A Handheld User Interface for GPU-Accelerated Large-scale Volume Visualization

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Figure 1: Prototype System

Introduction

The ever-increasing sizes of volumetric data produced from a variety of scientific studies post a formidable challenge for the subsequent real-time large-scale volume visualization and analysis. While steady advances in graphics hardware enable faster rendering, real-time rendering of large-scale volume data is still a tough problem. Unlike polygonal data, volume data must take care of transparency of internal values within the volume that thus requires time-consuming voxel sorting for conventional volume rendering algorithms.

Such large-scale volume visualization must also take into account interactive transfer function control for data mining and scientific discovery. A high-resolution large screen is often used for displaying large-scale volume data, in which conventional input devices such as a mouse and a keyboard is not a practical solution.

In this poster, presented is an ongoing work on an interactive large-scale volume visualization system using a handheld device and a GPU-accelerated particle-based volume rendering algorithm (see Figure 1).

Particle-based Volume Rendering

To treat large-scale volume data, a particle-based volume rendering algorithm is employed in our visualization system, which has been proposed by Kyoto University. In the algorithm, a set of tiny opaque particles are generated from a given 3D scalar field. The final image is then generated by projecting these particles onto an image plane. A semi-transparency effect is realized by sub-pixel processing and averaging and thus the necessity of voxel sorting is eliminated. This algorithm is further accelerated by GPU programming.

Interactive Transfer Function Control

For assisting data mining and scientific discovery, a handheld device is provided to control the transfer function in detail in real-time. Our visualization system consists of a server machine which renders volume data and a client handheld device (i.e. iPad) that are connected to each other via WiFi or Bluetooth (see Figure 2). The hardware specification in our system is summarized in Table 1.

The GPU-based rendering algorithm has been carefully modified to accept user input to be able to control a variety of visualization parameters with negligible perform degradation.

