Filtered Tractography

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Computer vision encompasses a host of computational techniques to process visual information. Medical imagery is one particular area of application where data comes in various forms: X-rays, ultrasound probes, MRI volumes, EEG recordings, NMR spectroscopy, etc. This dissertation is concerned with techniques for accurate reconstruction of neural pathways from diffusion magnetic resonance imagery (dMRI).

This dissertation describes a filtered approach to neural tractography. Existing methods independently estimate the diffusion model at each voxel so there is no running knowledge of confidence in the estimation process. We propose using tractography to drive estimation of the local diffusion model. Toward this end, we formulate fiber tracking as recursive estimation: at each step of tracing the fiber, the current estimate is guided by those previous.

We argue that this approach is more accurate than conventional techniques. Experiments demonstrate that this filtered approach significantly improves the angular resolution at crossings and branchings. Further, we confirm its ability to trace through regions known to contain such crossing and branching while providing inherent path regularization.

We also argue that this approach is flexible. Experiments demonstrate using various models in the estimation process, specifically combinations of Watson directional functions and rank-2 tensors. Further, this dissertation includes an extension of the technique to weighted mixtures using a constrained filter.