Interactive Exploration of PET and MRI Brain Scans with a 3D Virtual Reality System

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Abstract

In a world of rapidly emerging commercial Virtual Reality (VR) technologies, such as Oculus Rift, the ability to view medical images as an interactive 3D object, which can be virtually entered, becomes a possibility. In the past, virtual reality has been used as an educational tool, for therapy in motor disorders, and also as a visualization tool for surgery, however, many of these systems have been a combination of incredibly costly and often difficult to come by. Using these improved and more readily available technologies, we have created a application for use with a VR enabled computer and Oculus Rift to allow the 3D visualization of DICOM datasets, specifically MRI and PET brain scans.

Objectives

Traditional methods for viewing PET and MRI brain scans include cross-sectional 2D planar images (in axial, coronal, and sagittal views), stereotactic surface projections as 2D planar images, and maximum intensity projections as pseudo-3D rotating volumes. Recent advances in affordable consumer hardware and software have enabled the development of virtual reality systems that can be applied and used for more realistic interactive 3D visualizations of brain scans. We report the successful development of our software that transforms brain scans from standard DICOM format to a format necessary for visual exploration with the Oculus Rift head mounted display device and virtual reality system.

Methods

Software was developed to select a DICOM image set and to transform and reconstruct the brain scan data into the 3D textures necessary for interactive exploration of 3D volumes using the Unity3D v5.4 software engine together with the Oculus Rift v1.6 software development kit and runtime. Our brain scan viewing software was tested qualitatively by various users to visualize and explore selected brain scans in 3 different scenarios: 1) view from a stationary camera perspective from outside the brain with the brain rotating on a fixed axis, 2) view from a rotating camera perspective from a fixed point inside the brain, and 3) view from a moving camera perspective along a sequence of points that follows a pathway inside the brain.

Fig. 1: User with the Oculus Rift

Fig. 2: User Interface of Software

BrainWatch

Brain Scan	Camera Perspective	VR Device
Browse To DICOM Files	☐ Scenario #1	☐ Oculus Rift Headset
Process DICOM files	☐ Scenario #2	Speed of Camera
View Rendered Image	☑ Scenario #3	Opacity of Rendered Image

Current DICOM Folder D:\Data\Ktaswell\BHA\BHAVI2016\SampleScanData\t1_MR_Sc

Fig. 3: Scenario 1 – External Immobile Camera, Rotating Brain Scan

Front View   Front Side Perspective View   Back Side Perspective View
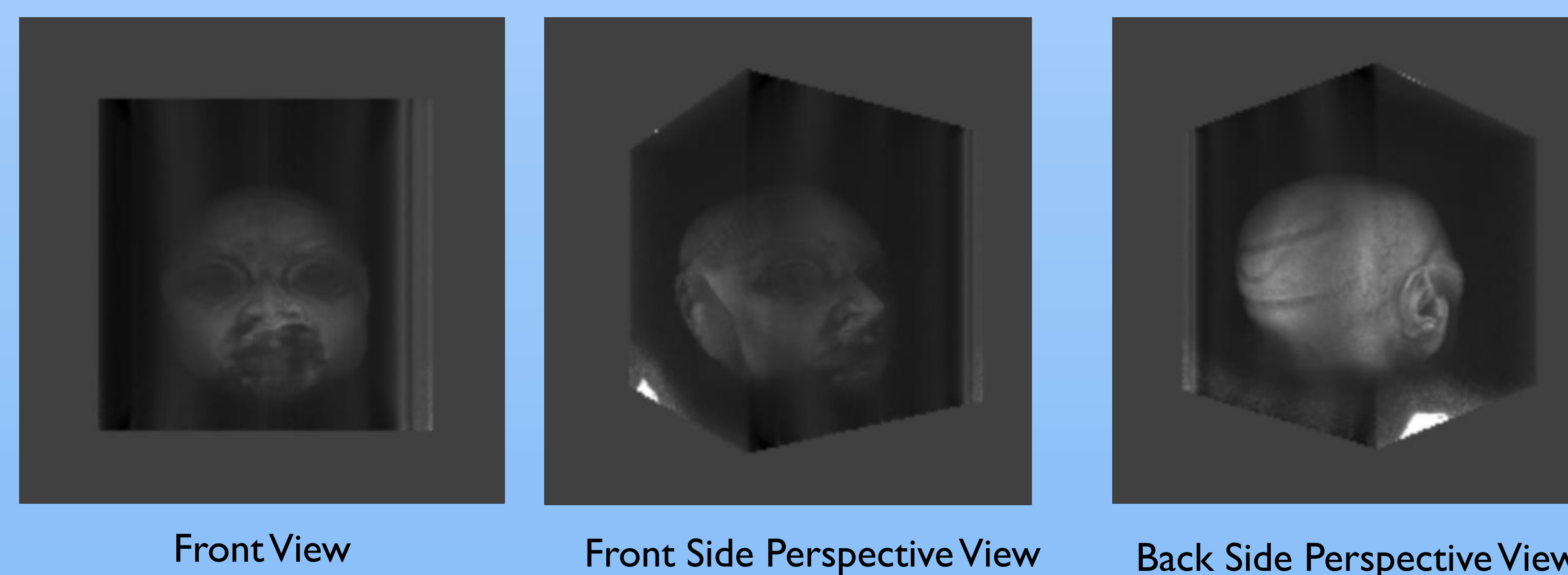
Fig. 4: Scenario 2 – Internal Rotatable Camera, Immobile Brain Scan

