Title:

Atlas-based Fiber Bundle Segmentation Using Principal Diffusion Directions and Spherical Harmonic Coefficients

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Abstract: (Your abstract must use **Normal style** and must fit in this box. Your abstract should be no longer than 300 words. The box will 'expand' over 2 pages as you add text/diagrams into it.)

Introduction: Quantification of diffusion characteristics inside a fiber bundle provides new insights for diseases evolution, therapy effects, and surgical interventions. Here, we present a novel method for segmenting fiber bundles using Principal Diffusion Directions (PDD) and Spherical Harmonic Coefficients (SHC). We first compute SHC of order 8 which describes diffusion signals from High Angular Resolution Diffusion Imaging (HARDI) protocols quite well [1]. Then, we calculate Orientation Distribution Function (ODF) [2]. After fitting the SHC of order 8, we apply a novel strategy [3] to extract the major peaks for each voxel, whose maximum number is 4. Finally, based on the PDD and SHC, we propose a similarity measure and a narrow-band strategy in level set framework to segment fiber bundles.

Methods: Extracting the most probable voxels of a desired bundle from an atlas [4], we seed from each and compare its PDD with the PDD's of the next voxel (pointed by the normal direction of the voxel). Keeping the most collinear direction and removing remaining PDD's, the front propagates based on the similarity in a narrow-band level set algorithm.

Results and Discussion: We compare the segmentation results of the proposed algorithm with that of our previous method [5] and methods using Tensor-based similarity measures [6] for synthetic diffusion pattern (Figs. 1-2) and show its advantages over them by quantifying correctness of the results in crossing fibers and low SNR conditions. As shown in Fig. 2, a gap is generated around each segmented bundle which prevents improper leakage into irrelevant bundles. Ultimately, only one PDD is preserved inside each voxel even in the crossing areas, generating a unique homogenous diffusivity pattern characterizing the segmented fiber bundle. Application of the proposed algorithm to real HARDI data shows its capability in segmenting major fiber bundles like Corpus-Callosum, Cingulum and Cortico-Spinal (Fig. 3).

Keywords: Fiber bundle Segmentation, Spherical Harmonic Coefficients, Principal Diffusion Directions, Level Set, Diffusion MRI.

Fig.1. Synthetic crossing bundles.

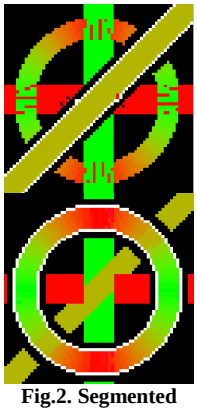
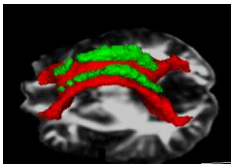


Fig.2. Segmented synthetic bundles.



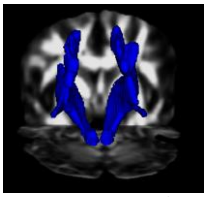


Fig.3. Segmented fiber bundles. Red, Corpus-Callosum. Green, Cingulum. Blue, Cortico-Spinal.

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