SPM normalisation toolbox for diffusion weighted images

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Introduction

For the assessment of white matter integrity there is continued interest in spatial statistical analyses of diffusion anisotropy indices such as the fractional anisotropy (FA), because the spatial statistics assumes no a-priori knowledge of location and extension of regions that potentially differ in their white matter integrity. The toolbox presented here implements normalisation strategies to prepare data for VBM-style voxel-based statistics of FA images (FA-VBS) in SPM[1]. We use SPM implementations of methods for inter-subject spatial registration of images (e.g. affine and non-linear spatial normalization[2]) and combine them with additional MATLAB routines to several workflows.

Implementation Details

Required Images

The toolbox requires DWI and FA images only. These images need to be affine registered to a reference image in MNI space before entering the toolbox. No images of other modalities are used. The toolbox can either use predefined templates or generate templates iteratively from the data of all subjects in a dataset.

Registration Approaches

Three single-contrast nonlinear registration methods are provided:

- b0 registration: The affine registered b0 images are used as source images (no selection mask).
- FA registration: The affine registered FA images are masked by a whole brain selection mask. The masked images are used as source images.
- LFA registration: The source images are constructed from affine registered FA images (denoted as LFA). Hemispheres are registered separately by using a hemisphere selection mask.

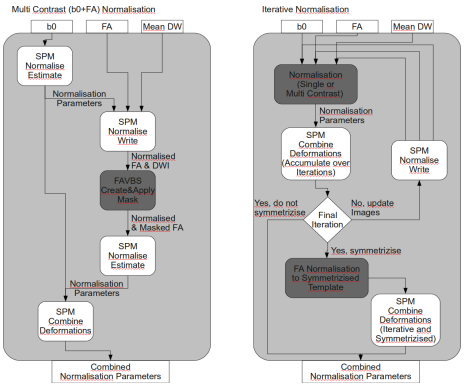

Figure 1: Multicontrast and iterative normalisation schemes.

b0 and FA registrations can be combined in an iterative procedure. LFA registration can be performed on its own or as a final step after the b0/FA iterations.

Discussion

The toolbox provides a convenient interface to spatially normalise DWI datasets even if no additional anatomical images are available. It integrates tightly into the SPM8 batch system within the Diffusion Toolbox[3]. The normalisation procedures can be used in combination with any other SPM functionality, and the toolbox itself calls SPM8 functions through the batch system. The combination of normalisation steps based on the different contrasts of b0 and FA images results in robust normalisation parameters. The resulting normalised images can be used for voxelwise or multivariate analyses in any of the common analysis packages for VBM. This toolbox may therefore help to standardize the FA-VBS normalisation step[4].

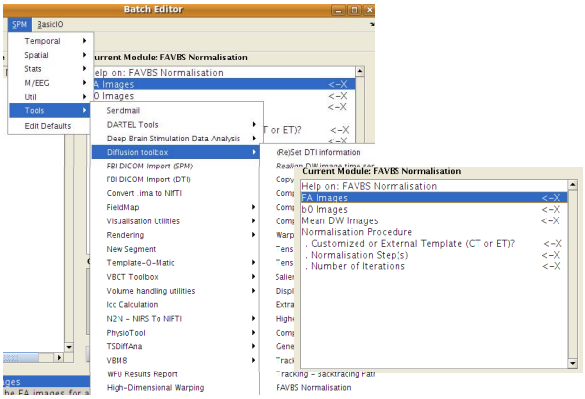

Figure 2: Integration into the SPM8 batch system

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[1] Statistical Parametric Mapping (SPM): http://www.fil.ion.ucl.ac.uk/spm/

[2] Friston, Ashburner, Kiebel, Nichols, and Penny, editors. Statistical Parametric Mapping: The Analysis of Functional Brain Images. *Academic Press*, 2007.

[3] SPM Diffusion Toolbox: http://www.fil.ion.ucl.ac.uk/spm/ext/#Diffusion_II

[4] Mohammadi, Floel, Glauche, Schwindt, and Deppe (2009) Comparing VBM-style voxel-based statistics of FA images and TBSS for the detection of hemispheric asymmetries. *Proceedings of the 15th Human Brain Mapping meeting, June 18-23, 2009, San Francisco, Neuroimage* 38, S128.