

Introduction

Diffusion Tensor MRI is a growing research field. DTI related image processing and meaningful visualization are crucial in analyzing DTI data. The MIPAV (Medical Image Processing, Analysis, and Visualization) application enables quantitative analysis and visualization of medical images of numerous modalities. Currently, a prototyped DTI processing and visualization tool is being developed under MIPAV. The DTI tool consists of three components: The DTI Sorting tool, The DTI Color Display tool, and the DTI Visualization tool

MIPAV - Medical Image Processing, Analysis, and Visualization

MIPAV is a comprehensive, extensible, and platform-independent JAVA based medical image processing and visualization application developed at the NIH. This application provides the foundation and tools needed to assist NIH intramural researchers with the processing of hypothesis-driven research data. Development includes the implementation of known solutions and novel, algorithms, or methods to quickly and efficiently meet the needs of our collaborators. It is freely available via the MIPAV website (<http://mipav.cit.nih.gov>). MIPAV supports over 20 different industry standard image formats including: DICOM, Analyze, Minc 1.0 & 2.0, NRRD, NIFTI, and TIFF.

DTI Sorting tool

The DTI Sorting tool takes in as input the study path Directory of the DWI images and the gradient file. The output of this tool is three files: a .path file, a .list file, and a .bmtx file. The purpose of these files is that they are then used in further DTI processing. The .path file is a sorted listing of file paths of individual slices. The .list file is a file containing metadata about the dataset. The .bmtx file is the computed b-matrix values.

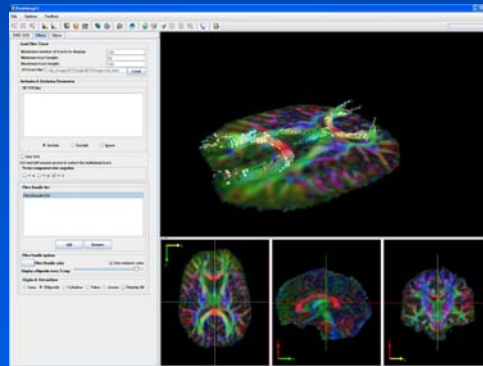
DTI Color Display tool

The DTI Color Display tool takes in as input the eigenvector file and an anisotropy file and uses one of several color schemes as defined in the paper¹ by S. Pajevic and C. Pierpaoli to represent the directionality of the fibers. The paper also defines several heuristic parameters that can be adjusted in this tool

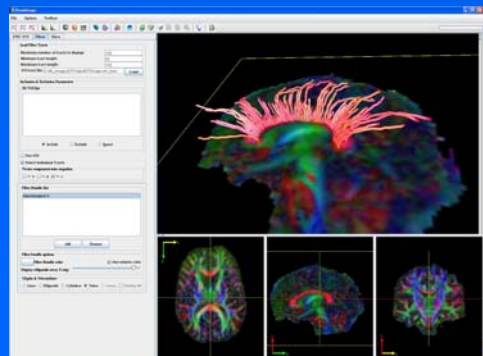
DTI Visualization tool

Based on the MIPAV Visualization framework, a DTI Visualization has been prototyped. This framework's pipeline goes from the raw DWI data to ultimately tract reconstruction and visualization. Inputs to this framework can be the .list file and an optional mask image or the input can be a DTI tensor image. If the input is the .list file and optional mask image, tensor computation then takes place. If, instead the DTI tensor image has been used as an input, the tensor computation step is skipped. From the tensor image, eigenvector, eigenvalue, and fractional anisotropy images are created. The eigenvector and anisotropy image are then used as inputs to the DTI Color Display tool to construct a color-mapped image that will be loaded into the framework to display as a background reference image. Fiber bundle tract reconstruction then proceeds.

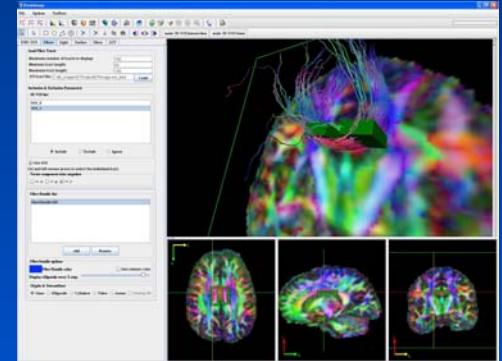
3D Visualization of the fibers use glyphs that represent the local diffusion tensor with its color, location, and orientation. The color coming from the color-mapped background image from the DTI Color Display tool. The following figures show fiber structure using glyphs (ellipsoids).



The tool allows users to seed points on a planar view, and corresponding fiber tracks will be generated automatically from that seeding point. The following figure shows the result of several seeding points.



The tool allows users to specify Volumes of Interest (VOIs). VOIs can be identified as Include VOIs or Exclude VOIs. If a VOI is identified as an Include VOI, the visualization tool will display fibers that go through this VOI. Alternatively, if a VOI is identified as an Exclude VOI, fibers that go through this VOI will not be shown. The following figure shows two Include VOIs and the result of displaying fibers that pass through both VOIs.



In addition to the visualization, the DTI tool outputs Fractional Anisotropy, Trace, Volume Ratio, and Apparent Diffusion Coefficient statistics.

Future Work

- Prior to the tensor computation, the MIPAV DTI framework does not handle registration of images, eddy-current distortion correction and echo-planar distortion correction. These steps will need to be added to the DTI pipeline.
- User inputs will be added to allow the user to filter fibers based on FA and angle threshold.
- Fiber statistics will be added
- To handle other image formats as inputs to the DTI tool, a new input interface will be added.

References

- [1] S. Pajevic and C. Pierpaoli, "Color Schemes to Represent the Orientation of Anisotropic Tissues from Diffusion Tensor Application to White Matter Tract Mapping in the Human Brain", *Magnetic Resonance in Medicine*, vol 42, no 3, Pp 526-540 1999
- [2] C. Pierpaoli, A.S. Barnett, S Pajevic, A. Vitta, and P.J.Basser, "Validation of DT-MRI tractography in the descending motor pathways of human subjects," *ISMRM, Conf. Proc.*, p. 501, 2001
- [3] Mori, Susumu, "Introduction to Diffusion Tensor Imaging", Elsevier, 2007

