Interactive volume rendering and anatomy model viewing in virtual reality: an inexpensive mobile implementation using Google Cardboard

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Objective: Advances in visualization software have allowed for viewing of stereoscopic 3D anatomy using virtual reality (VR) devices such as the HTC Vive and Oculus Rift. However, the practical use and uptake of such tools is blunted by financial and portability concerns. With increasing interest in using VR learning objects, lightweight, low-cost VR options such as smartphones equipped with Google Cardboard present strong alternatives to larger devices, especially in typical learning environments. In contrast to polygonal models typically used in anatomy model viewers, volume rendering allows the user to slice the model in order to visualize internal anatomy, and segment 3D anatomical structures into their constituent 2D planes. Previous research has indicated that viewing anatomy in stereoscopic 3D can provide for enhanced learning.

Methods: Documentation, instructions, and Unity files can be accessed openly at https://github.com/malyalar/vr-volume-renderer. Using the open-source ImageJ application, CT/MRI DICOM files are converted into a format that can be imported into a volume renderer implementation in the Unity game engine, which itself is free for educational/commercial use. The Google Cardboard mixed-reality plugin is used to enable VR. The resulting Unity app can then be exported to Android phones. A Google Cardboard headset with a built in headset button is required to make use of the app.

Results: The application developed by the authors allows clinical imaging data (CT, MRI) to be viewed in VR space as 3D volumes, creating self-contained learning objects. The user can interact with the sliders using a button located at the top of the headset, rotating and slicing the model freely in x/y/z axes. One of the limitations of using Google Cardboard-based VR is that there is no capability for positional tracking for authentic translational movement around the model. Additionally, in order to enable import into Unity, the resolution of the initial clinical imaging files must be reduced, which produces a slightly lower fidelity volume render compared to desktop applications. However, our process does have the advantage of high framerates and quick loading times.

Discussion: Google Cardboard mobile VR offers an inexpensive, portable, and relatively high-quality option for a stereoscopic 3D experience that is easily adapted for use in anatomy education. The authors' provided Unity application brings volume rendering to mobile devices in a VR environment, expanding the range of educational possibilities. The lightweight and inexpensive Cardboard VR solution takes advantage of the ubiquity of smartphone devices, helping with diffusion and uptake of VR anatomy education.