

DTI&FiberTools: A Complete Toolbox for DTI Calculation, Fiber Tracking, and Combined Evaluation

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INTRODUCTION

DTI and fiber tracking is a new and still developing discipline of MR post-processing. So far there is no commercial and easy extendable tool available. Therefore, most groups working on DTI have to develop their own tools in order to process and visualize their DTI datasets. This is very time consuming, needs know how and costs manpower. In addition, the results between studies and different groups are not comparable, since the used algorithms can differ in some details. In this abstract, a MATLAB based toolbox is introduced, containing GUI based tools for the whole working procedure of DTI and fiber tracking studies, containing data processing, visualization, evaluation, and documentation.

METHODS

The DTI&FiberTools was implemented under MATLAB [1]. This toolbox provides import-filters for several MR file standards, a processing unit to calculate the diffusion tensors; several GUI based tools to calculate fiber tracks and to evaluate the DTI dataset (see Fig 1). The results can be filed as images with 3D impression or can be logged in formatted ASCII files. The toolbox is available upon request.

DTI Processing Unit: To use the DTI&FiberTools, the diffusion tensors and their eigenvalues and eigenvectors have to be calculated by the DTI processing unit (see Fig 1) [2]. For the diffusion weighted MR-datasets, different file formats are supported (like DICOM, ANALYZE, etc). The standard SIEMENS and GE diffusion encoding schemes are supported; other schemes have to be defined in a separate text file.

FiberTracker: Fiber tracking is realized by a GUI based tool and uses the FACT algorithm [3]. By defining thresholds for FA-index and mean diffusivity or user defined ROIs the areas to be tracked follow defined constraints. The ROIs can be created graphically in the FiberViewer (see below). The resulting fiber tracks can be saved or transferred directly to the FiberViewer (see Fig 1).

FiberViewer: The FiberViewer is the central tool within this toolbox (see Fig 1). Maps of different parameters (e.g. FA, Trace, lambda images ...) can be visualized and evaluated in this tool. In Fig 2, a screen shot is shown. In the red 'view center', the different DTI maps or any other map of the same dimensionality can be selected and will be displayed in the magenta 'navigation center'. Additionally, ROIs, fiber tracks, and the main diffusion direction can be overlaid on the maps. The yellow marked part of Fig. 2 shows the 'ROI center' providing several tools to generate or manipulate masks such as free hand painting, thresholds, binary operations, region growing, and erosion/dilatation. The cyan marked 'fiber center' provides operation on fiber tracks. Subsets of the fiber tracks can be selected by ROIs and masks can be generated by the areas visited by one of the fiber subsets. An additional feature of the FiberViewer (the 'DocUnit') enables writing the mean value and the STD for each ROI and each opened map in a formatted ASCII file, which can be easily imported by Origin or MS Excel. The tool also allows summarizing statistics of the different fiber subsets.

3D Visualizer: In order to get a better understanding of the trajectory of the fiber bundles this additional tool was made to visualize fiber subsets, ROIs and slices of one data modality with 3D impression.

RESULTS & DISCUSSION & OUTLOOK:

The introduced toolbox provides a complete and platform independent set of tools containing data processing, fiber tracking, evaluation, and visualization. Additionally the 'DocUnit' was designed to allow larger studies with high number of subjects. Since most common MR file standards are supported, the tool is easily to adapt to the most MR facilities. Furthermore the results of the toolbox can either be imported into the most common statistical program or can be saved as image. The user-friendly GUI, provided by this tool, enables creation and evaluation of DTI data sets and fiber tracks without deep knowledge in DTI. A plug-in adapting the DTI&FiberTools to the SPM diffusion toolbox [4] is work in progress, and will be released in spring 2006. This extension will allow using the whole collection of the data processing facilities of SPM for the DTI&FiberTools. Additionally, this will allow combining the fMRI results with fiber track results all in one tool.

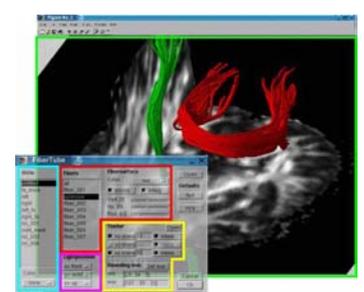
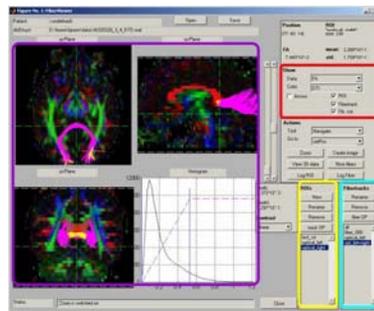
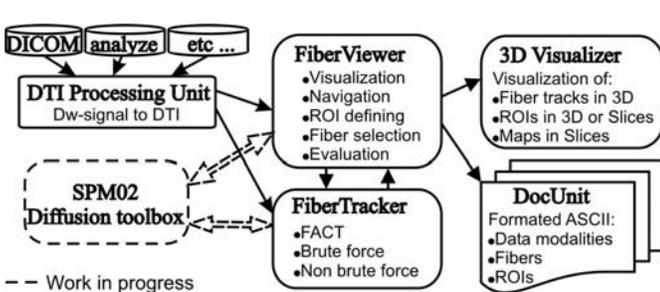


Fig 1: Flowchart of the DTI&FiberTools. The boxes symbolize the main tools, the thin arrow the flow of data between the tools. The dotted thick arrows symbolize the plugin interfaces between the SPM02 Diffusion toolbox [4] and the DTI&FiberTools, which is still in progress.

Fig 2: GUI of the FiberViewer. The navigation and histogram center is marked in magenta, the ROI center in yellow, the fiber center in cyan, and view center in red.

Fig 3: GUI of 3D Visualizer and an example. The fiber center is marked in red, the ROI center in cyan, the map center in yellow, and the output window in green.

REFERENCE

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[2] Basser P, et al; Journal of Magn Reson, Series B 103:247 (1994)
[4] Glauche, V; <http://www.fil.ion.ucl.ac.uk/spm/ext/>, Diffusion II