Spheree: A 3D Perspective-Corrected Interactive Spherical Scalable Display

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Figure 1: *Spheree is an interactive spherical rear-projected display that provides perspective-corrected views (based on the user's head position) to provide parallax, perspective, shading and occlusion depth cues.*

1 Introduction

We constructed a personal, spherical, multi-projector perspective-corrected rear-projected display called *Spheree*. Spheree uses multiple calibrated pico-projectors inside a spherical display with content rendered from a user-centric viewpoint. Spheree uses optical tracking for head-coupled rendering, providing parallax-based 3D depth cues. Spheree is compact, supporting direct interaction techniques. For example, 3D models can be modified via 3D interactions on the sphere, providing a 3D sculpture experience.

We developed a novel multiple pico-projector system that automatically calibrates and blends using a camera+projector approach creating a uniform pixel space on the surface of the sphere. Our auto-calibration algorithm uses a spherical modification of [Teubl et al. 2012]. Being scalable allows as many projectors as needed for virtually any size of sphere. Our spherical display design has no seams that cause singularities in blending and provides uniform pixel density across the whole sphere. No mirrors are used so there are no blind spots. We only use the regular lenses that come with the mini-projectors, so rendering is simplified. Spheree supports bi-manual gesture, hands-free and moving-the-display interactions.

We have coupled Spheree to a 3D modelling package, Blender, to illustrate it in a 3D modelling workflow. People can use their 3D modelling environment or capture real objects, such as designs moulded with clay, and easily put them inside Spheree. Once inside, users can modify them virtually. When satisfied, they can use them in their applications or even print them with a 3D printer. Thus, Spheree plays a key role in realizing a complete workflow for a 3D capture-modify-print environment. We also demonstrate what a 3D model of a person looks like in Spheree, illustrating how teleconferencing with eye-contact could be realized with this display.

We have created a medium and a small sized Spheree. The medium sized Spheree allows participants to experience and interact with 1:1 models. The small spheree can be held in your hands; thus, participants can pick it up and look around objects, bounce them around and interact with them just by moving the sphere.

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2 The Experience

With Spheree, users have a personal and engaging interactive experience with 3D content. It is personal as rendering is directed towards a single viewer. It is engaging because of the highly interactive nature of Spheree: participants are able to modify and sculpt objects, or carefully manipulate them through two-handed interactions and hand-held tools using a hand tracker. They also experience a 3D modelling workflow that combines Spheree with Blender to spark imagination of how design environments can be created with Spheree.

Related to Spheree, pCubee, a cubic fish-tank VR display, has interaction based on physical motion, it does not use touch, it does not scale well and the edges cause disruptive occlusion [Stavness et al. 2010]. The SnowGlobe spherical display used a single stereo 3D projector with a hemispherical mirror, but had non-uniform resolution and the mirror caused a blind spot [Bolton et al. 2011]. Other projection spheres[1] use a single projector with a fish-eye lens, but do not scale to high-resolution.

Spheree is the first display to offer uniform, high resolution pixels projected to a spherical surface with gesture interaction to manipulate 3D objects. The display is also interactive with respect to the participant's position using wireless, optical tracking, providing the participant with perspective-corrected virtual scenes; i.e., a spherical fish-tank VR experience. A live demonstration of Spheree and its associated technologies illustrate that calibrated, multiple projector spherical displays represent the future of interactive, scalable, high resolution non-planar displays.

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BOLTON, J., KIM, K., AND VERTEGAAL, R. 2011. SnowGlobe: A spherical fish-tank VR display. In *ACM SIGCHI Interactivity*, 1159–1164.

STAVNESS, I., LAM, B., AND FELS, S. 2010. pCubee: A perspective-corrected handheld cubic display. In *Proc of the SIGCHI10*, 1381–1390.

TEUBL, F., KURASHIMA, C., CABRAL, M., AND ZUFFO, M. 2012. Fastfusion: A scalable multi-projector system. In *Proc of the 14th Symp on Virtual and Augmented Reality*, 26–35.

[1] eclecti.cc/computergraphics/snow-globe-part-one-cheap-diy-spherical-projection, Dec 2013; www.pufferfishdisplays.co.uk, May 2014.