



Introduction

The human visual pathway's complex anatomy makes it particularly difficult to study with tractography. An especially challenging region is Meyer's loop, a portion of the optic radiation that courses anteriorly around the temporal horn before traveling posteriorly to the visual cortex. In this work, we propose an automated system to generate a tract-based representation of the visual pathway using precise LGN delineation and fiber orientation distribution (FOD) based probabilistic tractography.

FOD Computation and Tractography

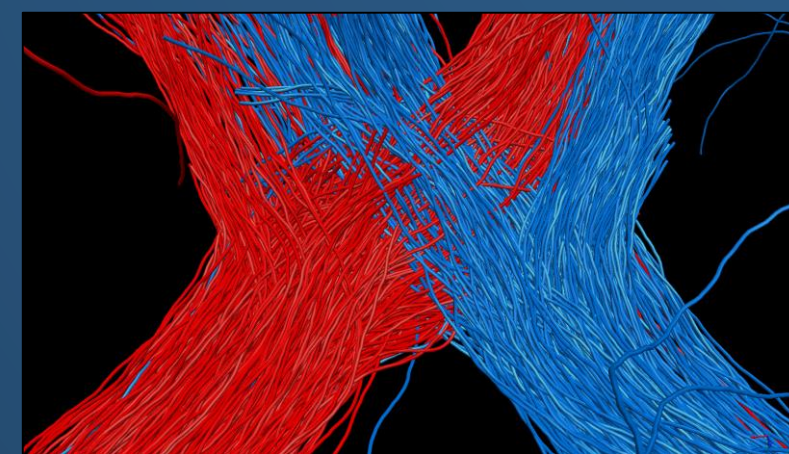
FOD Computation

We used an adaptively constrained optimization method to compute the FODs for data from the Human Connectome Project (HCP). This method has the advantage of being able to process data from arbitrary acquisition schemes including the multi-shell data from the HCP.



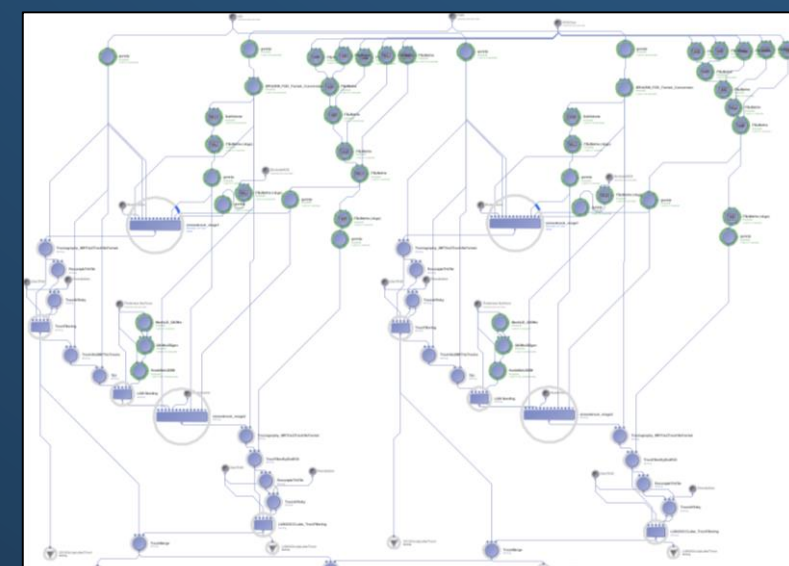
Tractography: Stage 1

We performed tractography in two stages to overcome the difficulty of manually identifying the LGN. Stage 1 tracked fibers between the optic chiasm and the visual cortex. Then using a volumetric mask of the bundle acquired in stage 1, a mask of the LGN was generated by automatically isolating the portion of the stage 1 bundle that corresponded to the lateral-posterior thalamus.

