§30. Development of Immersive Visualization Software for CAVE-type VR Systems

Kageyama, A., Masada, Y. (Kobe Univ.)

When a developer of CAVE programs tries to show several simulation data or multiple visualization programs to a person---who may be the developer himself/herself, or a guest---in the CAVE room, they experience frustrations because the VR applications should be executed one after another, through the keyboard-typing, outside the CAVE.

To resolve this inconvenience, we have developed an application launcher for CAVEs[1]. This program, Multiverse, is itself a CAVE application, and it can load and control other VR applications. These sub-application are symbolized by 3D objects called "Doors". Walking through them causes a "teleportation" to other VR space (or the sub-VR application). The development was performed with π-CAVE that was newly installed at Kobe Univ.

In the beginning of Multiverse, the user in π-CAVE's room stands inside a (virtual) building of IRC (Integrated Research Center, Kobe Univ.), in which π-CAVE is installed. The 3D model data of IRC building is loaded into Multiverse and it is rendered in π-CAVE in real time with the quick response to the head tracking system. In Multiverse, this virtual reality model with actual buildings and objects is called World.

In the World, the user can walk through the building and can enjoy watching some detailed 3D objects including virtual π-CAVE itself, shown in real π-CAVE.

As in other common CAVE systems, the user in π-CAVE brings a wand controller. In Multiverse, the user will find one or more curves or wires from the wand tip. This is a kind of guide that leads the user to a "Gate". A Gate is a

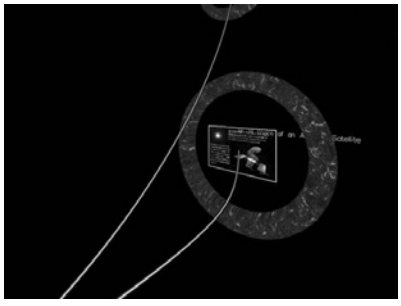

Fig. 1 Gates floating in World of Multiverse.

3D icon that floats in the World. See Fig. 1. A Gate is a virtual door that connects the World and a VR space for corresponding visualization of a simulation data. This virtual space is called "Universe". When multiple visualization applications are loaded into Multiverse, it automatically generates the corresponding number of Gates. All of them are connected to the user (or wand) with the Guide wires.

When the user "flies" to one of the gates, he or she will find an expository movie near the Gate. (Rectangular panel in Fig. 1.) It says what kind of visualization will be shown when the user passes through the Gate.

When the user walks through the Gate, the corresponding VR application program sets in and the user feels as if he or she has been "teleported" to the Universe.

In the program code, each Universe is nothing but a usual CAVE application with a unified interface to Multiverse class. In fact, a Universe is an instance of a class that is derived from a virtual class named Vacuum. Vacuum is for an empty space, having only the interface to the Multiverse class through member functions named, initialize(), draw(), update_per_frame(), and compute(). These names would convey their roles to readers who are familiar with the CAVElib programming.

We have been developing a CAVE visualization software named VFIVE to visualize vector/scalar fields produced by computer simulations. VFIVE is an open source program and it is now used in several institutions. One of new visualization methods implemented in VFIVE is called "tubeAdvector" that visualizes frozen-in vector fields.[2]

We have converted VFIVE into a class of Universe. Since VFIVE is a general purpose visualization software, this means one can visualize any vector/scalar field, as far as the data have the VFIVE's format, as one of application contents (or Universe) in the Multiverse framework.

Beside VFIVE, we have also developed new visualization programs as instances of the Universe. A snapshot of such a new Universe, called IonJetEngine, is

Fig. 2 An application loaded in Multiverse.

shown in Fig. 2.

To summarize, we have developed a kind of application launcher in VR space, named Multiverse. Multiverse is composed of World (actual objects like buildings and a town) and Universes (CAVE visualization applications). We have also developed several new CAVE visualization programs, or Universes, for simulations of geodynamo, plasma particle simulation, seismic wave propagation, and molecular dynamics simulations.

1) Kageyama, A. et al.: Proc. Intern. Conf. on Modeling and Simulation Technology (2011) 286.
2) Murata, K. and Kageyama, A.: Plasma Fusion Res., **6** (2011) 2406023.