Scalable Texture-based Volume Rendering of a Rhesus Macaque Monkey Brain

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Abstract

Three-dimensional data representing spatial volumes arise in many medical applications such as computed tomography (CT) and magnetic resonance imaging (MRI). The sizes of data sets that are being produced today present a challenge to current rendering architectures and techniques. In our demo, we are going to present a data set of a Rhesus Macaque Monkey Brain, which consists of 1400 slices scanned at 2200dpi, resulting in 76GB of real-color RGB image data. The data set was generated by the Center for Neuroscience at University of California, Davis, for the NIMH Human Brain Project (HBP).

Due to the enormous size, it is impossible to load the entire data set into memory at once for the visualization. Only an extremely high-end machine could possibly visualize all of the data at once. The goal is to develop a monkey brain atlas that allows to visualize both the entire brain and selected, annotated regions at varying levels of detail. The resolution of the image data enables zooming down to the cell level. We present an interactive demo of a 3D texture-based volume rendering of the monkey brain.

In the first step, the data is converted into an octree-based multi-resolution representation using a wavelet transformation. In this preprocessing stage, a stack of 2D slices is converted into sub-volumes using a hierarchical space sub-division scheme. A three-dimensional Haar Wavelet transform of the sub-volumes generates a multi-resolution representation that enables efficient access to the sub-volumes at different levels of detail. Once the user selects a region of interest, the detail coefficients for that sub-region can be read efficiently from the server and used to reconstruct the original volume at a higher level of detail. This way, the sub-region can be rendered at full resolution without impairing rapid navigation through any section of the volume. The method is scalable and enables both stand-alone and remote visualization.

Future work includes the integration of meta-data (hyperlinks, additional image data, annotation) and the development of a web portal.

Equipment Requirement

Hardware: SGI O2 R12000 (or higher), monitor, Internet access, hardware support for 3D Texture Mapping.
Operating System: IRIX 6.5
Software Packages: OpenGL and Qt.