§28. Virtual Reality System for Comprehending Complex Phenomena

Tamura, Y., Kageyama, A., Sato, T.

One of the most practical benefits of utilizing a virtual reality system in science is to make it possible to percept a really tangled complex phenomenon in an intuitive way.
We have developed a virtual reality system called 'CompleXcope' as an important part of the man-machine interactive system for simulation ('MISSION'). This CompleXcope is designed so that not only three-dimensional objects but also an auditory environment can be represented.

As the simulation study progresses in accordance with the progress of supercomputer technologies, it becomes possible to simulate a tangled nonlinear phenomenon. The traditional 2D-visualization tool becomes a slow coach to grasp what is happening in the simulation of a complex phenomenon. The electronic environments surrounding computers have realized a commercial-based 3D (solid) virtual reality system such as "CAVE". This environmental condition has driven us to develop an integrated man-machine interactive system for promoting new frontiers of Simulation Science into which virtual reality system is integrated.

CompleXcope system has four screens whose size is 10 feet x 10feet. The screens are set up in a cube made of three rear-projection screens for walls and a down-projection screen for the floor. The correct stereoscopic perspective projections are calculated by a graphic workstation in real time. A master viewer wears stereo liquid crystal shutter glasses and a 6-degrees-of-freedom head-tracking device (Fig.1). The workstation redraws images of each wall in response to change of the head position. CompleXcope application is developed by OpenGL and CAVE library. The functions of CAVE library are to synchronize each image drawn by OpenGL and to redraw images following a viewer's order.

In addition to the visual ability, CompleXcope provides an auditory ability. 3D sound systems are proposed in various fields. However they are yet premature in freely applying to the virtual reality. Nonetheless, we have installed in CompleXcope an auditory system that mainly consists of 4 sound synthesizers, 16 sound space processors, 4 sound mixers and 8 speakers. The auditory system transforms the physical data into the 3D sound data. Then, the sound data is sent out through MIDI interface in accordance with changes in head position or physical data (Fig.2). Thus, the present auditory system is very effective to percept dynamic phenomena.

One VR application of LHD simulation on CompleXcope is shown here. Since the LHD's helical coils have complex spatial structure and magnetic field, it is too inefficient to analyze merely by 2D-visualization tool that is generally used to comprehend physical phenomena. So it is necessary to investigate plasma behavior in real time. The real 3D virtual reality system is really useful for a complex simulation. Furthermore, presence of the movement of particles in LHD is well confirmed by the cooperative Doppler shift sounds generated by the auditory system. It is difficult to comprehend global behavior only using visual sense, so it is very effective to comprehend physical phenomena with both visual and auditory sense.

Simulation environments (simulation algorithms, supercomputers, graphics workstations, etc) have already matured so that almost any single complex phenomenon could be adequately solved. However, the perception technologies are yet premature. In order for us, simulation scientists, to go beyond the age of 'Nonlinear Solver', one must seek for an innovative concept to comprehend physical phenomena. CompleXcope, we proposed here, could be a powerful tool for comprehending complex evolutionary phenomena in 3D environment and in real time.

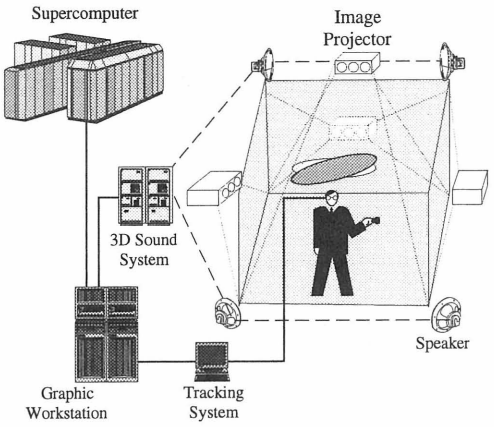

Fig.1. CompleXcope System

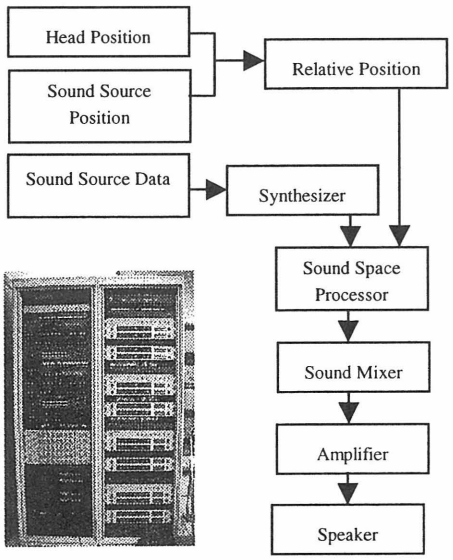

Fig.2. 3D Sound System