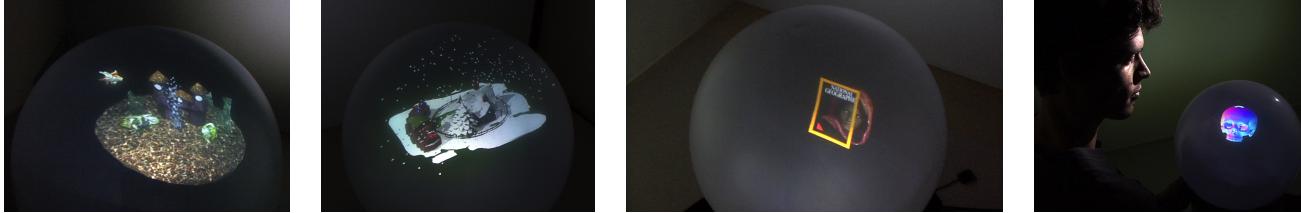


# Spheree: A 3D Perspective-Corrected Interactive Spherical Scalable Display

Ferreira, F.<sup>II</sup>, Cabral, M.<sup>†</sup>, Belloc, O.<sup>†</sup>, Miller, G.<sup>○</sup>, Kurashima, C.<sup>II</sup>, de Deus Lopes, R.<sup>†</sup>, Stavness, I.<sup>‡</sup>, Anacleto, J.<sup>△</sup>, Zuffo, M.<sup>†</sup>, Fels, S.<sup>○</sup> \*

<sup>†</sup>U of São Paulo & <sup>II</sup> Fed. U of ABC & <sup>‡</sup>U of Saskatchewan & <sup>△</sup> Fed. U of São Carlos & <sup>○</sup>U of British Columbia



**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.

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

We developed a novel multiple mini-projector system that automatically calibrates and blends using a camera+projector approach. This creates a uniform pixel space on the surface of the sphere. Our auto-calibration algorithm uses a spherical modification of [Teubl et al. 2012]. It is highly scalable allowing 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.

At Siggraph Emerging Technologies, participants experience *Spheree*’s head-coupled rendering to show dynamic, reactive 3D virtual objects and to support different types of tangible and gesture-based interactions with content inside the display. We exhibit a small and a medium sized *Spheree*, one for an experience interacting by moving the display and the other to see and interact

with high-resolution 1:1 scale of larger 3D objects.

**Experience:** With *Spheree*, we have created a personal and engaging interactive experience with 3D content. It is personal since *Spheree* rendering is directed towards a single viewer. The experience 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 handheld 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*.

**Novelty:** *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.

**Related work:** pCube is a cubic fish-tank VR device with 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<sup>1</sup> use a single projector with a fish-eye lens, but do not scale to high-resolution.

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<sup>1</sup>[electri.cc/computergraphics/snow-globe-part-one-cheap-diy-spherical-projection](http://electri.cc/computergraphics/snow-globe-part-one-cheap-diy-spherical-projection), Dec 2013; [www.pufferfishdisplays.co.uk](http://www.pufferfishdisplays.co.uk), May 2014.

\*contact emails: mkzuffo@usp.br, ssfels@ece.ubc.ca