§34. Development of Reactor Design Aid Tool Using Virtual Reality Technology

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A new type of aid system for fusion reactor design, to which the virtual reality(VR) visualization and sonification techniques are applied, is developed. This system provides us with an intuitive interaction environment in the VR space between the observer and the designed objects constructed by the conventional 3-D computer-aided design(CAD) system. We have applied the design aid tool to the heliotron-type fusion reactor design activity FFHR2m[1] on the virtual reality system, *CompleXcope*[2], of NIFS, and have evaluated its performance[3].

In recent years, there have been remarkable progresses in the methodology of engineering design, including the CAD techniques with the help of rapid advances in the computer environment. A nuclear fusion reactor is one of the most complicated, massive, and expensive products in present engineering subject. The design aid system described in this report provides us with an intuitive interaction environment between the observer and the designed objects, which are constructed by the conventional 3-D CAD system. If we apply VR to the engineering design, it will be possible to obtain a near-complete model at much lower cost, both economically and temporally, than making a conventional mockup like a clay model.

The *CompleXcope* system has 4 screens, on which stereoscopic images are projected, and 8 loudspeakers to enable a sonification approach. The observer can walk in a room surrounded by the screens, wearing the glasses with a head-tracking device to inform the system of the position and the direction of the observer's head. Thus, the observer can actually feel immersed in the VR world. If he wants to see the hidden side of the object, the only thing he has to do is to move his own head behind it and look back at it. In the VR room the observer makes a communication with VR world by a simple input device called Wanda, which have 3 buttons and the tracking sensor.

The design aid tool provides us with a convenient means to check subtle points, such as the motions of the movable parts and the interference among the structures, which have been examined conventionally with the help of a mockup or a scale model. It would help the designers refine the productions much more easily.

The output of CAD is converted into raw polygon data in an appropriate format beforehand. The given numeral polygon data is modeled into 3-D graphical objects by using the OpenGL library. Simultaneously, the information which is needed for numerical analyses like interference check is extracted from the raw data. The main program manages the objects and various kinds of functions, referring the signals from the sensors and buttons, and compiles the final 3-D models together with some supporting images for interface. The example of the execution of the aid tool is shown in Fig.1.

All the commands for handling the VR are arranged in a menu panel, which appears on the right wall while a button of the Wanda is keeping pressed. In addition to the standard functions like a translation of the observer's position and a scale measurement, this system has several unique functions by making use of the VR's capability. As a tool for manipulating the movable components, we have developed an intuitive method called a *fork* tool, which is shown in Fig.2. The observer can handle the object just like a forked hunk of meat, i.e., the object follows the motion of the Wanda held in his hand, including the translation and the twisting motion of the Wanda. The system can also record such motions into an external file, and can play automatically anytime. Moreover, to examine the interference among the movable and the fixed components, a new realtime interference check tool using the sonification technique has been developed. The latest version of the aid tool has a simplified one, where an alarm rings with a stereo sound from the position of the movable components approaching to the fixed objects.

This aid tool is applied and benchmarked to the heliotron-type fusion reactor design, FFHR2m. The total number of the polygons is around 710000 triangles and 350000 vertices at the maximum. It has been proved that the data are correctly and smoothly projected into a VR image, and that the functions run correctly. However, it is still to be hard to calculate the realtime interference check with the original data size. To seek for more accurate and faster examinations is our ongoing research.

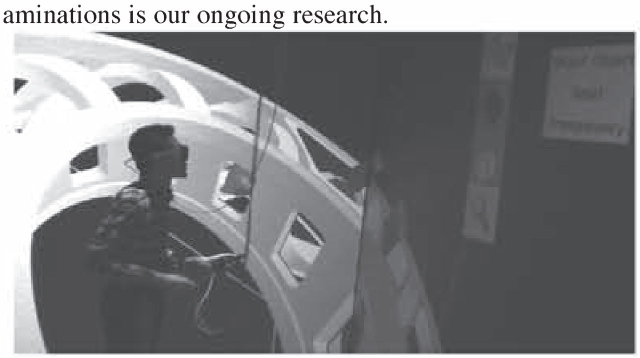

Fig.1 Example of the execution of the aid tool.

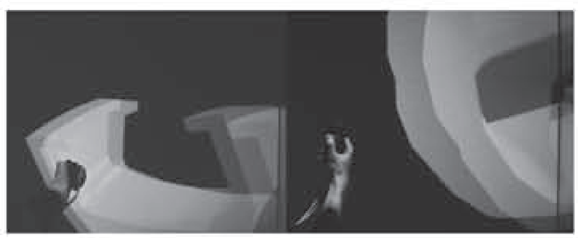

Fig.2 The "fork" tool.

Reference

1) A. Sagara, et al., Nucl. Fusion **45**, (2005) 258
2) Y. Tamura, et al., Comp. Phys. Comm. **142**, (2001) 227
3) N. Mizuguchi, et al. to appear in Fusion Eng. Design.