MI-Brain, a software to handle tractograms and perform interactive virtual dissection

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Target audience - Researchers developing streamlines interaction tools, as well as all medical researchers, physicians and clinicians who need to visualize or dissect tractography datasets.

Purpose - This abstract presents a free and public software created to improve visualization and interaction with tractography datasets. The proposed software is MI-Brain (www.imeka.ca/mi-brain), a new visualization application based on the MITK platform **[1]**. MI-Brain allows the user to perform state-of-the art interaction and analysis of tractography datasets. TrackVis, a widespread tractography segmentation tool, is no longer under development, causing a gap between what researchers have access to and what they need. The goal of this abstract is to showcase the MI-Brain software and describe its intuitive dissection workflows and powerful interactions features.

Methods -

Data Management: MI-Brain is built on top of the MITK library **[1]**, which is also based on the VTK **[2]** and ITK **[3]** libraries. This enables the software to support various types of neuroimaging datasets and support a wide range of file formats. 2D, 3D and 4D images (see Figure 1c), regions of interest (ROIs), tractograms and surfaces are loaded and saved from the application (see Figure 1a). One major difference with other visualization tools, such as TrackVis, BrainVisa, ExploreDTI or FiberNavigator, is that all data types can be loaded simultaneously in a common space (see figure 1e) using the 3D transformation information contained in the header of each loaded file, even if they don't have the same dimensions, voxel size or LPS/RAS convention. The user can then save each dataset to another appropriate format, or save the whole scene.

Tractogram virtual dissection features: Many dissection options and methods are already implemented in MI-Brain (see Figure 1b). For example, any tractogram can be dissected using ellipsoid, cuboid and hand-drawn ROIs. More complex dissections can be created by using logical AND or NOT operators to combine ROIs, as well as various segment selection criteria, such as any part, either end, both ends, no end (see Figure 1f). The resulting bundles can be extracted, saved or used within the application for visualization purposes. If they are mutually registered, multiples bundles can be segmented across multiple tractograms using the same ROIs all in the same common space.

Recently, a method for tractogram compression has been proposed **[4]**. This method can successfully discard more than 90% of the points on all streamlines by taking advantage of the collinearity of the streamlines' points. Software tools such as TrackVis, Mrtrix, ExploreDTI or FiberNavigator use points-based algorithms for dissection of streamlines and are therefore greatly affected by compressed datasets. MI-Brain uses segments-based algorithms enabling correct interaction with compressed tractograms **[5]**. Supporting compressed datasets enables the application to successfully load and interact with larger file sizes while keeping a responsive frame-rate. The memory usage can be decreased by a factor of 10 to 15. By removing so many points, rendering time is also decreased. **[5]**.

Other useful features are the crosshair rotation and the 'Swivel mode', both available in MITK, which give the ability to slice any loaded volume in any arbitrary direction. Ellipsoid, cuboid and hand-drawn ROIs do not have to be aligned with the X, Y, Z axes anymore, which is useful when dissecting specific bundles. As seen in Figure 1d, a 2D streamlines intersection option enables visualization of the streamlines intersecting the slicing plane, even if not aligned with the X, Y, Z axes.

Other features: Real-Time Tracking **[6]** for on-the-fly streamlines generation using peaks (extracted from tensors or any field of ODFs) is available in MI-Brain. This feature allows the user to quickly try various parameters and see their influence on the streamlines. MI-Brain supports real-time operations on masks, such as dilation, erosion, union, intersection or difference between masks. High-resolution screenshots or videos can be generated from the scene. There are also many basic coloring and opacity options for masks, surfaces, ROIs and tractograms. The segmentation plugin has various tools for drawing ROIs by hand without being limited to 2D square or circle. 3D segmentation is also available to quickly segment 3D regions without having to draw them slice by slice.

Discussion & Conclusion -

We have outlined the main functionalities of MI-Brain. The software allows the user to perform many state-of-the-art interactions with neuroimaging datasets. Work is still ongoing to improve dissection features as well as robustness of the application. Many additional features that have not been presented are some are planned, such as 3D surface coloring options and an improved dissection plugin more suited for research needs. A free and public release will be available in the future.

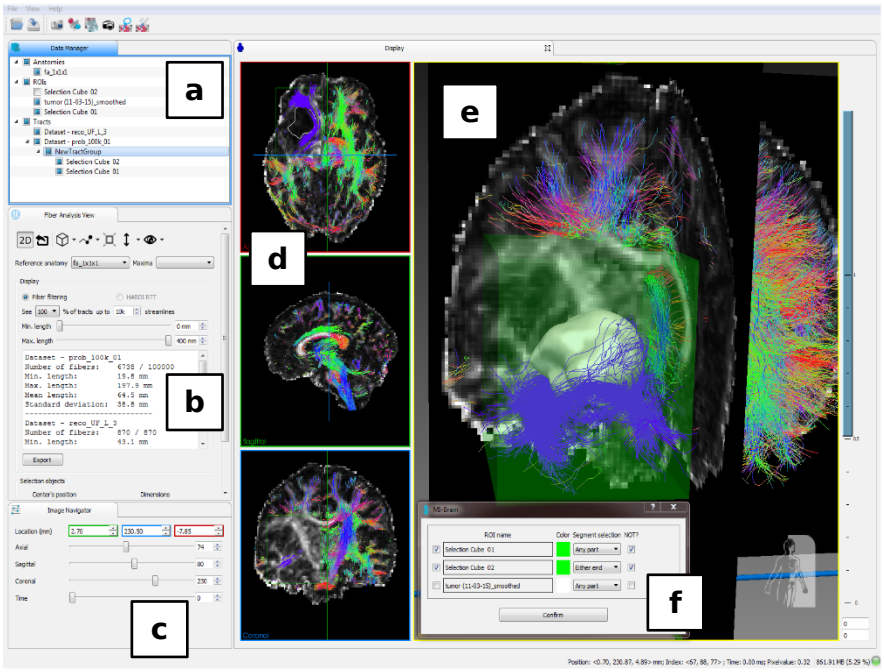

Figure 1: A standard view of MI-Brain, many plugin setups are available or can be moved and resized. **a)** the DataManager plugin displays all loaded datasets. **b)** the FiberAnalysis plugin displays streamlines' statistics and buttons for various dissection and coloring options. **c)** the ImageNavigator plugin navigates through 3D slices or the 4th dimension (DWI for example). **d)** 3 planar slices with intersecting streamlines. **e)** 3D view showing loaded datasets **f)** popup for segmentation criteria to select options for streamlines' selection using ROIs.

References -

[1] www.mitk.org
[2] http://www.vtk.org/
[3] https://itk.org/
[4] Presseau et al., NeuroImage 2015
[5] Rheault et al., ISMRM 2015
[6] Chamberland et al., Frontiers in neuroinformatics, 2014