Master Internship Postion 2016

Normal brain perfusion atlas creation in children from 0 to 10 years old

Supervisors: Olivier Commowick, Unité/Projet VisAGeS, Inria (Olivier.Commowick@inria.fr)

Christian Barillot, Unité/Projet VisAGeS, IRISA (Christian.Barillot@irisa.fr)

Location: Unité/Projet VisAGeS, IRISA, Campus de Beaulieu, 35042 Rennes Cedex, France http://www.irisa.fr/visages

Duration: 5 to 6 months, starting around March 2016

Context

VisAGeS U746 is a research team from Rennes 1 University, jointly affiliated with Inserm and Inria. It is also part of the IRISA (UMR CNRS 6074) and is located in Rennes, France on both medical and science campuses. The objective of the team is to work jointly with clinicians, radiologists from the Rennes university hospital to propose new advances in medical image processing. Those collaborations have lead to recent publications in brain functional image analysis, and particularly in arterial spin labeling (ASL). ASL imaging uses the blood protons as an endogeneous marker of the blood flow and brain perfusion. Detecting abnormalities in brain perfusion in a patient can be performed in several manners: the simplest consists in detecting visually the abnormalities on the perfusion map; regions of interest may also be used to measure a regional perfusion and compare it to contralateral values or expected values from the literature. Other more quantitative methods allow for the automatic detection of perfusion variations. These methods are often based on the use of a template (or atlas) and aim at comparing statistically the perfusion map of a patient with those of a normal population.

In children, cerebral blood flow (CBF) evolves drastically with age: it is very low for newborns and increases rapidly until the age of 6 months, then more progressively to reach a peak value in between 5 and 10 years of age before decrease to reach adult values. These CBF variations also change depending on brain regions in link with brain maturation. Studies on these variations in ASL imaging have only considered some age ranges with a specific lack of data around 6 years.

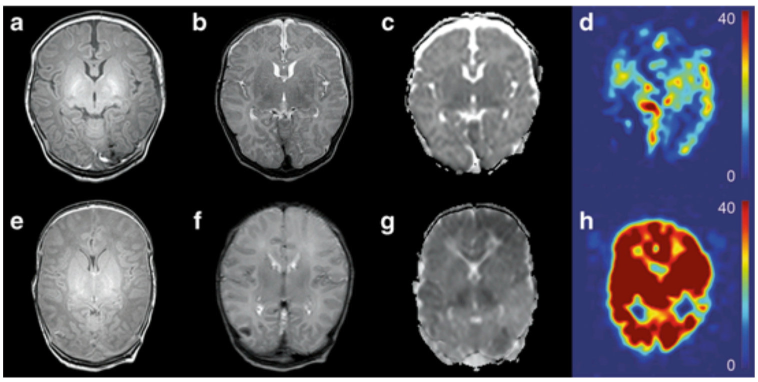

Figure: Illustration of conventional MRI from newborns with different clinical outcomes, and their perfusion images (d,h)

Internship objectives

The objective of this internship is to study the creation of a longitudinal atlas of brain perfusion in between 0 and 10 years old. As it is often difficult to obtain a reasonable number of normal controls MRI for atlas creation, data have been acquired from children having an MRI following a clinical indication at the time of the MRI. Only half hemispheres that are non-pathologic (after a thourough study from both clinicians and radiologists) will be extracted for atlas creation.
After a bibliography study on longitudinal atlas creation [1] and registration accounting for the presence of pathologies [2,3], the recruited student will use the perfusion images in conjunction with anatomical T1-w images in order to create a temporal atlas of brain perfusion, using for this methods developed in the team and developing new approaches to account for pathologies. The internship will, among others, concern the following topics:

- Motion correction and signal inhomogeneity correction
- ASL images registration with delineated anatomical images (white matter, gray matter)
- Quantification of blood flow in each voxel
- Partial volumes correction
- Intensity normalization to compensate for mean variations between subjects
- Healthy hemispheres extraction
- Atlas construction for different age ranges based on the extracted hemispheres only
- Atlas validation on normal and pathological data

Location

This internship will take place at Inria/IRISA, UMR CNRS 6074, among the VisAGeS U746 research team. The work will be conducted in close link with the MRI experimental platform at Neurinfo (http://www.neurinfo.org).

Keywords: Quantitative MRI, ASL.

Requirements: C++, Matlab, strong knowledge of applied mathematics: signal and/or image processing, some knowledge of MRI acquisition techniques.

References

[1] A. Serag, P. Aljabar, G. Ball, S. J. Counsell, J. P. Boardman, M. A. Rutherford, A. David Edwards, J. V. Hajnal, and D. Rueckert. Construction of a consistent high-definition spatio-temporal atlas of the developing brain using adaptive kernel regression. Neuroimage, 59(3), p. 2255-2265, 2012.
[2] R. Stefanescu, O. Commowick, Gregoire Malandain, Pierre-Yves Bondiau, Nicholas Ayache, and Xavier Pennec. Non-Rigid Atlas to Subject Registration with Pathologies for Conformal Brain Radiotherapy. In MICCAI, p. 704-711, 2004.
[3] M. Sdika, and D. Pelletier. Nonrigid registration of multiple sclerosis brain images using lesion inpainting for morphometry or lesion mapping. Human Brain Mapping, 30(4), p. 1060-1067, 2009.