Efficient Visualization of Risk Structures along Virtual Access Paths for Neurosurgical Planning

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Objective: For visualizing neurosurgical risk structures of the brain and neurosurgical planning, processing of fMRI and DTI data is becoming standard in respective software assistants. However, in recent tools the fusion of anatomical and functional data causes complex visualizations and a high amount of user interaction. Our aim was to develop efficient interaction and visualization techniques and to combine them within a prototype for assisting neurosurgical planning.

Methods: We integrated a set of synchronized viewers in our application in order to achieve a simultaneous and comprehensive visualization: 1) Multi Planar Reconstruction (MPR) views for slicing in the main directions, 2) indirect 3D rendering of intracerebral lesions and functional areas, and 3) volume rendering of the brain's anatomical and functional structures. In the indirect 3D rendering, the brain contours are visualized as anatomical hints using silhouettes. In the volume rendering, the brain as well as the functional data are visualized in an opaque fashion. A user defined virtual incision point and the chosen structure of interest define a line in the indirect rendering plus a corresponding cylindrical cut-out in the volume rendering in order to quickly identify relevant risk structures. These structures are enhanced depending of the distance to the path. The MPR views show the complete volume data of the volume plus the cylindrical path.

Results: We have developed a visualization prototype for neurosurgical planning. Recent visualization methods and rendering techniques were combined in the application. These techniques allow identifying risk structures along a virtual access path. Thus, important functional data as well as risk structures can be easily explored.

Conclusions: The proposed techniques provide means for optimizing neurosurgical planning. We believe the virtual access path could become an integral part of preoperative planning and promises to impact therapeutic decisions in neurosurgery.