OrbeVR - A Handheld Concave Spherical Virtual Reality Display

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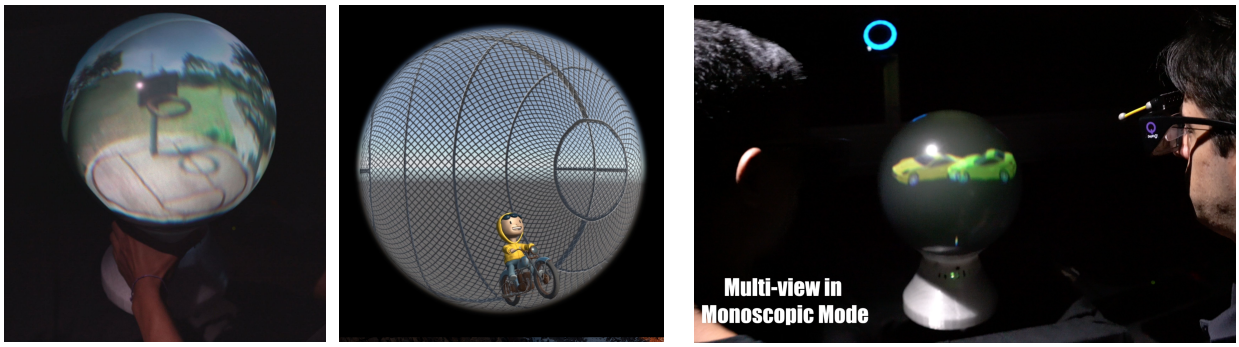

(a) Interactive applications **(b) Pixel on the globe of death** **(c) Multi-view application**

Figure 1: OrbeVR demo applications

ABSTRACT

We present OrbeVR, a handheld concave spherical perspective-corrected display. OrbeVR displays combined images projected by multiple calibrated high-performance laser pico-projectors positioned inside a translucent sphere. Users position and OrbeVR are tracked, so the spherical display renders head-coupled perspectives with stereoscopic depth cues. OrbeVR is an extremely compact, lightweight and small Virtual Reality spherical display based on multiprojection technology. This emerging Virtual Reality technology enables exciting interactive display devices comparable to snow-globes.

CCS CONCEPTS

•**Human-centered computing** → **Displays and imagers;** *Virtual reality;* •**Hardware** → Displays and imagers;

KEYWORDS

Spherical display, handheld display, virtual reality

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1 A HANDHELD SPHERICAL DISPLAY

OrbeVR provides an innovative Virtual Reality (VR) experience that uses a portable, handheld, lightweight and interactive spherical display, enabling several interactive applications (figure 1).

Considering the long trajectory of convex cubic CAVE multi-projector VR systems, OrbeVR is a novel VR display paradigm. Our ultra-compact multi-projector concave display design has no seams which could cause errors in singularities, since spheres do not have corners and vertices like cubes. The multi-projector approach provides a high density and uniform pixel distribution across the whole sphere. Also, we present a novel virtual reality approach taking advantage of extremely compact laser projectors that can be composed in convex non-planar surfaces by rear projecting images, such as presented in figure 2.

Orbe VR is robust, highly compact, lightweight and capable of supporting direct interaction techniques for a multi-participant experience. The availability of such emerging technology enables new frontiers of research in virtual reality, and goes beyond mid-size fixed and rectangular VR displays so called "fish-tank" VR systems.

The current system is comparable to snow-globes, waterglobe or snowdomes widely available on tourist shops. The traditional snowglobe is a transparent sphere enclosing a miniaturized scene

Figure 2: A prototype of the OrbeVR display with 30 centimeters (12 inches) diameter

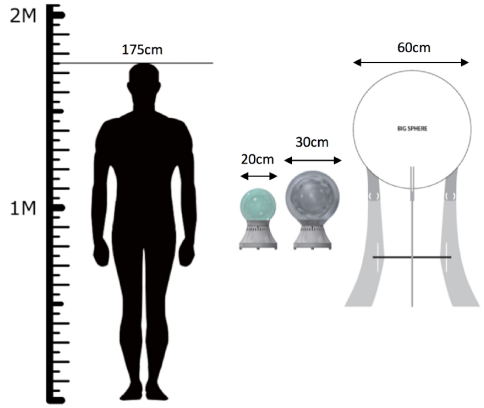

Figure 3: Display scale and previous versions

or object, often together with a model of a landscape. The possibility of having virtual reality computer generated graphics scenarios and interaction techniques opens a novel horizon of research.

At 2014 Siggraph E-Tech, we had showed a 24 inches diameter spherical display named Spheree [Cabral et al. 2015; Teubl et al. 2014a,b] with a surface resolution of approximately 2.1 Mpixels. In 2017, we will present two considerably smaller handheld spherical displays with diameters of 20 and 30 centimeters, both with 5 Mpixels resolution. Figure 3 shows the scale of the display compared to previous versions.

Our design works at refresh rates of 60Hz, and it can be used in two different modes for users wearing shutter glasses; one as a stereo 3D display for a single user and another as a multi-view display for two users, where each user will see a different perspective displayed at 30Hz. Even though the refresh rate is not ideal for stereoscopic applications, the prototype is able to demonstrate an early concept of stereoscopic images on a spherical display.

We also improved our pico-projector stitching system, which calibrates the geometry, color, contrast and brightness of multiple laser pico-projectors, resulting in a near uniform high contrast pixel space on the surface of the sphere.

Existing 3D models inside the sphere can be modified via interaction interfaces, or by just handling it. For example, OrbeVR can be shaken such as a snow globe, or users can just look around and move it on their hands for an appropriate view.

OrbeVR is coupled to the Unity3D game engine, so we can easily design and run VR immersive spherical games on it.

In figure 4 we present the block diagram of our current implementation. The tracking system provides the position and orientation of the users with respect to the center of the sphere. This approach is compared to a planetary system, where satellites (users) orbit around a planet arbitrarily positioned in space. The current implementation offers a range of viewing possibilities, including single viewer, multiple viewers, monoscopic and stereoscopic (3D) display.

At SIGGRAPH 2017 Emerging Technologies, more than 10 different interactive 3D immersive applications will be displayed, including mini-games and interesting 3D objects.

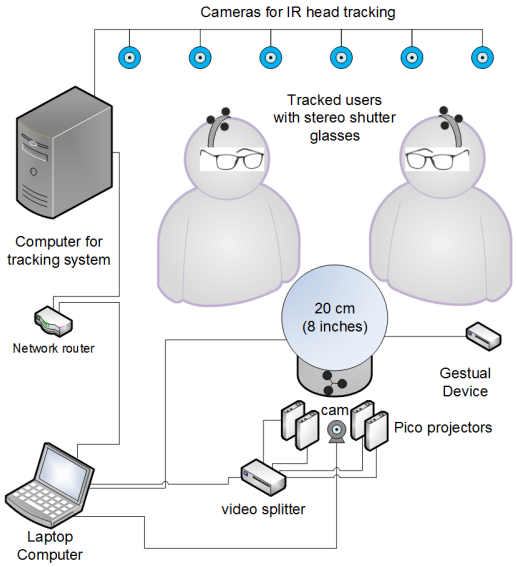

Figure 4: OrbeVR System Block Diagram

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