§39. Angle-changeable Immersive Projection Display

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i) Introduction To comprehend complex phenomena or data, we sometimes use three-dimensional (3D) stereo displays. However, if we use a small 3D representation system, such as a cathode ray tube (CRT) or a liquid crystal display (LCD) 3D system, we cannot see the entire area and details of a complex 3D object simultaneously. To overcome these problems, it is necessary to fill one's field of view with the 3D image. An immersive projection display is a powerful tool for evaluating 3D data. The CAVE system [1)] is a pioneering immersive projection display that is widely used for viewing complex 3D images. However, these systems require a large amount of space and are expensive, so they cannot be installed easily. One solution to this problem may be head-mounted displays, but the angle of the field of view is too narrow for users to become deeply immersed in a virtual environment.

We constructed an immersive projection display that can represent the top and bottom of 3D objects, has a wide field of view, allows several people to observe a 3D object simultaneously, does not need a big space for installation, and is relatively inexpensive.

ii) System Configuration Figure 1 shows the configuration of our proposed system. This system is designed to be installed in a general room and the system measures about $3.6 \times 4.1 \times 2.8$ m (maximum). The cylindrical screen is made of polycarbonate. The radius of the cylindrical screen is 1591 mm and the center angle is about 90 degrees. This screen is set in a steel frame in front of the user. A stereo projector (Christie Mirage S+3K SXGA+ 3000 ANSI Lumen stereoscopic projector) is connected to this cylindrical screen by a steel pipe. The user wears liquid crystal shutter glasses (Stereo Graphics, Crystal Eyes 3) and sees the projected 3D objects. The screen and projector are not connected to the ground or ceiling and can be moved freely by the user as one united body, provided that neither the screen nor the projector touches the walls, ceiling, or floor.

For providing a correct image to the user, it is necessary to measure the angle of the screen. For example, if the screen is moved toward the left, the position of the represented object relatively moves towards the right from the position of the user. To do this, we install the magnetic sensor (Polhemus Patriot) in the screen to measure the position and the angle. This sensor is attached on the back of the screen and the transmitter of this sensor is attached on the connecting pipe. By this sensor, if we move the screen, the image of the screen is also changed at once.

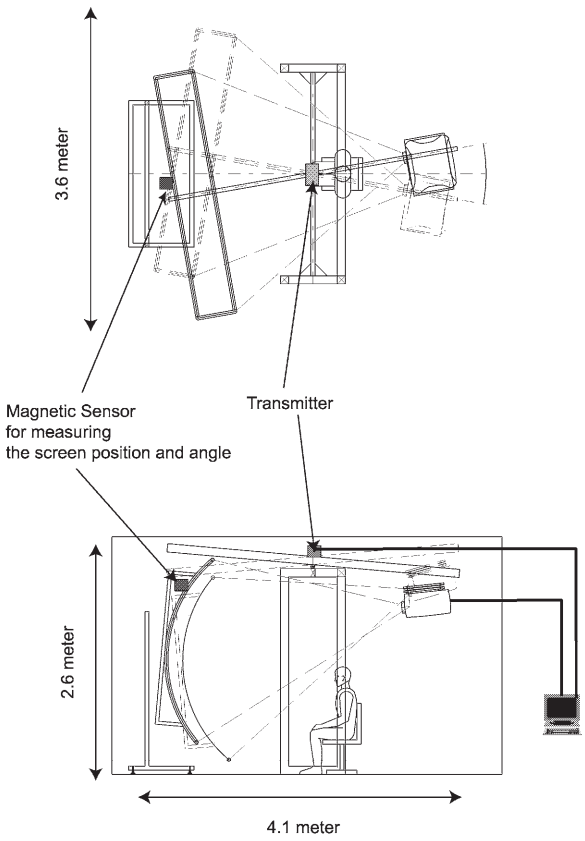

Fig. 1: Configuration of the angle-changeable immersive projection display.

iii) Data Processing A single personal computer is used to control this system. To make stereo images, the PC obtains the screen's angle from the magnetic sensors. Using these, the model-view matrix of the scene is changed to project correct 3D images. For projection onto a cylindrical screen, it is necessary to distort the images, because normal (square) images would appear distorted on this screen. To provide the correctly adapted image, we use CHRISTIE TWIST

iv) Conclusion This proposed system enables the user to see the top, bottom, or side view of 3D objects. A further advantage of this system is its low cost and small size (compared with a CAVE-like system). This system uses one PC and one projector and can be installed in a 4-m-square room.

Acknowledgements This study was funded partly by KAKENHI(19700122) and the Hirao Taro Foundation of KUAAR, Japan.

1) C. Cruz-Neira, D. J. Sandin and T. A. DeFanti, "Surround-screen projection-based virtual reality: the design and implementation of the CAVE, " Proceedings of SIGGRAPH 1993, 135–142, 1993.