

Paint and Track: Surface-based ROI Selection in DTI Fiber Tracking

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Abstract

Diffusion Tensor Imaging (DTI) measures *in vivo* water diffusivity, allowing for exploration of white matter pathways with tractography techniques. In this abstract, we present a novel method to select any gyrus or sulcus as the Region of Interest (ROI) for fiber tracking. Such a method is more user-friendly than standard ROI selection algorithms because it enables users to interactively select brain regions with a paint brush. In this sense, our work represents an application of visualization techniques to facilitate DTI tractography.

Introduction

One major goal of integrated application of DTI and functional MRI (fMRI) in pre-surgical planning is to track white matter fibers associated with specific brain cortical surface areas such as those delineated by fMRI. In general, DTI fiber tracking algorithms requires a ROI as the seeding area. Such a ROI can be defined automatically or manually. Automatic ROI selection uses methods such as projecting gray matter activity from fMRI scans to white matter, while manual ROI selection is usually done by defining a rectangular box or drawing a free-shape polygon on 2D slices. Here, a manual ROI selection method is developed to allow the user to use a "brush" to paint (or highlight) the white matter surface. Note that we use surfaces from white matters rather than gray matter for two reasons. First, white matter surfaces can reveal the sulci much better. Second, white matter surfaces enable fiber tracking to start immediately, while in the case of gray matter surfaces, selected points have to be first projected onto white matter following its reverse normal vector direction [4]. A newly selected area can either be added to or replace existing areas. Highlighted surface areas are then used as the seeding region for fiber tracking. Thus, this proposed ROI selection method allows users with anatomical knowledge to select target gyri and sulci as the ROI for fiber tracking.

Method

This method is built into the MediCAD software package [1]. The software detects the current mouse position and then uses OpenGL's Unproject function to compute the 3D position P where this point lands on the surface. Surface vertices within a user-defined *radius* distance to P are consequently highlighted. A free-shape ROI is then constructed by marking all voxels to 1 if their relative distance to P is less than *radius* and 0 otherwise. It is worth noting that this 3D point selection method can be used on selecting points from slices in 3D, as demonstrated by the videos (available at <http://medixad.googlepages.com/home>).

This method has been routinely used in our research. All data were acquired on a 3T MR scanner (Achieva, Philips Medical System, Best, The Netherlands). T1-weighted anatomical images were collected as 160 axial slices with 1x1x1 voxel size using a 3D gradient echo sequence. The DTI parameters were set to 32 diffusion-weighted directions, 256 to 300 mm FOV, 128 matrix size and reconstruction size, single-shot EPI with shortest TE (around 80 ms) for a b-value of 850 s/mm², 90° flip angle, shortest TR for 60 slices of 2mm thickness. Eddy current distortion correction had been carried out based on a mutual information-based algorithm [2].

Results

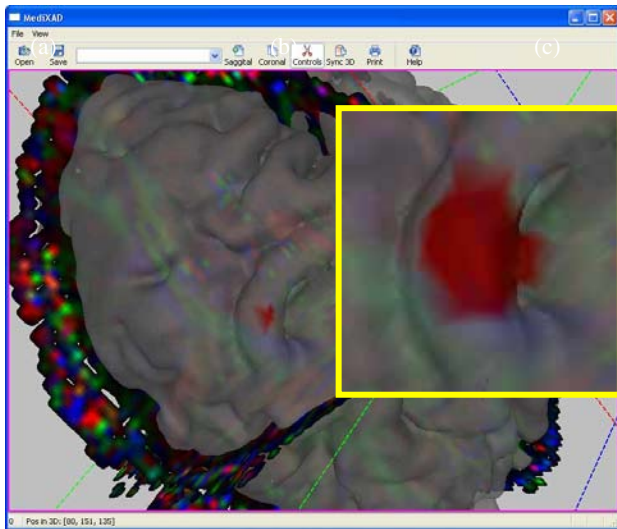


Figure 1. Paint brush with different radii. Radius is 2 in the back overview image and 6 in the zoomed up insert.

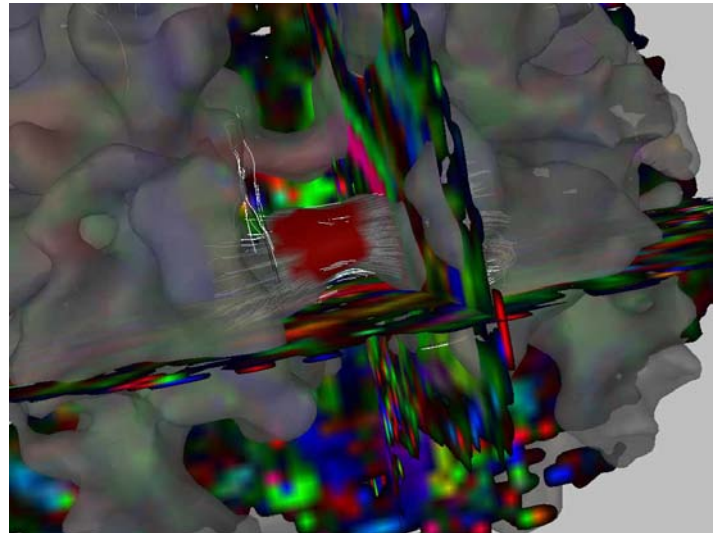


Figure 2. Fibers (in white, behind the white matter surface) tracked from the selected surface area (in red). Minimum starting FA is 0.35. Minimum FA to maintain tracking is 0.25. Maximum curvature is 80°. A fixed step size of 1.0 is used.

Discussion and Conclusion

We have implemented a surface painting and seeding scheme, which has an important virtue of allowing for interactive selection of brain gyri and sulci for DTI fiber tracking. One limitation comes from the added computational time for segmenting white matter. However, this is acceptable in practice because white matter segmentation with SPM [3] is fully automatic and therefore can be done off-line. Other possible concerns are the accuracy of white matter segmentation or imperfect image registration. In these cases, the user can use the iso-surface from the FA volume, whose values are equal to the Fractional Anisotropy (FA) value of the DTI data.

Reference

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