Master project / Internship

Location:
Lausanne University Hospital (CHUV)
Centre de recherche en Radiologie
Rue Centrale 7, 4ème étage
CH-1003 Lausanne, Switzerland
Dates/Duration:
Spring 2022 or Autumn 2022 semester
4-6 months

A simulation platform for magnetic resonance imaging of the *in utero* fetal brain

There is a growing awareness of the importance of early brain development on health later in life. Magnetic resonance imaging (MRI) is a powerful tool complementary to the ultrasound gold-standard in the follow-up of the fetus during pregnancy. However, unpredictable movements of the fetus may hinder appropriate diagnosis. Image processing methods can compensate for the resulting motion artefacts, but their development and validation require access to large-scale fetal datasets. Numerical simulations can mitigate the limited amount of good quality, exploitable MR acquisitions available in this cohort of sensitive subjects by providing a controlled environment with a known ground truth for accurate, robust and reproducible research.

In this context, we have developed the first simulation framework for fetal brain MRI. Nicknamed FaBiAN for “Fetal Brain magnetic resonance Acquisition Numerical phantom”, it is open-source and based on a general and realistic setup that simulates as closely as possible the physical principles involved in MR sequences routinely used for fetal brain examination [1,2]. Among other applications, FaBiAN takes advantage of the variety of the images generated to complement clinical fetal datasets that remain scarce, and therefore enhance the performance of current deep learning algorithms by supporting data augmentation and domain adaptation strategies.

The proposed research project aims at generalizing FaBiAN to other MR vendors and to MR sequences/contrasts that can provide additional information on the developing fetal brain, especially for quantitative analysis. Another goal of this project is to improve the current synthetic fetal brain model by accounting for maturation processes that occur throughout gestation and by including most common developmental pathologies. Ultimately, we aim at providing the research community with a unified software platform for *in utero* fetal brain MRI.

Aim 1 – Fetal brain model: Provide a more accurate representation of the developing fetal brain throughout gestation, which also includes the most common pathologies.

Aim 2 – MR physics and image reconstruction: Generalize the current framework to other MR vendors (e.g., Philips).

Aim 3 – Software: Implement additional MR sequences and contrasts to support new methodological developments in fetal brain MR image reconstruction and analysis.

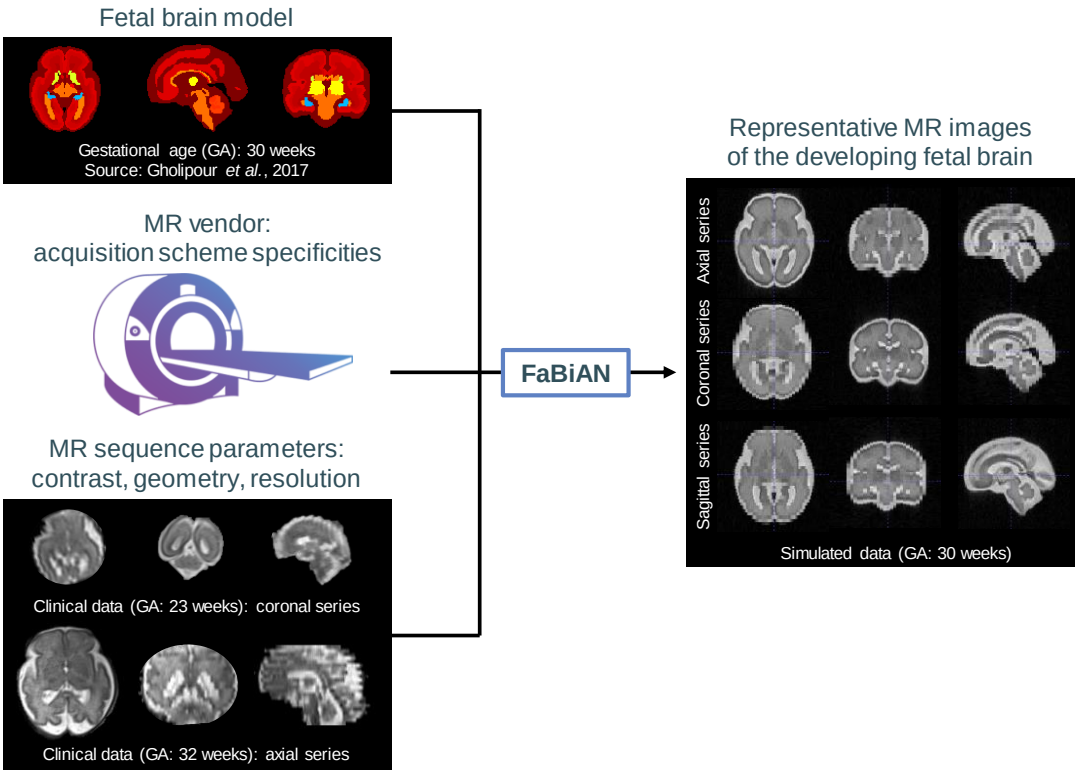

Figure 1: Illustration of the importance of the fetal brain model and of the choice of the MR vendor and acquisition scheme to simulate realistic MR images of the developing fetal brain using FaBiAN.

References

[1] Hélène Lajous et al., FaBiAN: A Fetal Brain magnetic resonance Acquisition Numerical phantom. arXiv:2109.03624 [physics.med-ph] (2021). http://arxiv.org/abs/2109.03624

[2] Hélène Lajous et al., FaBiAN v1.0. Zenodo (2021). https://doi.org/10.5281/zenodo.5471095

Medical Image Analysis Laboratory project webpage:
https://wp.unil.ch/mial/research/projects/quantitative-mr-imaging-qmri-of-the-in-vivo-fetal-brain/

Supervisors

Hélène Lajous, Research Staff Scientist, CIBM Signal Processing CHUV-UNIL Computational Neuroanatomy & Fetal Imaging Section, helene.lajous@unil.ch

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Miscellaneous

The student will be supervised in French or English.

The Master project / internship will be remunerated.

Skills

- **Qualifications, previous experience and background:** We are looking for a highly motivated person with a background in electrical engineering, computer science or equivalent, and a strong interest in image reconstruction and analysis, computational neuroanatomy, and biomedical applications. This project requires very good programming skills: Matlab mandatory, Python optional.

- **Desirable:** Knowledge of MR physics as well as experience in (medical) image processing will be a strong asset. A taste for research and clinical translation will be key to further improve and extend the capabilities of this first prototype.

How to apply:

Please send your CV and motivation letter to the main supervisor: helene.lajous@unil.ch. Applications are open until the position is filled.

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.

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