3D User Interfaces for Ultra-Scale Visualization on Tiled Display Wall

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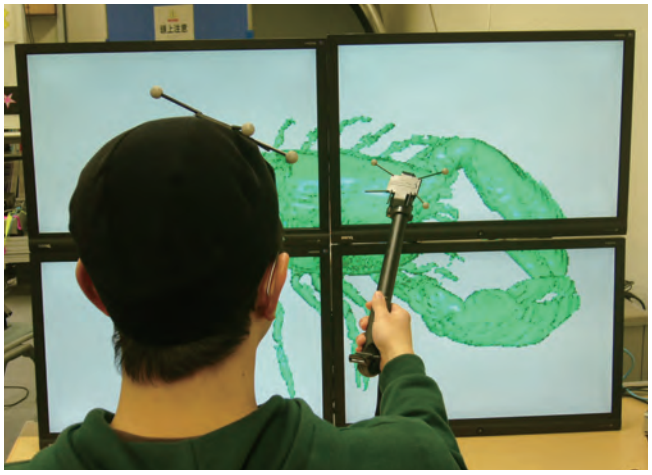


Figure 1: Prototype System

Introduction

Volume data generated from advanced simulations by using supercomputers and high-end measurement equipment in the field of medicine, for example, MRI system, has a tendency to become ultra-scaled and complicated. Therefore, many researchers in various fields find it difficult to detect and analyze the considerable amount of valuable knowledge contained in these volume data. In order to solve this issue, new techniques are required to interactively detect the knowledge by high-resolution display of these volume data on a large-sized screen. However, an effective 3D user interface has not been hitherto developed.

In the past, volume rendering, tiled display wall applications, and 3D-user-interface techniques have been studied individually. We integrated them to visualize large and complicated data with intuitive 3D interfaces. Concretely, we implemented the following technologies:

- Particle-based volume Rendering (for visualization of ultra-scale volume data)
- Tiled display wall (for high resolution representation)
- 3D user interfaces (for intuitive manipulation)

Particle-based Volume Rendering

Volume-rendering has become popular as the method for visualization of volume data in various research fields. However, the research and development on a practical visualization system for large-scale and complex volume data has not been conducted. Particle-based Volume Rendering, proposed by Kyoto University, is a method that could be used for this purpose. However, it is also difficult to render data precisely in real time, and this is a challenge for implementing 3D user interfaces. More details are exhibited in booth 2796.

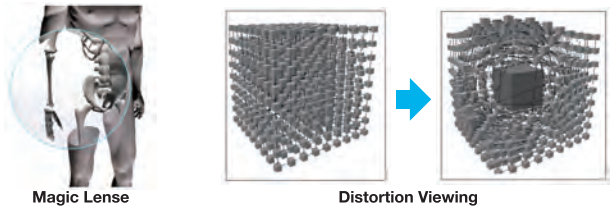
Tiled Display Wall

In this technology, a high-resolution image is displayed on large-scale display with two or more LCD panels in order to construct an effective wide-screen system. We constructed a tiled display wall environment that consists of one master node, two display nodes, and four LCD panels. We applied SAGE to delivery streaming pixel data with a virtual high-resolution frame buffer having a number of graphical sources for the tiled display wall.

3D User Interfaces

In the case of the 3D-user-interface technique, the following methods are proposed:

- 3D magic lenses (Figure 2-left)
- distortion viewing using the probe (Figure 2-right)



Magic Lense — Viega et al. 1996, Ropinski et al., 2004

Distortion Viewing — Sheelagh et al., 1996

Figure 2: Proposed 3D User Interfaces

The 3D magic-lenses method is a technique that changes the rendering method inside a region, forming a virtual lens. For example, in Figure 2-left, the body is rendered outside the region behind the lens, while the bones are rendered inside the region behind the lens. This image shows that the lens enables us to see through bodies. On the other hand, the distortion-viewing method enables us to show data in various ways. The simplest application is to magnify regions of interest (Figure 2-right). This method distorts only a part of the model. This enables us to understand the relationship between the entire model and the distorted region and also enables us to observe the region of interest in detail.

The distortion-viewing technique seems to be suitable for complicated volume data. In addition, the extraction of the interesting region is a basic but useful method; therefore, we implemented these two 3D user interfaces using OptiTrack, which is a 3D tracker system. Figure 3 shows the configuration of the prototype system. Table 1 lists the specifications of the prototype system.

Table 1: Specifications of the Prototype System

Each Master Node and Display Node	AMD Opteron 2350 2.0GHz, RAM 32GB nVIDIA Quadro FX 4600 Ubuntu 8.10 (64bit)
3D Tracker	NaturalPoint OptiTrack FLEX:v100

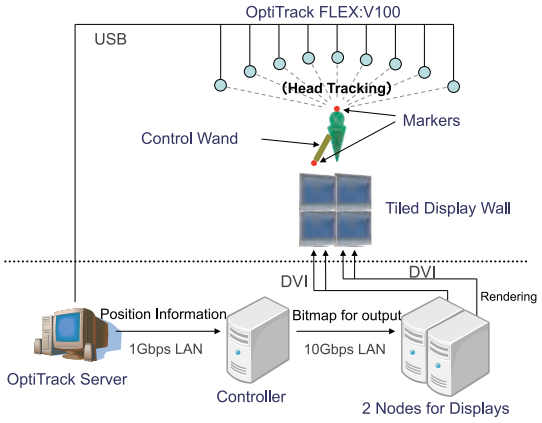


Figure 3: Prototype system configuration

Conclusion

We proposed an integrated system with an intuitive 3D user interface for ultra-scale volume data that are displayed on a wide area and at a high resolution by particle-based volume rendering and tiled display wall. In future, we will improve the interface and evaluate the integrated system.

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