§29. Activity of Virtual Reality Research

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Since NIFS Virtual Reality (VR) System "CompleXcope" was installed in 1997, it has been developed continuously (Fig.1).

Developments of new software such as, VFIVE, AVS for CAVE, sonification and automatic speech recognition system have been performed. By using these new tools CompleXcope has been made use for scientific investigation such as analysis of MHD simulation results for MHD dynamo and spherical tokamak, analysis of molecular dynamics simulation results for chemical sputtering of plasma particle on divertor, analysis of particle simulation of magnetic reconnection, analysis of fluid simulation of turbulence, and analysis of satellite observation data of solar, and so on.

Fig. 1: CAVE system.

For scientific VR visualization using the CAVE system, we develop software to analyze the results of the plasma particle simulation in the time-varying electromagnetic fields[1,2]. We can trace the trajectories of plasma particles in the time-varying electromagnetic field obtained by the particle simulation using the advanced VFIVE with animation function. The orbit of a single partilce is calculated by integrating the Newton-Lotents equation. We can point the initial position of particle by the 3-D mouse "Wand." The initial velocity is given by the flow velocity which is given by simulation data. Animation function added newly to VFIVE loads time-sequential simulation data one after another, and reproduces the visualized objects of isosurfaces, stream lines and so on about physical quantities according to the temporal changes of them in VR world. Because the seeds of objects, for example, levels of isosurface, are saved through the reproduction of the visualized objects, it is possible to observe the temporal changes of objects with same seeds in the VR space. Particle trajectory is calculated under the newly loaded electromagnetic field, that is, under the time-varying electric field. By using this software, it is possible to observe the temporal evolution of particle meandering motion strongly related to the reconnection mechanism in the time-varying electromagnetic field (Fig. 2).

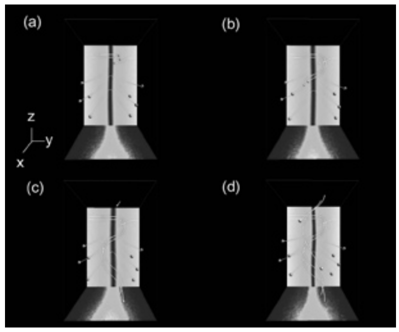

Fig. 2. Scientific visualization of simulation results of magnetic reconnection in time-varying electromagnetic field at (a) $t/\Delta T = 40$, (b) 60, (c) 80 and (d) 100, where ΔT is the interval time of updating field data. Color contours in xy and yz planes show ion temperature profile and reconnection component $B_x^2 + B_y^2$, respectively. White lines are ion trajectories.

We succeed in visualizing both simulation results and experimental device data simultaneously in VR space. Figure 3 shows an example of simultaneous visualizations (Virtual LHD and LHD vessel). Virtual LHD is a software which can show magnetic field lines, particle trajectories and isosurface of plasma pressure based on the data by MHD equlibrium simulation [3]. LHD vessel is objectively visualized based on the CAD data. By using this simultaneous visualization, it is possible to grasp the relationship of positions between the device and plasma in the VR space.

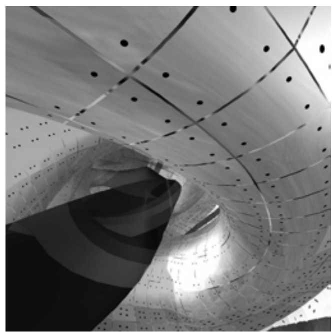

Fig. 3: CAVE visualization of VLHD and LHD VR vessel.

1) Ohtani, H. and Horiuchi, R.: PFR **3** (2008) 054.
2) Ohtani. H. et al.: PFR accepted (2009).
3) Kageyama. A et al.: Porc. ICNSP, 138 (1998).