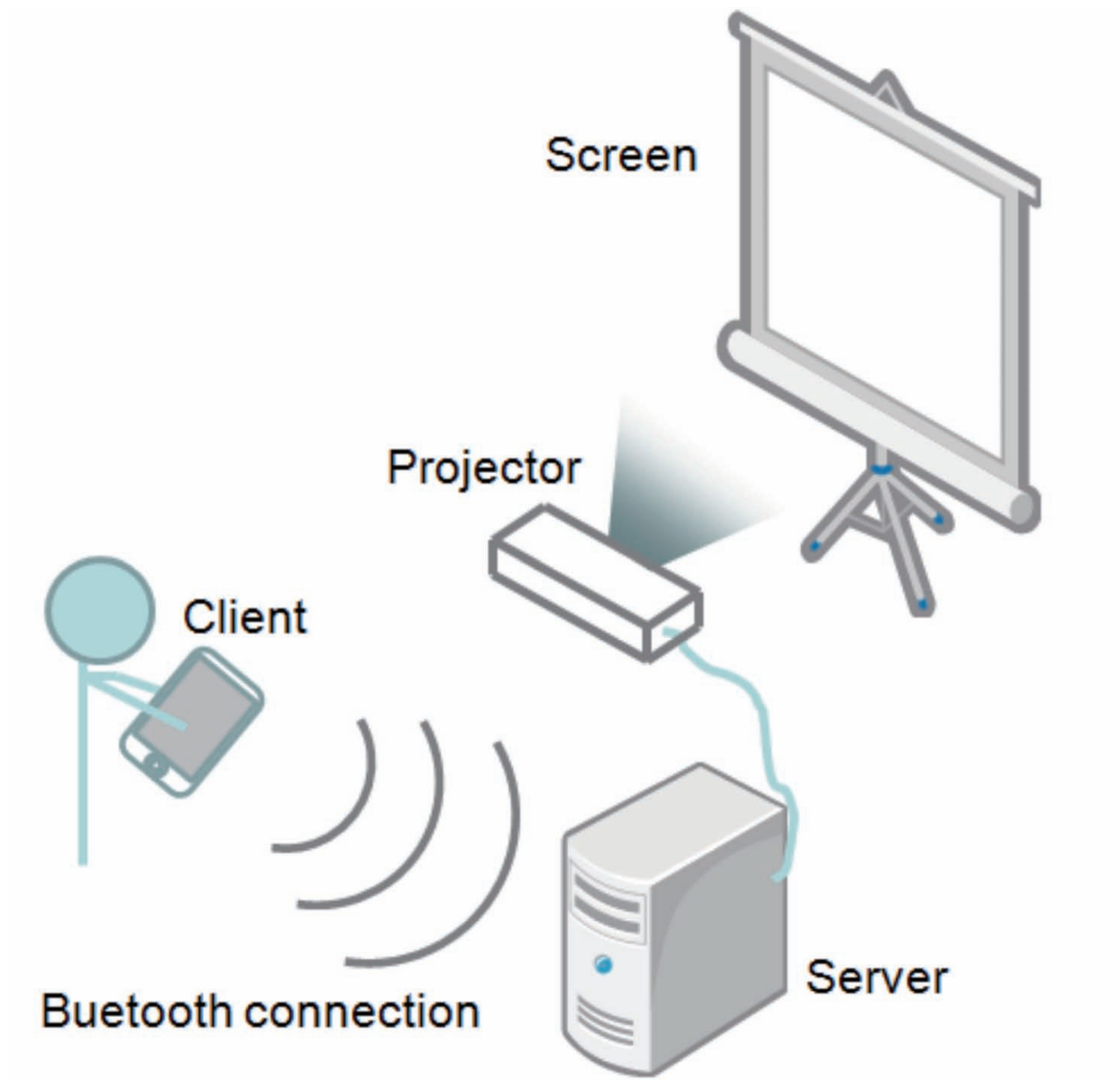

Figure 2: System configuration

Table 1: Specification

Server CPU：AMD Opteron 2350 2.0GHz RAM：32GB GPU:nVIDIA Quadro FX 4600 OS:Ubuntu 8.10 (64bit)	Client Multi-touch Display: 9.7 in Resolution: 768 x 1024

A set of graphical user interfaces (GUI) are under development (see Figure 3) for the handheld device. A user will be able to control the visualization parameters interactively. Example interactions implemented are:

- Color curve editing. Mapping between a scalar value of voxel data and its rendered color can be changed simply by deforming the color curves.
- Particle filtering. Particles with specified values can be hidden or highlighted.

Any change in visualization parameters will be immediately reflected to the rendering result.

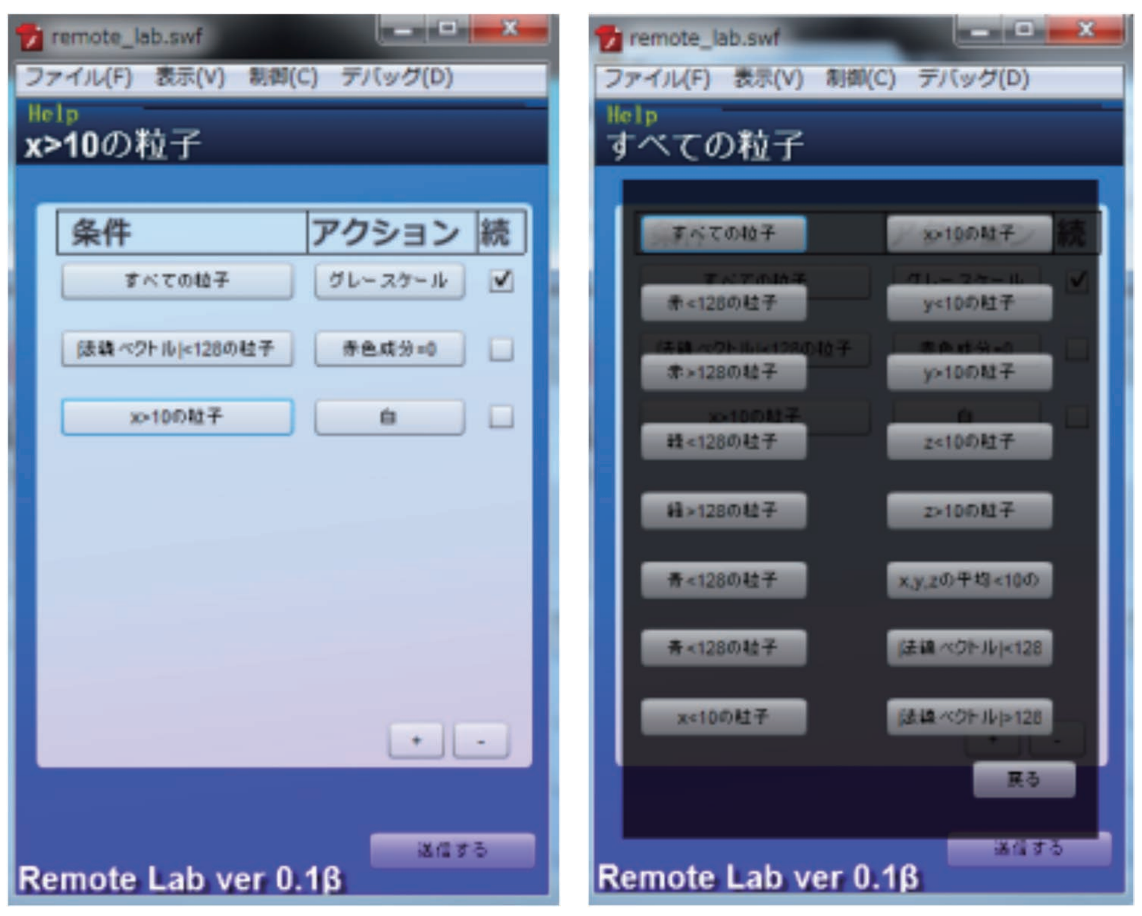

Figure 3: User Interface

Conclusion

An interactive visualization system for large-scale volume data has been proposed. Large-scale volume visualization has been realized thanks to the GPU-accelerated particle-based volume rendering. Interactive transfer function control has been realized by a dedicated graphical user interface on a handheld device.

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