

An interface for DTI tractography

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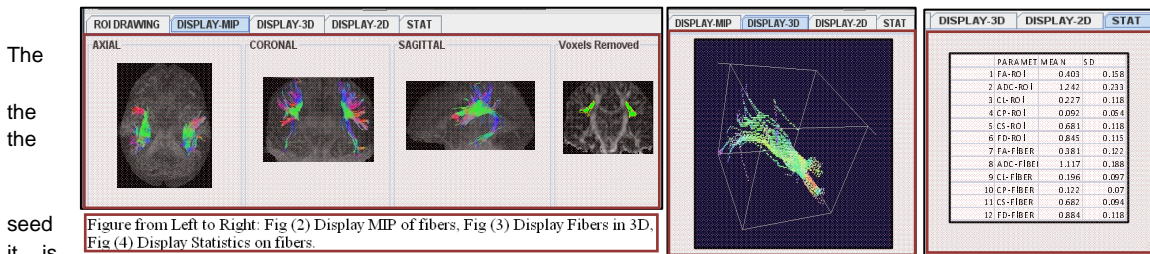
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Introduction: Diffusion tensor imaging (DTI) with MR is an exciting technique for non-invasive white matter fiber tracking in the brain. For this a user-friendly interface with robust algorithms and visualization techniques is needed. We have developed a cross-platform graphical user environment using JAVA. Maps necessary for evaluating fiber tract architecture in the brain were computed. From a given volume data, multiple ways for selecting ROI (Region of Interest), from which user can reconstruct various fiber tracts have been provided. The interface incorporates a number of plug-ins for the operations of add/delete selected fibers, morphological trimming operations, boolean set operations on fiber bundles and gathering statistics on the obtained fiber volume or parts of it. The resultant fiber bundles can be visualized in various ways, like maximum intensity projection or displaying them on 2D image stack or in 3D space.

Methods: Tools in the Module can be grouped in the following way: **1) Reconstruction of Fiber Tracks.**

Visualization of Reconstructed Fiber tracts. 3) Shaping of Reconstructed Fiber tracts. 4) Statistical Analysis of Reconstructed Fiber tracts.

1) Reconstruction of Fiber Tracks: There are seven types of ROI drawing tools (Rectangle, Oval, Poly, freehand, line, point, and tracer) available to draw ROI. Selection can be made on anyone of the orthogonal planes. **a) "Generate":** Fibers whose seed voxels in ROI are reconstructed [ref.1,2]. **b) "OR":** Add fibers from the new ROI in the fiber bundles. **c) "AND":** To retain fibers passing through both the ROIs. **d) "NOT":** To remove fibers passing through the ROI from the fiber bundles. **"3D-connection Voxel"** tool display the location of a voxel in all the three orthogonal planes. **"3D-connection sphere"** tool create a sphere around the ROI and display that sphere in all the three orthogonal planes. **"3D-connection surface"** display the surface of the volume stack. This tool has been specifically designed to choose the ROI around central sulcus. It helps in choosing seed points for the reconstruction of Motor and sensory fibers (Fig 1b, 1c). Tracking parameters (FA threshold, minimum/maximum fiber length, and angle) can be changed using **"Change parameters"**. **2) Visualization of Reconstructed Fiber tracts:** Three ways of displaying reconstructed fiber tracks: **i)** projection of reconstructed fiber bundle in Axial, Coronal and Sagittal planes. **ii)** Display on the 2d images of the volume stack. **iii)** 3D- visualization of the tracks (Fig 3). Tracks can be colored according to Principal Eigen vector directions (Fig 2) and by choosing color from the palette. Different fiber bundles can be colored differently. (Fig 1d) **3) Shaping of Reconstructed Fiber tracts:** Two operations have been deployed for shaping: **addition and deletion** of fibers. The module has options for *manual and automatic addition & deletion* (Fig 2: seed voxels of deleted fibers are shown in fourth image) of fibers. Automatic addition and deletion is done by using similarity measure. **4) Statistical Analysis of Reconstructed Fiber tracts:** **"Statistics"** tool (Fig 4) of the module provides user with **i)** selection of **parameters** of interest (like FA, ADC etc.) **ii) "Statistics on ROI"** shows statistics of ROI corresponding to fibers. **iii) "Statistics on Fiber Bundle":** Statistics on the voxels occupied by the reconstructed fibers. **iv) "Statistics on FOI":** Statistics on the selected fibers of interest. A module has been provided for selecting FOI interactively. (Fig 1d).



Results and Discussion: interface has been designed after discussing common requirements of clinicians (viz., calculating statistics of FOI, finding sulcus, highlighting the point of deleted fiber). Thus user friendly and intuitive

The algorithms in the program have been implemented independent of external libraries, making it easy to port the code into other languages. Modules have been designed so that they could be easily extended for future work. To improve the *time and memory efficiency*, rapid algorithms for manipulating ROIs/fibers have been adopted. This platform provides the user to save the intermediate outcome as a data file for re-loading it for later use. The result data is saved in a way, so as to occupy little space, by saving fiber coordinates as voxel numbers rather than the entire stack. All the work has been evaluated and currently in use for patient and normal studies at the Department of Radiodiagnosis, SGPGIMS Lucknow, India.

References: 1. Mori S et al. Annals Neurology 45:265 (1999). 2. Basser et al. MRM 44:625 (2000)