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

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Abstract

In this poster we present Portable-Spheree, an interactive spherical rear-projected 3D-content-display that provides perspective-corrected views according to the user's head position, to provide parallax, shading and occlusion depth cues. Portable-Spheree is an evolution of the Spheree and it is developed in a smaller form factor, using more projectors and a dark-translucent screen with increased contrast. We present some preliminary results of this new configuration as well as applications with spatial interaction that might benefit from this new form factor.

1 Introduction

Portable-Spheree is a small sized version of Spheree [2] that uses multiple pico projectors and a dark translucent 30cm diameter plastic sphere to create seamless, high contrast projected imagery on a spherical surface. In this version, Portable-Spheree has evolved to using more projectors and a dark translucent screen, thus increasing spatial resolution and viewing contrast. It uses multiple calibrated pico-projectors inside a spherical display with content rendered from a user-centric viewpoint. Portable-Spheree uses optical tracking for head-coupled rendering, providing parallax-based 3D depth cues. It is also compact and it supports direct interaction techniques. Images on the surface of the sphere are automatically calibrated and blended 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 [4]. 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. Portable-Spheree supports bi-manual gesture and moving-the-display interactions. Additionally, we have coupled Portable-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.

2 Technical Details

Portable-Spheree is pictured in Figure 1 of our abstract and is currently constructed from a black-translucent plastic sphere (30cm diameter) mounted on top of eight mini-projectors (Brokestone Pocket Mini Projector 640×360 resolution) assembled in the base

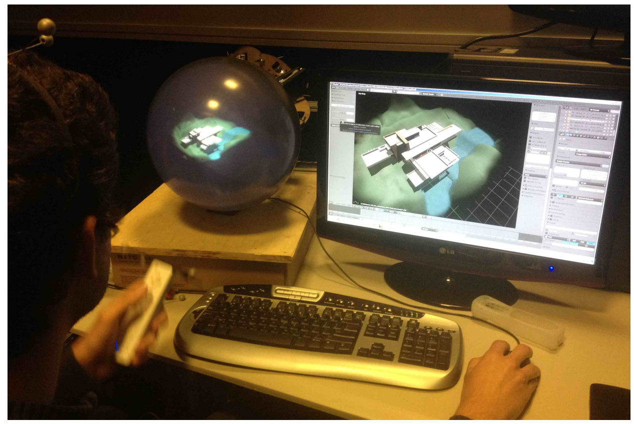

Figure 1: Portable Spheree is an evolution of Spheree [2]. It is an interactive spherical rear-projected display that provides perspective-corrected views (based on the user's head position) to provide parallax, perspective, shading and occlusion depth cues.

(see Figure 3). The projectors are driven by a single computers that run the visualization and simulations. The projectors are automatically calibrated using a paired camera and calibration software modified for spherical projection based on [4]. Perspective-corrected rendering requires tracking the position of both the user and display. We use an Optitrack with 6 17W cameras for robust, low-latency position tracking that does not require wires attached to the sphere or person; but does require retroreflective markers be attached. Rendering is currently done using a single computer with multiple quad graphics output (see Diagram in Figure 2). We have combined the designer version of Blender for demonstrating how Portable-Spheree can be used in a design workflow.

2.1 Spheree Interactions

Users can interact with Sphere in a variety of ways in order to create an engaging experience. The main interaction modes in Portable-Spheree are:

Viewing static objects inside the display A natural interaction for viewing a 3D scene within Portable-Spheree is to look around or rotate it (take it in your hands) to see into different areas of the sphere. In static viewing, while objects are stationary within the display, the perspective of the scene is constantly changing, corresponding to the movements of the user's head and the Portable-Spheree display. Complex 3D objects can be viewed from different sides in a tangible manner.

Manipulating objects with gesture Direct selection and manipulation of objects allows for fine-grained user control. We will be using an adapted Wiimote controller coupled with reflexive markers to provide a gesture based interaction for scaling, rotating and manipulating 3D objects in Portable-Spheree. Thus, par-

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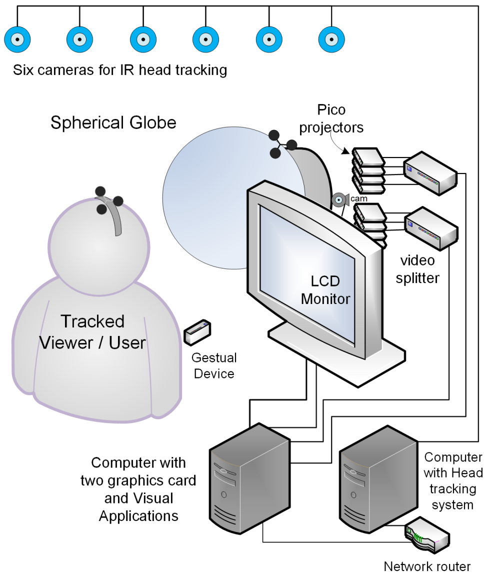

Figure 2: System Setup

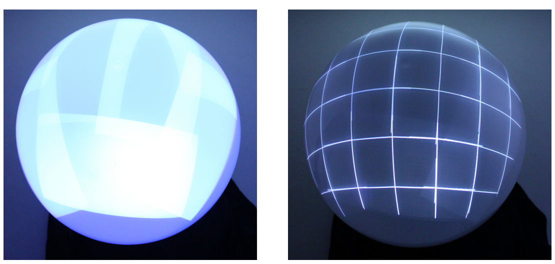

Figure 3: All the projectors are arranged in a circular pattern to maximize coverage with a camera in the middle. The left image shows the initial, uncalibrated projection area from the eight projectors. The next image to the right shows calibration patterns that are used by the camera to align the projectors.

ticipants can try bi-manual interaction, gesture-based interaction as well as moving the Portable-Spheree itself.

Sculpting existing 3D models We have bi-manual gesture interaction using an optically tracked device that allows CAD object manipulation such as sculpting. Given a model currently being viewed by the participant, the model's shape and/or color may be changed by using the hand tools.

3 Discussion and Conclusion

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 [3]. 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 [1]. Other projection spheres[1] [2] use a single projector with a fish-eye lens, but do not scale to high-resolution.

Portable-Sphere can be used in a variety of scenarios. Its smaller form factor allows for usage in scenarios such as holding the spher-

Figure 4: Portable-Spheree in action: the base contains the projectors and the camera used for projector calibration (the image shown is tracked as per the user's viewpoint).

ical display in hand and manipulating it directly. Portable-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 Portable-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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