§39. Construction of Collaborative and Seamless Virtual Environment for Numerical Simulation

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In numerical simulation research, visualization is indispensable method, and virtual reality (VR) technology is also very effective for visualizing numerical data.
We have been developing an immersive VR system, called CompleXcope [1-2], which can represent real 3D visual and aural environment. But VR is not friendly for simulation researchers, since computer for simulation is different from visualization computer in general. So we constructed integrated virtual environment for numerical simulation and visualization. In this system, the user can use these computers seamlessly without recognizing calculation and visualization computer. Also it is very important issue to construct a multilateral communication network system where any researcher in any remote site can equally observe simulation result from any point.
In this research, we propose collaborative and seamless virtual environment for numerical simulation by network communication.

The users of the immersive VR systems can watch their own numerical simulation data or visualized something interesting, but they cannot discuss their data with partners in remote site if they have VR systems.
Since products from the immersive VR system are real 3D movies, images and sounds, they cannot be shared perfectly. So if they want to discuss these data, they must meet together in spite of using same VR systems. To improve these issues, connecting each VR systems through a public network is very effective.

In our system, virtual reality network is accomplished by socket communication (client-server model). In this system, not only numerical simulation result and simulation model, but also the position of observers and actions (e.g. drawing new isosurface, changing magnification) in remote sites, are shared. This system is very simple, but very effective since we cannot communicate with any researcher in any remote site without recognizing what he looks at and is interested in.

Generally, the researcher calculates in calculating server, and visualizes the output data in graphic workstation or his PC. But when he uses VR system for visualization of large-scale simulation result, there are some obstacles. A VR, especially immersive VR system, is generally situated in a location away from researcher's office. In addition, in immersive VR system, observers enter the VR space and control visualized objects, but for changing simulation parameters, he needs to exit VR space, calculates by calculating server again and transfers the output data from the calculating server to the graphic workstation. It is serious problem for practical use. So we introduced real time simulation and visualization system to the CompleXcope system. The simulation result is shared between calculating server and graphic workstation. If the observer, in the CompleXcope system, changes some simulation parameters (such as temperature, arrangement of simulation model and so on), these information is sent to the server, which controls all shared data, and this server sends information to the calculating server. Finally the result from this calculating server is sent to the graphic workstation. By this system, the observer can simulate interactively without getting out. Figure 1 shows an example of this system.

We developed collaborative and seamless virtual environment. This system enables user of virtual reality system to visualize in the immersive projection display (virtual reality system), calculating with remote computer.
In addition to this, the result of numerical simulation can be shared among remote sites, and the user can visualize and communicate in real time by network communication.

[1] A. Kageyama, Y. Tamura and T. Sato, Prog. Theo. Phys. Supplement 138 (2000).
[2] Y. Tamura, et al}., Comput. Phys. Communications 142 (2001).

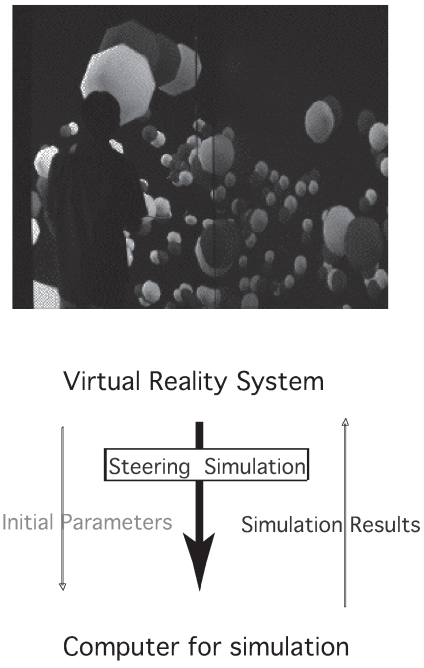

Fig. 1 Example of seamless numerical simulation environment