

DTI Registration using Tensor Geometry and Orientation Features (DTI-DROID)

1. Introduction

This package provides a general registration algorithm for diffusion tensor images. This DTI registration algorithm takes advantages of the tensor geometric measures: linear, planar, and spherical measures for registration. It also includes the tensor orientation feature to refine the registration of major fibers of diffusion tensor images. For details of this algorithm, please refer to our paper submitted to MICCAI 2008 [1].

The repository includes the following folders:

- doc/: documents and manuals
- sample/: sample DTI data
- src/: source code

2. Compile and installation

Since the whole package consists of several parts, it takes 5 steps to get all the executables. Please note that the source code can only be compiled on Linux/UNIX machine and it requires the GUN GSL library, ITK and CMake installed.

1) Compile DTI-DROID:

```
cd ./dtidroid; make all
```

2) Compile HAMMER:

```
cd ./hammer; make all
```

3) Compile DTITools:

```
cd ./DTITools;  
ccmake ./  
make
```

4) Compile and install the Slicer3 plugin:

- follow the instructions from:
http://www.slicer.org/slicerWiki/index.php/Slicer3:Build_Instructions to build Slicer3 from source.
- Suppose in last step, the directory in which Slicer3 is built is "slicerbuild". Copy DTIRegistration.cxx and DTIRegistration.xml under directory ./plugin/ into ~/slicerbuild/Slicer3/Applications/CLI/
- add the following lines:

```
#####DTIRegistraion#####
```

```

SET (CLP DTIRegistration)

SET (${CLP}_SOURCE ${CLP}.cxx)

GENERATECLP(${CLP}_SOURCE ${CLP}.xml)


ADD_EXECUTABLE(${CLP} ${${CLP}_SOURCE})


TARGET_LINK_LIBRARIES    (${CLP}          ITKIO      ITKBasicFilters
ITKCommon)
#####

into      ~/slicerbuild/Slicer3/Applications/CLI/CMakeLists.txt
just before the line "subdirs ( Realign )"
● under    ~/slicerbuild/Slicer3-build/Applications/CLI/,      run
"make".

```

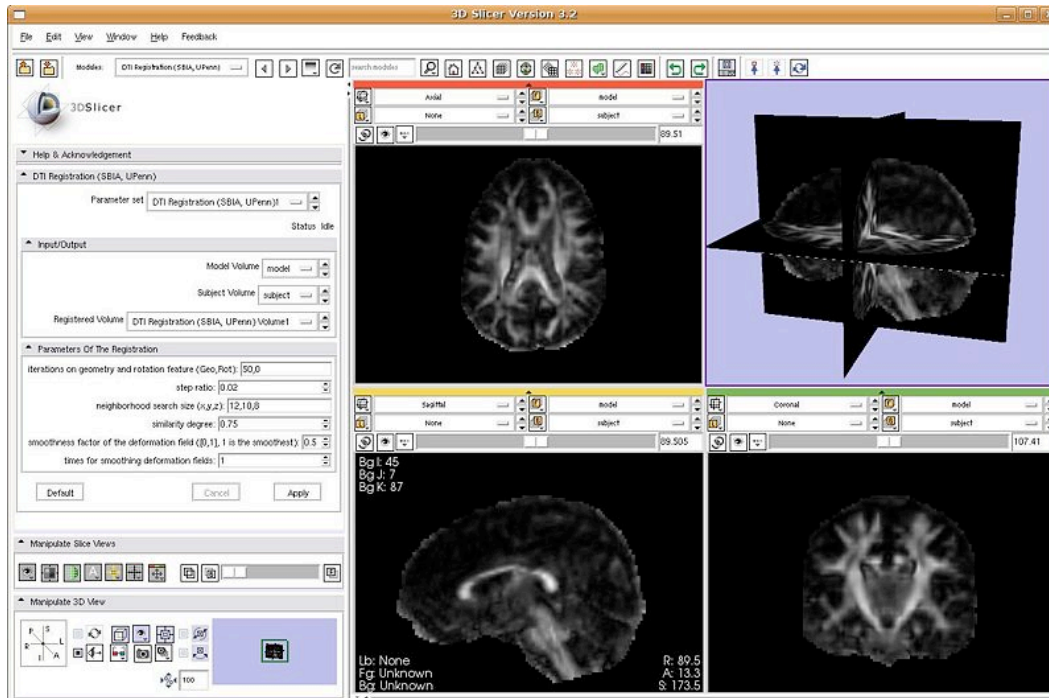
2.5 Set the following folders in your search path:

- ./src/dtidroid/bin/
- ./src/dtidroid/scripts/
- ./src/DTITools/
- ./src/hammer/bin/

3. Usage

- start Slicer3:
cd ~/slicerbuild/Slicer3-build/Slicer3; Slicer3
- in Slicer3:
File->Add Volume->choose ./exmaple/model.nrrd
File->Add Volume->choose ./exmaple/subject.nrrd
- load the module:
modules->Registration->DTI Registration (SBIA,UPenn)
- Under sub-window input/output
set "Model Volume (template)" to "model"
set "subject Volume (subject)" to "subject"
set "Registered Volume" to "Create New DiffusionTensorVolume"

The layout of the loaded module is shown as the picture below:



- click button "Apply" to start the registration.

for this example, a 128x128x40 DTI dataset, it takes about 15min to get the result.

4. The Parameter Setting:

The default parameter settings can register most dataset quite well. However, in some cases, the user may need to change the parameters. The brief explanations of every parameters are as the following.

- Iterations on geometric (Geo) and rotation (Rot) feature: the number of iterations of geometric and rotation feature driven registration are set to 50 and 0 respectively by default. Usually, more iterations can improve the accuracy but require more time. In order to further improve the registration quality on white matter fibers, users can set the iteration number of rotation feature to 1~3.
- Step ratio: the step size in the greedy search. Bigger step ratio increase the converge speed, but may potentially lose accuracy.
- Neighborhood search size: different in different resolution level. Similarly, bigger neighborhood improves the accuracy at the cost of time.
- Similarity degree: the threshold of choosing the candidate corresponding voxel. Higher threshold can make the pool smaller, but it may miss the best correspondence in next step.
- Smoothness factor of the deformation field: the kernel size of the smoothing algorithm. 1: very smooth; 0: no smoothing

- ¹ Times for smoothing deformation field: how many times the deformation field is smoothed. Bigger number result in smoother field.

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5. References:

[1] J. Yang, D. Shen, C. Davatzikos, and R. Verma, "Diffusion tensor image registration using tensor geometry and orientation feature," submitted to MICCAI 2008.