University of Salzburg — Lecturer: Roland Kwitt

Imaging Beyond Consumer Cameras – Proseminar (911.422)

Exercise sheet **C**

Image registration

Exercise 1. 17 P.

In this multi-step exercise, you will learn how to use image registration to *automatically segment an MR image of the human brain into medically relevant regions*. In medical image analysis, the pipeline that is outlined below is referred to as *atlas-based image segmentation*.

Background. The idea is the following: say, we would have an MR image, where medical experts have hand-segmented certain regions (e.g., the brain stem, the ventricles, etc.). In medical imaging, such an image is often referred to as an *atlas* (see figure below), or a *template*. Sometimes, the atlases are constructed from images of *multiple* patients, or from a *single* patient only.

To automatically segment a new image (from a new patient), e.g., to study the size of certain brain structures related to some disease (e.g., Alzheimer's, etc.), we could try (1) to *map* this patients' MR image onto the atlas, then (2) transfer the labels from the atlas to the new image, and eventually transform the MR image back into its original space.

The exercise is split into multiple parts:

1. Download the T1-weighted brain MRI scan (`img.nii`) from
2. Download the atlas image (`ATLAS_img.nii.gz`) + its segmentation (`ATLAS_seg.nii`) from
3. Register the image **affinely** to the atlas (using `reg_aladdin` of the NiftyReg tools)
4. Register the image **non-linearly** to the atlas (using `reg_f3d` of NiftyReg)
5. Visualize the registration result using ITK Snap (affine + non-linear)
6. Map the atlas labels to the image space (using `reg_resample` of NiftyReg)
7. Extract the *corpus callosum* (label 140; using ITK Snap) as a surface mesh
8. Visualize the corpus callosum (e.g., using ParaView, or ITKSnap)
9. Get the volume of the corpus callosum in mm^3
10. Document the process in 1-3 pages with visualizations and parameter settings of the tools that you used!

Additional help

Note that the registration and label transfer steps can be (almost) exactly replicated from the Segmentation Propagation Tutorial.

In ITK Snap, you can take snapshots of the difference slice views (including the 3D view) for visualization.

When using `reg_f3d` always visualize the registration result to see if the transformation did not introduce any clearly visible artifacts. If so, e.g., adjust the `-be` parameter of `reg_f3d` which controls the bending energy.

Evaluation criteria. 5 points for affine registration; +5 points for non-linear registration; +5 points for correctly mapping the labels into the image space (be careful regarding the type of interpolation that is used) and +2 points for visualization.

Total #points: 17 P.