

DTI analysis of pediatric populations using landmark-based approach

Nayoung Lee, Center for Imaging Science, Johns Hopkins University

Advances in medical imaging such as magnetic resonance image (MRI) allow neuroscientists and clinicians to study normal and abnormal neuroanatomy of human brain non-invasively. Structural MRI is able to yield information about its gray and white matter volume and macrostructure (gyri and sulci). Diffusion tensor (DTI) is an emerging MRI application and has the potential to contribute a much richer understanding of brain white matter structure than conventional MRI by delineating white matter pathways in vivo and quantifying microstructural changes not visible on conventional MRIs.

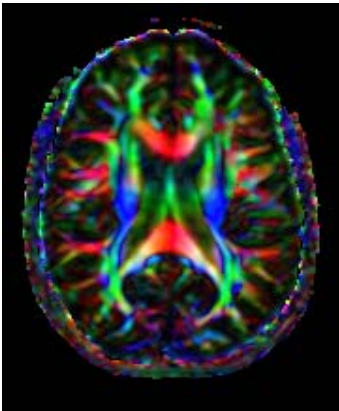


Figure 1. Color map of eigenvectors from DTI scan represents the orientation of the fiber tracts (blue-superior to inferior, red- left to right, green – anterior to posterior).

The long term objective of my current research in Center for Imaging Science (advisor : Dr. Michael Miller and Dr. Tilak Ratnanather) in collaboration with Dr. Susumu Mori in Kennedy Krieger Institute is to characterize the structural development of pediatric brain by applying landmark based Large Deformation Diffeomorphic Metric Mapping (LDDMM) on DTI image. A database of developing children's brain DTI scans (cross sectional) is available. The principal underlying hypothesis is pediatric brains show morphologic and photometric change as they develop.

We quantified the reliability of manually placed landmarks (237 landmarks on each brain scan) on DTI images to identify the homologous structures of white matter in a consistent manner. Once the reliability of the landmarks is achieved, the landmark based LDDMM was modified to reflect each landmark's reliability and applied to the images acquired from children of different ages to characterize the nonlinear structural change as the brains develop. The 237 landmarks guide LDDMM to map one brain scan to a template brain scan. LDDMM also calculates the vector fields from one brain to another brain that describes the change of shape. Once the brain scans are aligned to a common template coordinate, we overlay scalar properties of the brains acquired by DTI scanning such as fractional anisotropy, mean diffusivity to represent photometric change of the developing brain in a common coordinate.