Multivariate Statistics of Tensor-Based Cortical Surface Morphometry

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Introduction: We propose a new set of multivariate statistics of tensor-based morphometric framework that quantifies biological shape variations using the strain matrices. It can catpure more deformation information than Jacobian determinant based local area element.

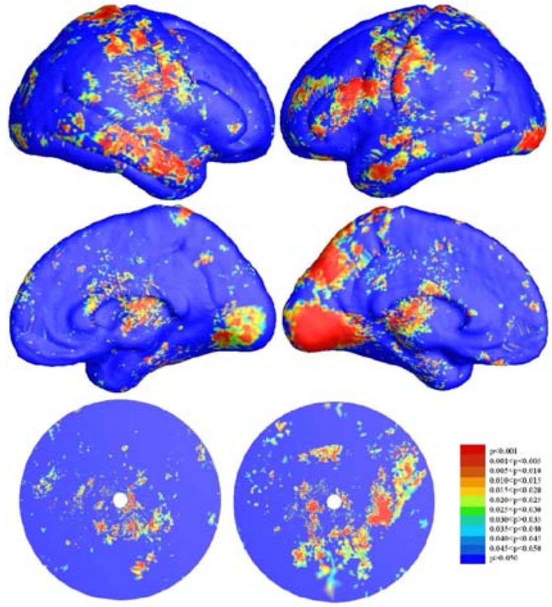
Methods: Suppose $Ø:S_1\text{->}S_2$ is a map from the surface S_1 to the surface S_2, we define the derivative map of Ø is the linear map between the tangent spaces, dØ:TM(p)->TM(Ø(p)), induced by the map. Let J be the derivative map and define the deformation tensor as $S=(J^TJ)^{1/2}$. Instead of analyzing shape change based on the eigenvalues of the deformation tensor, we consider a new family of metrics, the "Log-Euclidean metrics". Later on, we apply Hotelling's T^2 test on the log-Euclidean space of the deformation tensors.

Results: We propose a method that computes a conformal mapping from a multiply connected mesh to the so-called *slit domain*, which consistes of a canonical rectangle or disk in which 3D curved landmarks on the original surfaces are mapped to concentric or parallel lines in the slit domain. Between different surfaces, we matched the landmark curves and build a harmonic map where the matched landmark curves are used as boundaries conditions.

We use slit mapping and harmonic map to register 80 cortical surfaces. Among them, 40 cortical surfaces are from control subjects and 40 are from William Syndrome. We applied the multivariate statistics of tensor based morphometry to study the shape variations because of the disease.

Figure 1 shows the experimental results. It shows more detection power than the simple Jacobian determinant based local area metric.

Conclusions: The new set of multivariate statistics of tensor-based morphometric framework can well capture the surface morphometry. It can be used to study surface morphometry of various brain anatomical surfaces, such as cortical, ventricular and hippocampal surfaces.



Category: *Modeling and Analysis*
Sub-Category: *Motion correction/Spatial normalization, atlas construction*