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Creating Diffusion Tensor Images (DTI)

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ABSTRACT

This procedure describes the steps required to create diffusion tensor images (DTI) from data from the MRI scanner.

OPEN ACCESS

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Protocol status: In development
We are still developing and optimizing this protocol

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27354

The following programs are required to go through the protocol:

- MRtrix3
- TORTOISE
- ITKsnap

Note: If you are working from a Windows computer, you will need to follow X2Go Client Set-Up (dx.doi.org/10.17504/protocols.io.6tvhen6) before you can begin this protocol.

Set Up Directory with Required Files

- 1 Open a new terminal.

- 2 Confirm what directory you are currently in.

Command

pwd (0-58-generic #64-Ubuntu SMP)

```
pwd
```

- 3 Create a directory to place data. *(If not already created.)*

Command

Check bash profile to make sure that the TORTOISE folders have been added to it. (0-58-generic #64-Ubuntu SMP)

```
~/.bash_profile
```

- 4 Go to the directory that you plan to use.

Command

Go to directory where TORTOISE is located (0-58-generic #64-Ubuntu SMP)

```
cd ~/rsgrps/hutchinsone/Programming/TORTOISE_V3.1.4/
```

5 Copy directory where your raw data files that will be acquired, reside in.
You will need the following file types:

- Bvals
- Bvecs
- data.img
- data.hdr* - (*may not need this in all cases - used for FOV origin*)

5.1 Find where the files you plan to copy are located. *Make sure to use the original root i.e /home/... as you will get an error if you start from another location.*

Command

Run the bash command to have the files and path set for TORTOISE. (0-58-generic #64-Ubuntu SMP)

```
bash install_TORTOISE.sh
```

5.2 Copy the specific files that you need. Alternatively, you can use . to specify the current directory you are in.

Command

Copy file or entire directory to a specified location. (0-58-generic #64-Ubuntu SMP)

```
cp
```

6 Perform conversion between different file types.

Command

mrconvert (MRtrix3)

mrconvert

- 7 Import data from nifti format to TORTOISE list file format. A new directory will be created and the folder will be labeled ____**proc**.
Example:

Command

ImportNIFTI (TORTOISE)

ImportNIFTI

- 8 Go to the new directory that was created from the previous step.
- 9 Correct motion. Use **DIFFPREP** command. (*This is a command from TORTOISE*). **Note: This step is time & core consuming. Also, this step removes Gibbs ringing and noise**

Command

Corrects motion. (TORTOISE)

DIFFPREP

Create Mask and Segmentation

- 10 Open one of the populated files using ITKsnap.

- 11 Within ITKsnap, select **Active Contour (aka Snake) Segmentation Mode** from the toolbar.

A new side window will appear. Select **Segment 3D**.

Snake Inspector

ROI for auto-segmentation:

Position (x,y,z):

1 1 1

Size (x,y,z):

256 256 35

Reset ROI

☐ Resample ROI

☐ Initialize with current segmentation

Segment 3D

- 13 Toggle the thresholds (lower & upper) so that the blue mask covers the region you want repelled. (*Regions that are empty space or not the brain of interest should have this mask*). **Note: Try not to change the defaults.**

- 14 When the thresholds have been finalized, select **Next**.

- 15 Set the cursor in the relative center of your object of interest. Select **Add bubble at cursor**. A red circle(seed/bubble) will be placed at the location.
Note: You may need to repeat this if you have multiple objects of interest.

- 16 When the bubbles have been set and you have no more to add, select **Next**.

- 17 Press the play button to have the seed grow within the mask that was set-up in a previous step.
Note: Red should propagate and fill the entire region(s) of interest. This may require viewing the images from the different planes to confirm.

18

Once the region(s) of interest are completely filled, select **Finish**.

- 19 Press **Update** in the lower left corner of the ITKsnap interface to view the new 3D segmentation image.

- 20 Select **Segmentation** and **Save As** from the drop-down menu. You will be prompted to save your file as a **__nii.gz** file type.

*It is recommended you name your file **__mask** to clarify segmentation has already been performed.*

- 21 Close out of ITKsnap.
- 22 In an open terminal, unzip the `____.nii.gz` file that was segmented in the previous step.

Command

Unzip file(s) of interest.

```
gunzip __.nii.gz
```

23 Estimate diffusion tensor and B0 amplitude.

Command

Generates diffusion tensor and B0 amplitude. (TORTOISE)

```
EstimateTensorNLLS -i __DTI_DMC.list -m __mask.nii
```

This command will generate 2 files:

- **__N1_DT.nii** (diffusion tensor)
- **__DT_AM.nii** (B0 amplitude)

24 Compute all tensor maps on the **__N1_DTI.nii** output file from the previous step.

Command

Computer all tensor maps. (TORTOISE)

```
ComputeAllTensorMaps.bash __N1_DT.nii
```

25 Open the **__DEC.nii** output file in ITKsnap to view the primary eigenvector map.

26 Within ITKsnap, select **Layer Inspector**.

- 27 From the **Layer Inspector** window, select the **Display mode** drop-down menu and select **RGB Display**.

- 28 Press **Update** in the lower left corner of the ITKsnap interface to view the image in the new display mode.

- 29 The final result will show a colored image of your region of interest that allows a visual guide that estimates location, orientation, and anisotropy of the brain's white matter tracts based on the diffusion of water molecules.