Baby Brain Toolkit

Fbrain ERC project: Computational Anatomy of Fetal Brain

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1 Introduction

BTK stands for Baby Brain Toolkit. This toolkit is developed in the context of the Fbrain ERC project: "Computational Anatomy of Fetal Brain"[1]. Studies about brain maturation aim at providing a better understanding of brain development and links between brain changes and cognitive development. Such studies are of great interest for diagnosis help and clinical course of development and treatment of illnesses. Several teams have begun to make 3D maps of developing brain structures from children to young adults. However, working out the development of fetal and neonatal brain remains an open issue. This project aims at jumping over several theoretical and practical barriers and at going beyond the formal description of the brain maturation thanks to the development of a realistic numerical model of brain aging.

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[1]http://lsiit-miv.u-strasbg.fr/miv/index.php?contenu=erc

1.2 Dependencies and Compilation

Baby Brain Toolkit (BTK) depends on:

- the most recent version of the Insight ToolKit (ITK) – www.itk.org.

- Tclap library: this library can be installed for debian-based distribution using the following command line : `apt-get install libtclap-dev`

- OpenMP library: this library can be installed for debian-based distribution using the following command line : `apt-get install libgomp1`

2 Applications

2.1 Denoising

btkNLMDenoising This program applies a non-local mean filter to a 3D image for denoising purpose. Usage: `-i input_image_filename -o output_image_filename`. The best results are usually obtained by using a mask (or a padding value).

btkNLMDenoising4DImage This program applies a non-local mean filter to each 3D image of a 4D image, for denoising purpose. Usage: `-i input_image_filename -o output_image_filename`. The best results are usually obtained by using a mask (or a padding value).

2.2 Tractography

Executable presentation

btkTractography This program performs a probabilistic tractography using a particle filtering. Usage: `-d dwi_image_filename -v dwi_gradient_vectors -m white_matter_mask -l seeds_label_image`.

Standard usage

Suppose you want to perform a tractography on a diffusion weighted MRI dataset. You should have a dwi image, the gradient vectors' coordinates, a mask of the brain white matter and a label image of the seeds. This data is stored in files named repsectively for instance `data.nii.gz`, `data.bvec`, `mask.nii.gz` and `seeds.nii.gz`. The tractography is accomplished by the command below.

```
btkTractography -d data.nii.gz -v data.bvec -m mask.nii.gz -l seeds.nii.gz
```

When the program terminates its task, the probability connection map and the fibers estimation files, respectively named `map.nii.gz` and `fibers.vtk`, are produced. The connection map is a volume image of probability intensities (`i.e.` intensities between 0 and 1) with the same origin, orientation and spacing as `data.nii.gz`. The fibers are polygonal data of VTK library in world coordinates. The standard pipeline of the program is shown in Fig. 1.

Advanced usage

In addition to standard arguments of `btkTractography` program, there are some other parameters that let you to alter algorithm's behaviour. Since the default parameters values may work in the most of cases, they are optional. The program arguments are described below.

`-d --dwi` Diffusion weighted sequence

`-v --vectors` Gradient vectors' coordinates

`-m --mask` White matter mask
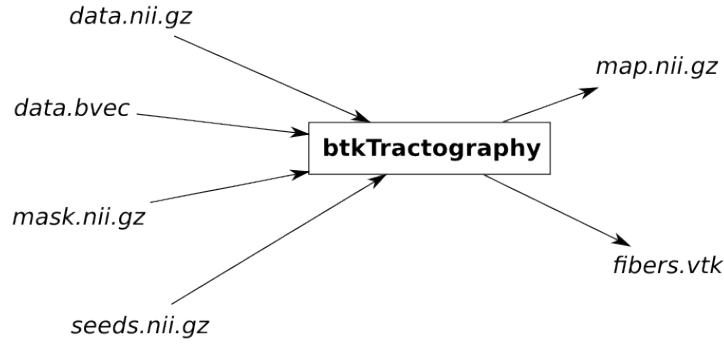
`-l --label` Seeds' label volume

Figure 1: Standard pipeline of the btkTractography program.

--angular-threshold Angular threshold between successive displacement vectors of a particle's trajectory

--curve-constraint Curve constraint of particle's trajectory

--step-length Step displacement's length of a particle

--model-regularization Regularization coefficient of the model (`i.e.` regularization term of the model regression estimation)

--model-order Order of the model (`i.e.` of spherical harmonics)

-- --ignore_rest Ignores the rest of the labeled arguments following this flag.

--version Displays version information and exits.

-h --help Displays usage information and exits.

3 Utilities

btkModifyImageUsingLookUpTable This program modifies one image using a look up table defined in a ascii file (2 columns, one for the original values, one for the final values). Usage: `-i input_image_filename -t input_table_filename -o output_image_filename`

Acknowledgment