Statistical Brain Structure Analysis

National Alliance for Medical Image Computing

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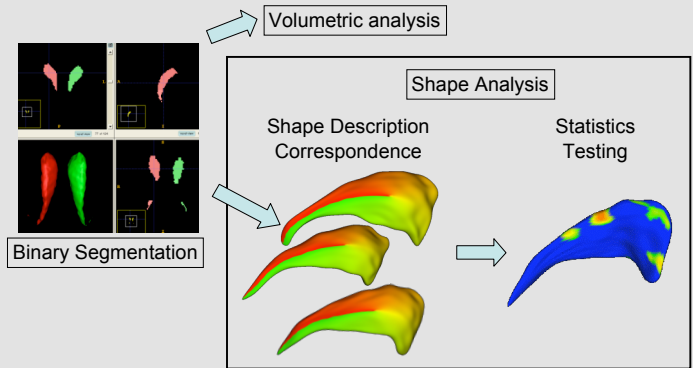[1]University of North Carolina, Chapel Hill, NC, [2]Georgia Tech, Atlanta, GA
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Overview

Routine quantitative morphologic assessment based on volumetric measurements capture global atrophy or dilation due to illness. Changes at specific locations are though not sufficiently reflected. Shape analysis has thus become of increasing relevance to the neuroimaging community due to its potential to precisely locate morphological changes between healthy and pathological structures.
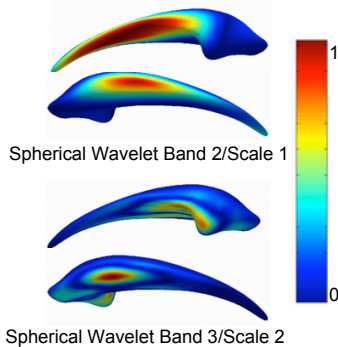
Within the NA-MIC network, all key problems in structural shape analysis are being tackled in a joint effort. A coherent framework and set of tools have been implemented, disseminated to several groups, as well as applied to clinical data. Selected projects are presented in this poster.

Volumetric analysis

Binary Segmentation

Shape Analysis

Shape Description Correspondence

Statistics Testing

SPHARM-PDM

We have developed a toolset for the computation of the statistical shape analysis on triangulated meshes using correspondence defined by spherical harmonics (SPHARM). The tools have been disseminated and are in use in several NA-MIC sites, as well as major international research labs. Its application to two schizo-typal personality disorder (SPD) studies on caudates are currently being written up (see Figure below for the mean difference between male controls and male SPD).
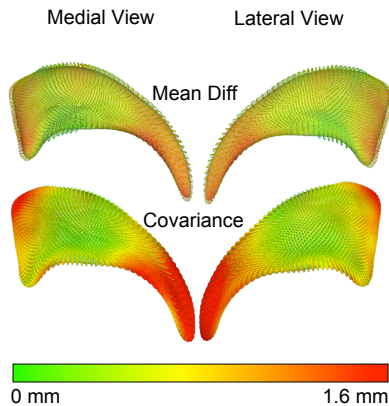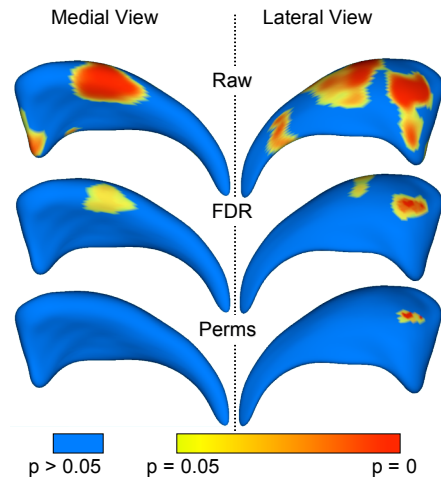
Intermediate results of this tool set are used as input to other types of shape analysis, e.g., based on spherical wavelets.

Medial View   Lateral View

Mean Diff

Covariance

0 mm   1.6 mm

Wavelets/Particle Shape

Spherical Wavelet Band 2/Scale 1

Spherical Wavelet Band 3/Scale 2

Two additional novel shape representations complement SPHARM-PDM. Our spherical wavelet based representation allows a hierarchical decomposition and an increased sensitivity of the statistical analysis through a reduction of the number of shape features (see above Figure for an example of an hierarchical analysis). Further, our particle-system based representation allows the analysis of non-spherical topology structures, such as the cranium, and is insensitive to noise-induced topological variations.

Statistical Testing

New methods for the computation of group discrimination and group mean difference testing have been developed. Three levels of statistical shape analysis are in the testing framework (from optimistic raw values to conservatively corrected values), These correction methods are crucial in enhancing the sensitivity and the power of the analysis.

The results of the three statistical levels are shown in the Figure below on the NA-MIC male SPD study.

Medial View   Lateral View

Raw

FDR

Perms

$p > 0.05$ $p = 0.05$ $p = 0$

http://www.na-mic.org

http://wiki.na-mic.org