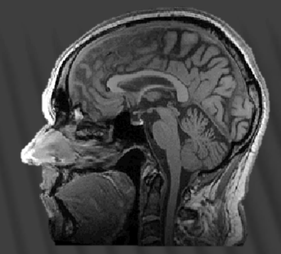
Improvement of MRI brain segmentation

-Multi-spectral and multi-label approach from SPM-



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ABSTRACT

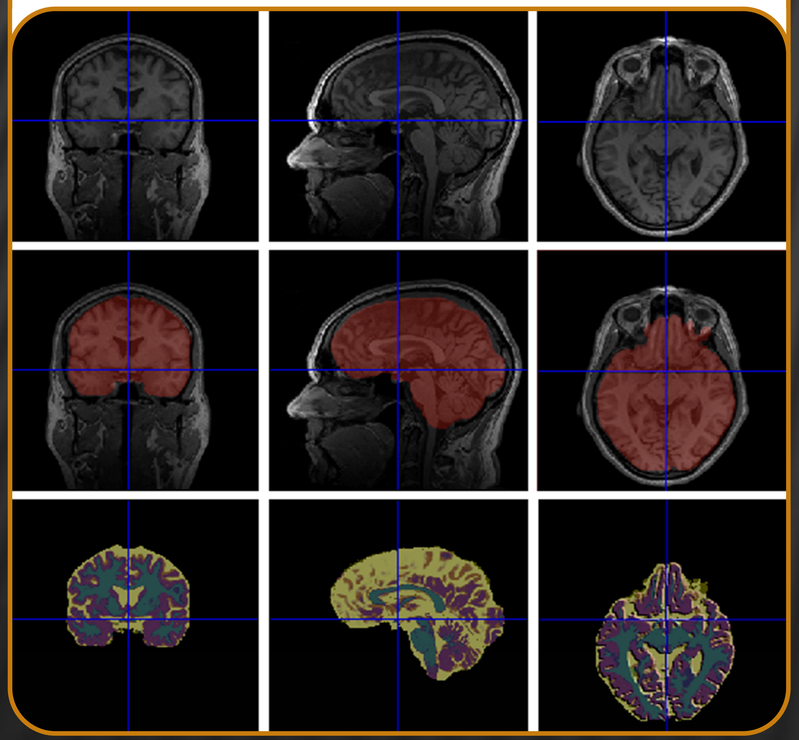
The **motivation** comes from the Neurobiology Research Unit (NRU) of Rigshospitalet. They are interested in a precise segmentation of MR images into grey matter (GM), white matter (WM), and cerebrospinal fluid (CSF) in order to correct the PVE of the PET images by means of co-registration.

The **dataset** comprises 200 3T MRI scans with T1 and T2 weighted sequences (~1mm isotropic voxels) done on Healthy Control subjects (male and female in the range 20-90 years old).

The **actual segmentation pipeline** is based on SPM5 with VBM5, where T2 images are used for scalp-stripping and T1 for brain tissue classification.

The **goal** is to modify SPM8 to include multi-spectral data and multi-label, which is expected to improve the brain tissue classification. Several authors have highlighted the possibility of combining both modalities to improve the voxel classification. In addition, each class has an intensity variability that can be better modeled with a set of labels instead a single one.

ACTUAL SEGMENTATION



Statistical Parametric Mapping (SPM)

It is a method developed by K. Friston and J. Ashburner that generates a Posterior Probability Map (PPM) for each class. It is based on:

- Generative model: Mixture of Gaussians (MOG)
- Prior probability maps of model parameters.
- Bayesian framework with iterative EM optimization, which includes bias field correction, regularization, and tissues classification.
- Spatial information of neighboring voxels is included with Markov Random Field (MRF).

The method has several assumptions.

- Intensity distribution are normal. (* intended to be improved)
- Multiplicative bias field.
- The source of noise is the variation in tissue properties.
- Uncorrelation among modalities. (* intended to be improved)

Multi-spectral

It is based on the combination of both modalities: T1 and T2.

Most of tissues have different contrast on each neuroimaging technique. Therefore, the use of both types of modalities increases the discrimination between different tissues and PVE correction.

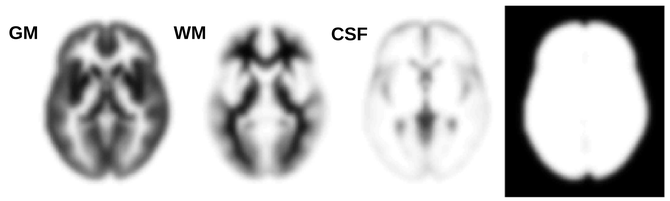
As the intensity contrast does not match between each other, it is needed to combine them properly.

The starting point is the 'New Segmentation' toolbox of SPM, which will be modified to, at least, parameterize the inter-modality correlation.

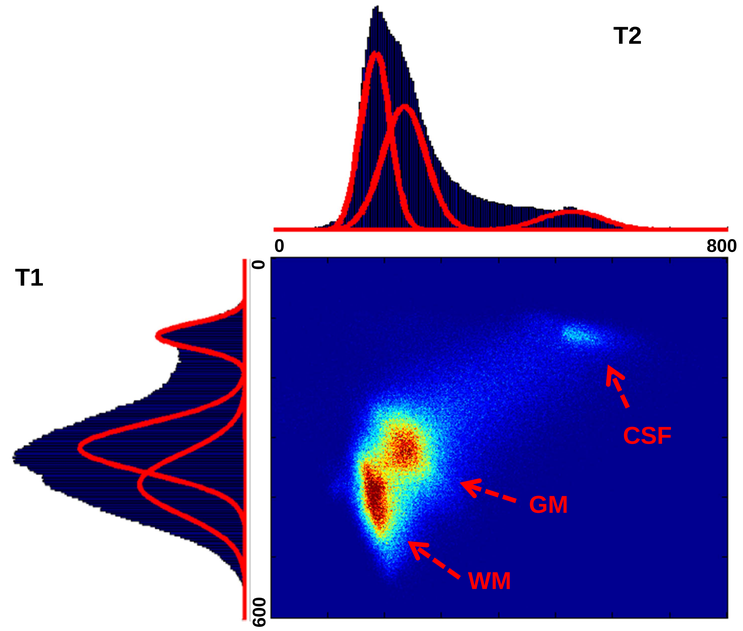
Multi-label

Intensity distribution of each tissue class can be represented with more than one Gaussian, which leads to a better characterization of head tissue variability.

Originally, SPM segmentation includes 3+1 labels: GM, WM, CSF, and no-brain (brain-extraction). It is intended to increase this number, for example by using: 3 GM, 2 WM, 2 CSF, and 5 no-brain labels.



JOINT INTENSITY HISTOGRAM



FINAL REMARKS

It is assumed that each voxel is composed by different kinds of brain tissue. Therefore, the resulting PPM is used to determine the label proportion at each voxel.

The implementation will be done in Matlab. Several ideas have been proposed for the validation of the method, and they will be analyzed to decide which technique fits more with the requirements from the NRU.

The deadline of this project is the August 30th, 2011.

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