Haptics-Assisted 3D Lasso Drawing for Tracts-of-interest Selection in DTI Visualization



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Motivations

This project is motivated by the desire to help doctors in better understanding the white matter structure within human brain for studying diseases.

- Visually locate brain structures faster
- Reduce navigation/manipulation overhead that experts









experience when working with 2D selection interfaces

- Reduce visual cluttering of white matter tractography
- Provide faster more direct manipulation in 3D space



User Interactions

Head Tracked Stereo Glasses







Obtain refined fiber bundle based on the characteristic trajectory using AND operation

User can place multiple lassos and perform logical combinations of AND and OR operations

Methods

- Fishtank virtual reality (VR) environment with head tracker reduce visual cluttering
- 3D hand tracker controls rotation and zooming by hand gestures
- Tracts-of-interest selection by drawing freeform 3D lasso directly in 3D space



Conclusions

New TOI interface adopting haptics

Phantom Force Feedback Device (Input and Output)

- Haptics constraints in phantom force feedback device enables direct smooth 3D curve drawing
- Dynamic dragging haptics constraint ease drawing in dense and narrow fiber tract bundle area



6D input phamton device provide tangential guiding filter assisting smooth curve drawing

Expert Feedbacks

• 3D stereo environment let them identify 3D structures much more easily

• Make selection by direct 3D lasso drawing

- Expert evaluation suggests this is a promising approach
- VR environment reduced visual cluttering of the tractography model
- Brain scientists using the tool gained more confidence in identifying the structures
- Manipulation of brain model using hand gesture with hand tracker greatly reduced navigation time

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- Brain model navigation time was greatly reduced by visual aid of 3D stereo combined with simple hand gestures with hand tracker
- The users located and identified WM structures and the area they project in the brain quickly and with high confidence
- Selection by lasso drawing is easy to learn. Directly placing flexible 3D lasso in the 3D space let them easily segment tortuous brain structures
- Users were highly engaged in the process and noticed a reduction of eye fatigue common in stereo interfaces