

Application framework for Immersive Virtual Reality Visualizations

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Visualization is a key step in the simulation study. In accordance with the exponential growth of the computer hardware, complexity of the output data and, therefore, the difficulty of their visualizations are rocketing up these days. A new technology for visualization is strongly required and will be more in future. The modern virtual reality (VR) technology provides an answer to this challenge. Within various types of VR systems, a room-sized, projector-based, immersive-type virtual reality system called CAVE provides one of the best quality of VR. Its user who stands in the CAVE room is surrounded by stereo images projected onto the walls and the floor. A wireless motion capture technology with high speed graphics processors make it possible to render the visualized objects in VR space in real time from any view position and angle in the CAVE room.

We have been using CAVE-type VR systems for more than ten years to analyze large scale simulation data [1]. Through the immersive, interactive, and 3-dimensional visualizations in the CAVE's VR space, we have, for example, discovered a new 3-D structure in electrical current field in our MHD dynamo simulation [2]. From our experiences, we can conclude that CAVE is a powerful tool to find and show complicated 3-D structure and dynamics. Recently in Kobe University, the largest CAVE system in Japan was installed in a research center at Port Island, Kobe city. This system, P. I. CAVE, or π -CAVE, will be used not only for the scientific discovery, but also for the scientific communication, i.e., to convey the simulation results to non-specialists.

When we regard a CAVE as a presentation visualization environment, it will be soon noticed that a basic software is missing. It is like a PC without an operating system. We have therefore developed an application framework for CAVE systems. This framework, named Multiverse, is a kind of PC's application launcher or "Desktop". The user in the CAVE room can select a VR visualization application by touching the corresponding 3-D icon floating in VR space (Fig. 1). Then, the user is suddenly surrounded by different VR space (Fig. 2). Each VR application is called "Universe" in the Multiverse environment. One can jump back to the "Desktop" and select other Universe any time. We have developed several new Universes, including a visualization of plasma particle simulation for ion jet engines, MD simulation of a protein. To realize a high speed rendering of various data in these Universes, we have developed fundamental VR tools such as: (i) A 3-D model loader that is used to show 3-D CAD data in VR, (ii) A movie data loader that is used to read and play MPEG files in VR, (iii) A high speed stereo volume rendering that is used to show time development animation of scalar data (Fig. 3).

References

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- [2] A. Kageyama et al., Nature, 454, 1106-1109 (2008), T. Miyagoshi et al., Nature, 463, 793-796 (2010), T. Miyagoshi et al., Phys. Plasmas, in press



Fig. 1: A snapshot of Multiverse framework in π -CAVE VR system. Virtual touch screens, or virtual "Desktop" is shown. Expository movies are played in 3D space.



Fig. 2: A snapshot of VR visualization, or a Universe, loaded in Multiverse framework. An MHD dynamo simulation data is analyzed in this Universe by arrow vectors, tracer particles, volume rendering, etc.

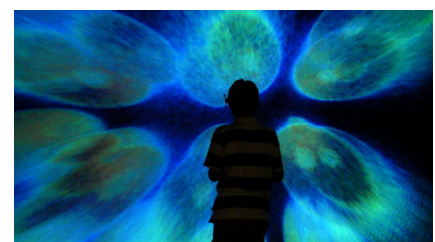


Fig. 3: High speed stereo volume rendering played in animation