0° Rotation   125° Rotation   300° Rotation

Fig. 5: Scenario 3 – User Guided Pathway Following within the Brain Scan

Lower Cerebellum   Upper Cerebellum   Lower Occipital Parietal View
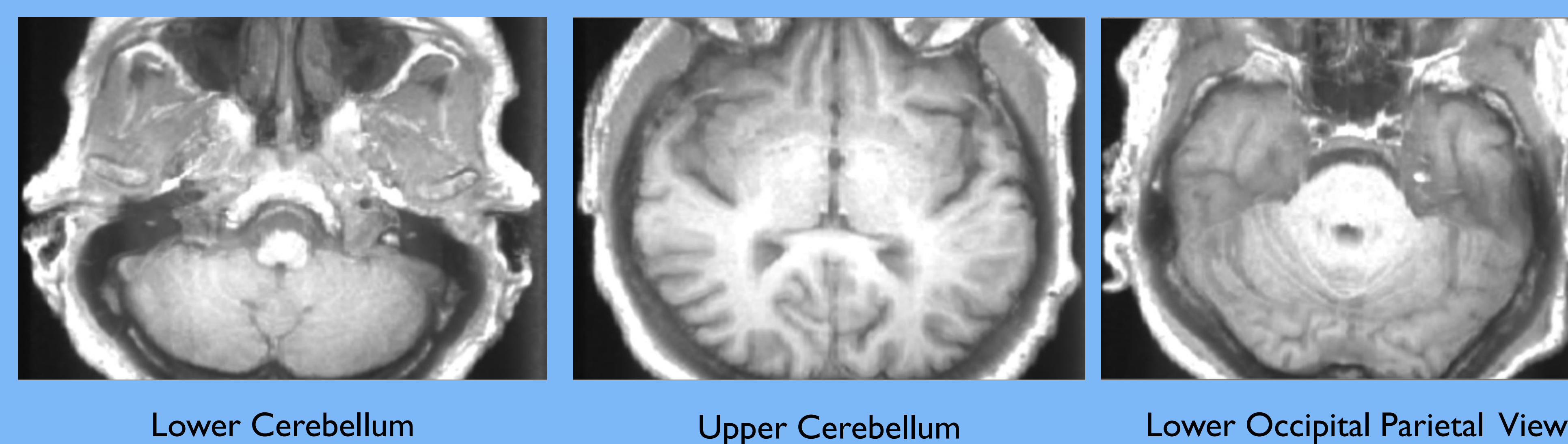
User guided path following superiorly along a line through the brain stem.

Results

Our prototype software has been successfully tested by 3 different users on 3 different computers. Visualization and exploration scenarios #1 and #2 have been demonstrated on both PET and MRI brain scans. Scenario #3 has been demonstrated with user-guided path following of the white matter fiber tracts visible in post-processed DTI-MRI scans. Note that this path navigation in scenario #3 has not been automated, and does require user-guided navigation. The three figures shown are all displaying a different view of the rendered 3D Image generated from the same DICOM Scan set. Figure 3 shows three external views of the subject's head at different rotation points, in scenario 1. Figure 4 shows three internal views of the subject's head at different rotation points, in scenario 2. Figure 5 shows three internal transverse views of the subject's head as the user moves the view superiorly along a line through the brain stem, in scenario 3. A live demo will be available at the presentation of this poster.

Conclusions

With improvements in the hardware, that make VR more comfortable for the user, the use of a VR system to better evaluate and visualize brain scans may provide a useful tool for learning about the brain as well as for clinical review of brain imaging data. Prototype software has been developed for 3D viewing and exploration of PET and MRI brain scans with the Oculus Rift virtual reality system. As we continue to develop our software, upcoming versions will include improved functionality in user control, image processing and rendering techniques, and improved user interface. Future iterations of both our software and affordable virtual reality systems portend a very exciting future for educational and clinical research applications of 3D virtual exploration and analysis of brain scans.

References

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