University of Salzburg

Lecturer: Roland Kwitt

Imaging Beyond Consumer Cameras – Proseminar (911.422)

Exercise sheet D (April 20, 2016)

Prepare for presentation on May 10, 2016

Image registration

Exercise 1. 30 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, but can be 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 in combination with some disease (Alzheimer's, etc.), we could (1) *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.

Caution: An important detail that we need to take care of, is to *strip* the skull from the MR images, since image registration would immediately hinge onto the skull structure, instead of the soft-tissue structures (because of very strong gradients). For affine registration this is not a big issue, however, when a more fine-grained registration (non-linear) is computed, *skull-stripping* typically makes a huge difference.

The exercise is split into multiple parts:

- 1. Download example brain MRI scans (CUMC12 dataset) from here \Box and select 1-2 images
- 2. Download the SPL 2008 brain atlas from here
- 3. Register the image affinely to the atlas (using aladdin of NiftyReg for instance)
- 4. Register the image non-linearly to the atlas (using f3d of NiftyReg for instance)
- 5. Visualize the registration result (just one slice) via 3DSlicer's Checkerboard Filter
- 6. Transform labels from atlas to image (using reg_resample of NiftyReg for instance)
- 7. Extract the *corpus callosum* (using Convert3D; read the documentation for how to extract a label with a certain number)
- 8. Visualize the corpus callosum (e.g., using ParaView, or ITKSnap)
- 9. Document the process in 1-2 pages with visualizations and parameter settings of the tools that you used

Resources

Below, you can find links to software packages that you can use (I do recommend using NiftyReg in combination with BET):

✓ NiftyReg

✓ ANTs

☑ 3DSlicer

☑ FSL Brain Extraction Tool (BET)

Additional help

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

Total #points: 30 P.