Towards an Anatomically Meaningful Parameterization of the Cortical Surface

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Abstract. We present here a method that aims at defining a surface-based coordinate system on the cortical surface. Such a system is needed for both cortical localization and intersubject matching in the framework of neuroimaging. We therefore propose an automatic parameterization based on the spherical topology of the grey/white matter interface of each hemisphere and on the use of organised and reproductible anatomical markers. From those markers used as initial constraints, the coordinate system is propagated via a PDE solved on the cortical surface. Preliminary work and results are presented here as well as further directions of research.

Introduction. In the context of inter-subject brain data matching and localization, the most common methods deal with 3-dimensional images and consider the problem as an inter-subject registration one, known as *spatial normalization*. Nevertheless there is great interest in analyzing data projected on the cortical surface [1]. In this context, matching cortical surfaces implies facing several problems, the main one being the lack of an implicit coordinate system, such as the voxel grid in 3 dimensions. Therefore the problem can be approached in terms of localization more than registration. Few methods aim at building a surface referential by parameterizing the cortical surface in a reproductible way [1,2]. In this framework, we propose here a method to automatically provide an anatomically meaningful parameterization, based on the definition of invariant and organised anatomical features, and which does not require any warping of the surface (e.g. to a sphere [1,2]).

Method. The outline of our method is to build a complete parameterization, in a longitude/latitude manner, starting from a few anatomical markers and propagating a coordinate systems from those original constraints over the whole cortical surface of each hemisphere. From MR anatomical images, a triangulation of the cortical surface is extracted and all the major sulci are automatically labelled [3]. A subset of parts of these sulci is projected on the surface, which are anatomically reproductible and geometrically organised as subparts of meridians or parallels on the cortical surface of each hemisphere [4], topologically equivalent to a sphere. Those projections are attributed a constant longitude (meridians)

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or latitude (parallels). Those markers are then used as sources of a surfacic heat-equation diffusion process [5] that drives the propagation of both longitude and latitude over the whole hemisphere surface (figure 1), resulting in a global coordinate system that complies with the initial constraints.

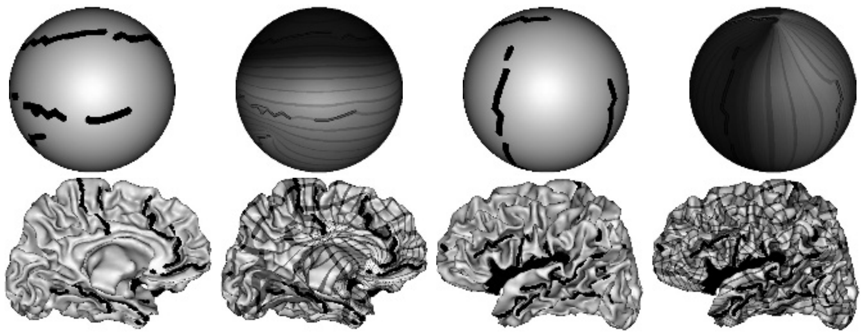

Fig. 1. Results on (top) synthetic spherical data (constraints and resulting isoparameter lines for longitude and latitude); (bottom) real brain data (constraints and isoparameter lines).

Further work. From this preliminary work, several line of research arise : the definition of the set of anatomical markers, the possible coupling between the two diffusion systems (longitude and latitude), and validation in a neuroimaging experimental context. Future applications are surfacic analysis of functional brain data, surface morphometry, or localization for the integration of modalities such as EEG and MEG.

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