Applications of Visual and Haptic Virtual Reality System to 3D Plasma Simulations

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With the recent development of supercomputers, large scale 3D computer simulations for space plasmas are getting practical. We obtain variety of 3D structures or configurations from 3D numerical simulation data. However, technique and environment for analyzing the 3D space plasma simulation data have not been established. We have been developing the data analysis environment using various types of 3D visualization techniques and visual virtual reality (VR) systems such as CAVE, Portable VR, NuVision. This analysis environment works on the 3D visualization tool, AVS/Express. AVS/Express has programmable, interactive, visual environment and time-dependent visualization features so that it can visualize all types numerical simulation data.

In the near future, a tool that realizes interactive analyses of various physical data will be required. We developed the analysis environment with a haptic virtual reality system 'PHANToM'. This device provides force feedback and 3D object manipulation capability.

We have analyzed 3D Global MHD simulations with this system for the interactions between solar wind (observed by satellite ACE or WIND) and the Earth's magnetosphere. Figure shows helical magnetic field lines around high temperature plasma in the Earth's magnetotail. This helical magnetic field lines are named as magnetic flux rope are too complex to analyze 3D structure in this plot. As shown in Figure, force feed back is given to 'PHANToM' according to plasma density, and the magnetic field lines passing through the 'PHANToM' pointer (shown as red sphere) are visualized. Moreover, it is also possible to display the time series plot of the arbitrary point that the 'PHANToM' pointer specified. The visual VR systems are used, because it is difficult to specify a voluntary point in the 3D space.

In the present presentation, we will report the efficiency of this analysis system and its techniques using visual and haptic VR system. We will also discuss the application of this system to PIC simulation.