PhD proposal

Image Analysis of Neonatal Brain MRI

Lab

LaTIM, INSERM, Télécom Bretagne, Brest France

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Funding : ANR (French National Research Agency)

Supervision

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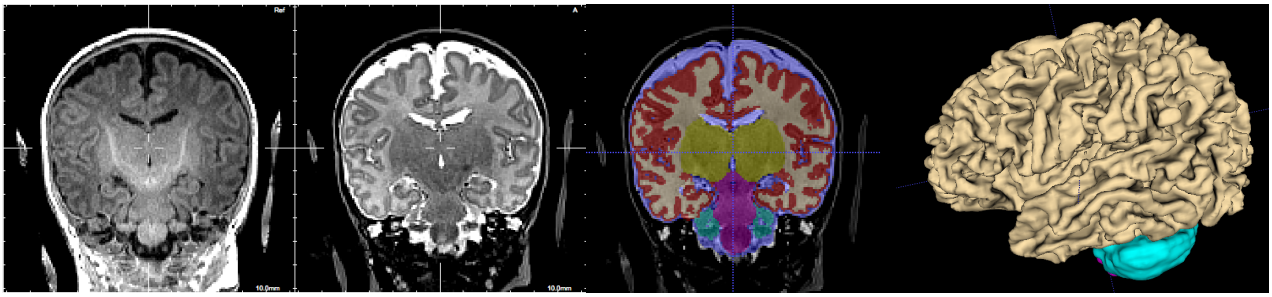
Context

Every year around 10% of all babies in Europe are born premature. Prematurity was about 5.4% of births in France in 1995. The rate of preterm birth is rising and it has now reached 8% in France, which represents 65 000 children each year. This trend is only expected to rise. One of the major challenges we face is the monitoring step of preterm infants, particularly for seizure detection, treatment, and prognostication. The non-invasive nature of Magnetic Resonance Imaging (MRI) provides unique opportunities for in vivo investigation of the early developing human brain. MRI is a powerful technique widely used in adult brain studies focusing on brain morphometry and function, and more specifically on the study of cortical thickness and folding, myelination and structural connectivity.

Neonatal brain morphometry is the analysis of brain shape and size structures and changes thereof during development or disease. Morphometric methods have different aims: 1) localizing significant structural differences among population, 2) highlighting overall brain structure related to some effect of interest, 3) producing some form of classification. Morphometry studies rely on high-resolution 3D structural image of the brain and possibly some segmentation or parcellation of the brain. In this context, MRI appears to be the most appropriate technique for accurate morphometric studies.

Figure 1 – From left to right : MRI data (T1w and T2w) and tissue segmentation map ; 3D rendering of surface meshes.



Objectives

This PhD thesis work aims at developing image processing tools for extracting, from MR images, some anatomical structures of interest. They will constitute a unified spatial reference for further fusing functional, spectroscopic and electromagnetic signals gathered from the other modalities.

Objective 1: To provide very high-resolution structural MR images of premature infants brain using super-resolution methods.

Objective 2: To develop a topological segmentation method dedicated to premature infant brain, based on recent advances in topology-based multilabel 3D deformable models.

Objective 3: To provide an accurate 3D model of the brain, with a focus on structures of interest for premature newborns, e.g. myelinated white matter, unmyelinated white matter, deep gray matter, cortical gray matter, cerebellum, cerebro-spinal fluid, ventricles, brainstem, corpus callosum.

Required skills

- Image processing and analysis
- Medical Image Computing
- Applied Maths
- Programming (C++ and Python)

How to apply

Candidates are invited to email (to François Rousseau and Nicolas Passat) a motivation letter and CV detailing in full your academic background, including all modules taken and grades assigned.