Ecole Doctorale STIC

Sciences & Technologies de l'Information et de la Communication

ED STIC - Proposition de Sujets de Thèse

pour la campagne d'Allocation de thèses 2011

Titre du sujet :	Diffusion tensor imaging of the brain: towards quantitative clinical tools
Mention de thèse :	ATSI
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Description du sujet :

Diffusion tensor imaging is a recent MRI modality that quantifies the anisotropy of the water diffusion in brain tissues. For clinical purposes, the tensor (covariance matrix of the Brownian motion of the water) estimated at each point of the image is often simplified into two scalar measurements (mean diffusivity and Fractional Anisotrpy). However, the modality is carrying much more information than just these two measurements. The goal of this PhD research work is to develop robust methods to extract more clinically relevant information from noisy clinical quality DTI images. In order to end up with clinically relevant tool, the PhD research will be completed in close collaboration with neuroradiologists and neurosurgeons.

The PhD research will address three levels of applications. The first level will deals with the statistical analysis of populations of DTIs. It will be done in the context of the Neuradapt study (Nice University Hospital) comparing HIV subjects to controls. The goal is to detect significant changes between different clinical conditions first on the scalar indices, and second on the full

tensor information. This study will be extended to a database of DTI images of elderly and Alzheimer's disease subjects in collaboration with potentially different medical centres including the University of California San Francisco (USA) or UCL (UK) and hospitals / neuroimaging centres in Grenoble and Clermont-Ferrand in France.

The second level of application will be to move from population studies to individual analysis. In particular, one important goal is to build a method to robustly determine if the scalar or tensor quantities are within the normal range, so that the clinician could easily decide if an area is abnormal. Due to the non-stationary of the statistics, one needs to determine anatomically corresponding points, which require registering to an atlas. It will be necessary to investigate the stability of the atlas (and of the resulting detection power) with respect to the parameters of the atlas construction method: type of images registered (T1, B0, tensor) and the type of transformation used (affine, slightly non-linear or highly non-linear deformation).

The third level of application will address patient specific tractography analysis of subjects. Such an analysis might bring quite a lot of information for the previous neurodegenerative diseases. However, the most impactful area targeted is brain tumor surgery. In such an application, it is crucial to understand how the tracts are modified by the tumor in order to optimize the surgical path and the amount of resection. The planned approach is to compare the tracts with the contralateral ones, and once again a statistical approach at the population level will be needed to provide quantitative measurements. This part will be conducted in close collaboration with a professor of neurosurgery in Clermont-Ferrand, France.

References

* Pierre Fillard, Xavier Pennec, Vincent Arsigny, and Nicholas Ayache. Clinical DT-MRI Estimation, Smoothing and Fiber Tracking with Log-Euclidean Metrics. IEEE Trans. Med. Imaging, 26(11):1472-1482, November 2007.
* Andrew Sweet and Xavier Pennec. Log-Domain Diffeomorphic Registration of Diffusion Tensor Images. In Proc. of W. on Biomedical Image Registration 2010, LNCS 6204, Lübeck, Germany, p.198-209, July 2010.

URL : http://www-sop.inria.fr/asclepios/recrutement/PhDTenseur2011.pdf

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