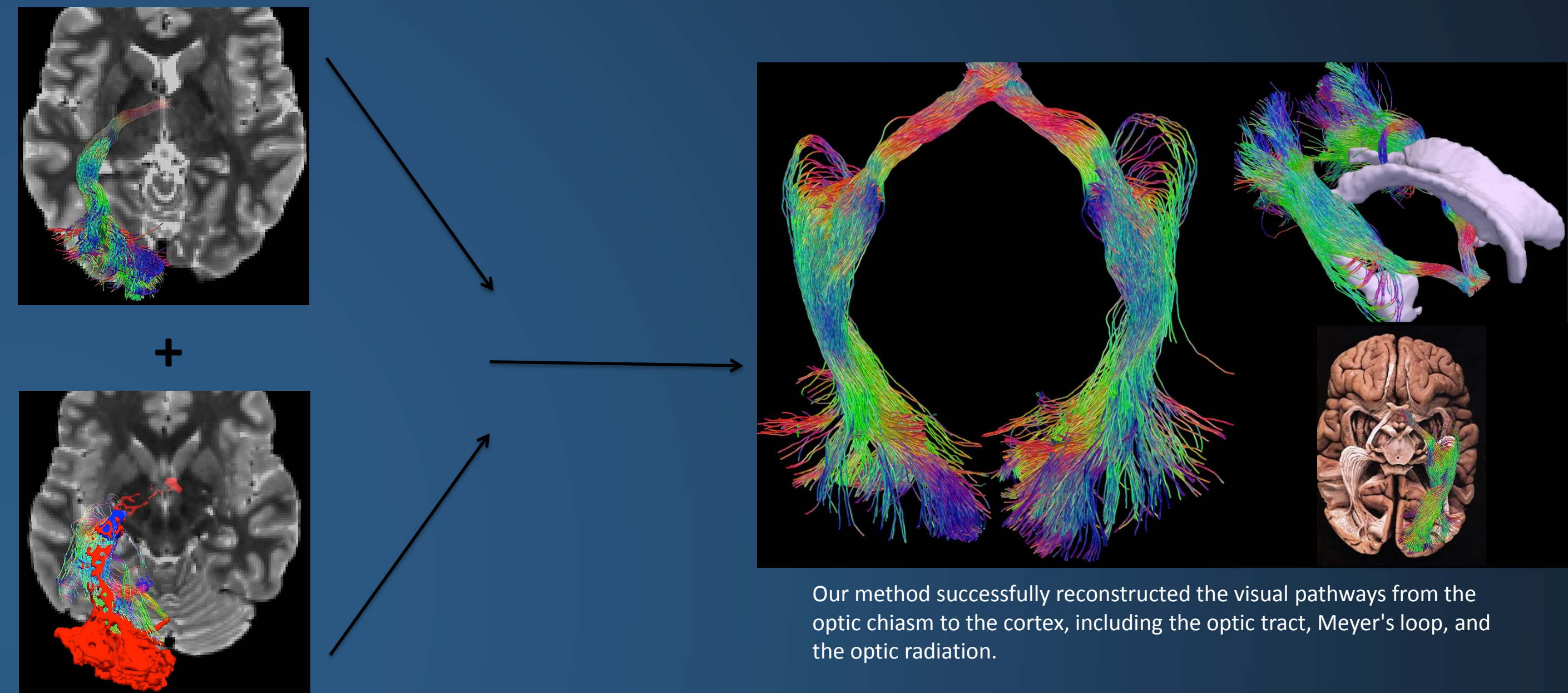


Tractography: Stage 2

Stage 2 tracked fibers between the LGN and the visual cortex, using the automatically-generated LGN mask as the seed. The two stages were then compiled together. All tractography was performed using LONI Pipeline.



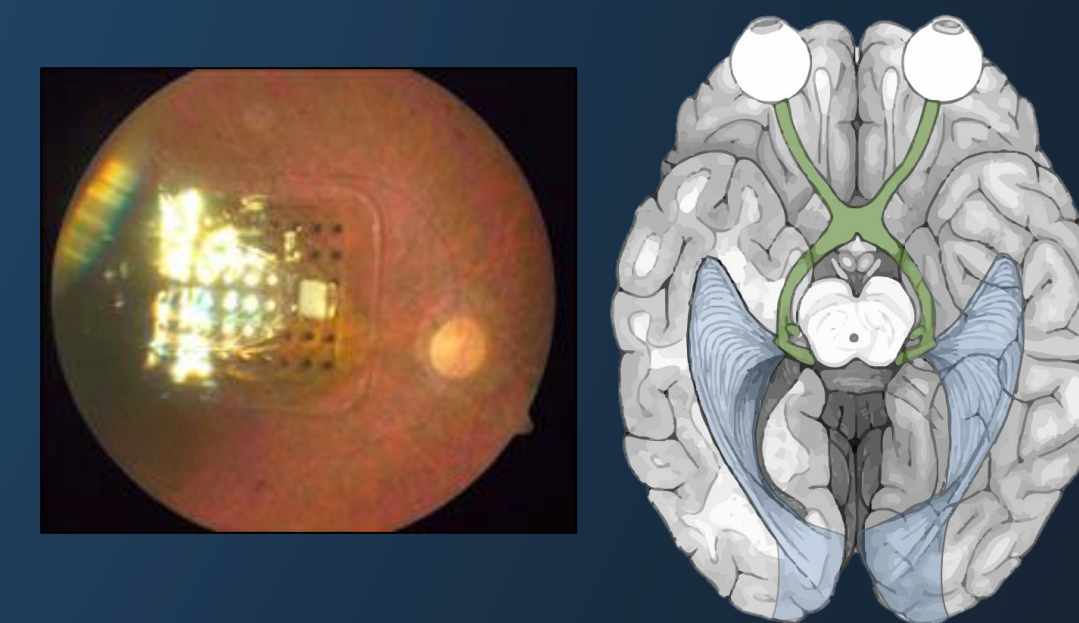
Results



Our method successfully reconstructed the visual pathways from the optic chiasm to the cortex, including the optic tract, Meyer's loop, and the optic radiation.

Discussion & Future Directions

In this work, we proposed an automated system to reconstruct the human visual pathways. One seminal feature of our system is that it provides a reliable way to capture Meyer's loop with minimal human input. Preliminary data shows promising results that we can use the method to reliably distinguish between normal and visually impaired subjects. We are currently working to apply the method to disease-states such as macular degeneration and multiple sclerosis. Additionally, we are investigating the application of the method to monitor changes in the visual pathway following retinal prosthesis implantation.



References

1. Van Essen D et al. 2012 The Human Connectome Project: A data acquisition perspective. *NeuroImage*, 62(4):2222-31.
2. Tran G & Shi Y 2013 Adaptively Constrained Convex Optimization for Accurate Fiber Orientation Estimation with High Order Spherical Harmonics. *Proc. MICCAI*, 485-92.

