Workshop: Building an Affordable Projective, Immersive Display

Dave Pape
Res Umbrae
dave.pape@acm.org

Josephine Anstey
University at Buffalo
jranstey@buffalo.edu

Abstract

Immersive, interactive virtual reality is a tool with hypothetically limitless uses. However, so far it has been put to serious use primarily in technical application areas such as computational science, automotive engineering, and chemical exploration. Groups working in these fields often have large budgets and can afford expensive, advanced displays. VR should also be of value to schools and museums, but most of them have much smaller budgets than major research labs, or are not able to support high-end graphics workstations. A simple, affordable, projection based display system can make VR far more accessible. In schools, displays could be put into individual classrooms and not just a central computer lab. In the museum world, small institutions would be capable of showing cutting edge digital work that previously has been restricted to a few large museums.

This workshop describes the construction of a single screen, passive stereo, VR display based on commodity, or otherwise low-cost, components. There are many options available for the major elements of such a system and the basic system can be modified or adapted to many different styles of use. Figure 1 shows a photo of such a system in use at the University at Buffalo.

1 Construction

The core elements of the system are three PCs, two projectors, tracking, and polarized stereo. The main computer, for the graphics, is a dual processor Linux PC with a two-channel 3D video card. The tracking system is a PC with an electromagnetic, 6 degree-of-freedom position tracker and a wand interactive device. The audio system is a PC with a generic sound card and speakers (and optionally a mixer and more expensive speakers). The stereo display uses circularly polarizing filters for the two projectors and inexpensive polarized glasses. The screen used is one specifically chosen to preserve polarization in rear-projection, minimizing the amount of stereo crosstalk (e.g., ghosting). Table 1 lists the components and estimated prices for a typical system.

A number of design decisions went into the choice of each of the system components. We favor projection-based display over head-mounted displays due to the intended use in museums and schools. Projection displays are easier to use for people inexperienced with VR and are able to support whole groups of viewers. We use polarized stereo, rather than active stereo, for two major reasons—the glasses are significantly cheaper and less fragile than LCD shutter glasses and low-cost LCD and DLP projectors are not capable of the scan rates necessary for active stereo. The rear-projection display requires more floor space than a front-projection display, but we accept that cost because we want to allow people to get up close to the screen to interact directly with the virtual environment. Finally, we chose the Linux operating system for greater compatibility with existing VR tools and applications that we use, most of which were developed for SGI workstations. In other environments, other operating systems would work just as well.

Figure 1 The projection display at the University of Buffalo.

Table 1 Typical budget for a tracked, passive stereo system.

Dual-processor Linux PC	$ 2,500
Two-channel 3D graphics card	$ 300
2 DLP projectors	$ 7,000
Circularly polarizing filters	$ 150
Polarization-preserving rear projection screen	$ 1,500
Polarized glasses	$ 200
Tracker PC	$ 500
Electromagnetic tracker	$ 1,500
Wand	$ 2,000
Audio PC	$ 1,000
Speakers	$ 1,000
Total	**$ 17,650**

2 Conclusion

In basic performance tests, the low-cost system is comparable to one using an SGI Onyx. The quality of the graphics is not quite up to the level of high-end systems, though—aliasing can be particularly bad with some PC graphics cards and most cards only perform at their best when using limited color depths and texture resolutions. Affordable LCD and DLP projectors also have lower resolution than high cost CRT projectors, but are superior in terms of brightness and contrast.

Our system is being used in undergraduate and graduate media studies courses, allowing students to program their own interactive virtual environments. The students generally have backgrounds in the arts, rather than computer science, and their computer experience is primarily with packaged software on PCs and Macintoshes. Because it is based on common PC hardware, the students involved in the courses have also been able to help in constructing and maintaining the VR system. They can move between their own computers and the VR system more easily than if it were a high-end workstation. In addition to the VR classes, the display has been used as an Internet videoconferencing tool, for a study group distributed between Buffalo, Chicago, and Bloomington, Indiana.