cone (ETICone): A 3D-Cone Trajectory for Sampling-Efficient Free-Running bSSFP Cardiac MRI at 0.55 T,” Journal of Cardiovascular Magnetic Resonance, vol. 28, p. 102611, Mar. 2026, doi: 10.1016/j.jocmr.2025.102611.

[3]C. Zhang et al., “Large-scale 3D non-Cartesian coronary MRI reconstruction using distributed memory-efficient physics-guided deep learning with limited training data,” MAGMA, vol. 37, no. 3, pp. 429–438, Jul. 2024, doi: 10.1007/s10334-024-01157-8.

Supervisor

- Main Supervisor: Rapacchi Stanislas, CHUV-UNIL, https://wp.unil.ch/cvmr/stanislas-rapacchi/ , stanislas.rapacchi@chuv.ch
- Co-Supervisor: Yerly Jerome, CIBM-CHUV-UNIL, https://wp.unil.ch/cvmr/jerome-yerly/, jerome.yerly@chuv.ch
- Collaborators: Nicoletti Martin https://wp.unil.ch/cvmr/martin-nicoletti/, Borso Kevin, https://wp.unil.ch/cvmr/kevin-borsos/

Skills

Qualifications, previous experience and background: We are looking for highly motivated candidates with a background in computer science, engineering, mathematics, physics, life science, or similar. Familiarity with signal and image processing and/or deep learning libraries (eg. PyTorch) is preferred. The ability to think creatively and critically within a team environment are required.

How to apply: Please send your CV and motivation letter to: stanislas.rapacchi@chuv.ch and jerome.yerly@chuv.ch

About CIBM

The CIBM Center for Biomedical Imaging was founded in 2004 and is the result of a major research and teaching initiative of the partners in the Science-Vie-Société (SVS) project between the Ecole Polytechnique Fédérale de Lausanne (EPFL), the Université de Lausanne (UNIL), Université de Genève (UNIGE), the Hôpitaux Universitaires de Genève (HUG) and the Centre Hospitalier Universitaire Vaudois (CHUV), with the generous support from the Fondation Leenaards and Fondation Louis-Jeantet.
CIBM brings together highly qualified, diverse, complementary and multidisciplinary groups of people with common interest in biomedical imaging.

We welcome you in joining the CIBM Community.