

Cubee: A Cubic 3D Display for Physics-based Interaction

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Introduction

Cubee is an *interactive* cubic fish tank VR display that is suspended to enable viewing from all sides and free manipulation. It encloses a small virtual space inside the physical boundaries of a cubic display. The display motion is mapped into the virtual scene to create a compelling interaction metaphor of objects inside a box. The system presents a tangible way to evaluate interactive realism of dynamic simulations.

The goal of the Cubee exhibit, shown at Siggraph Emerging Technologies 2006, is to create a unique physical experience with computer-generated, physics-based animation through an interactive 3D display system. Cubee brings dynamic simulation into the participant's physical space and supports interaction that maintains a coherent relationship between the virtual and physical worlds.

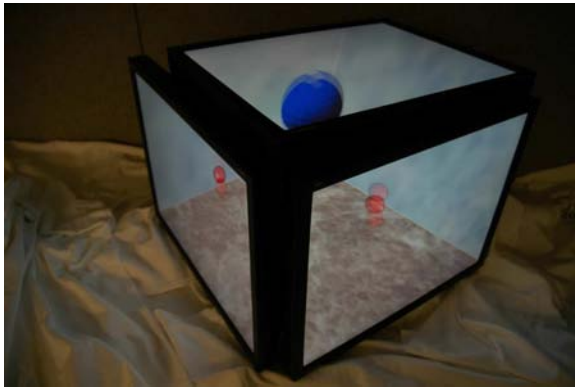


Figure 1: The interactive Cubee display showing bouncing balls.

Innovation

The display extends head-tracked perspective rendering by allowing interaction with a multi-display system that renders virtual objects behind the display plane as if they are inside the box. This display technique differs from the conventional approach, in which virtual objects float in front of the display [Djajadiningrat et al. 1997]. Our method enables the seams of the LCD panels to be used as occlusion cues to help realize the “inside the box” metaphor in a similar manner to [Inami 1997].

Cubee's design affords a large movement space around the entire display, which enhances motion parallax cues for a strong 3D effect. The display is suspended so that participants can move around it or move it around. Participants are not required to use a mouse or other input device to manipulate objects in the virtual scene: movement of the display causes the objects to respond just like real objects in a real box.

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Technology

The Cubee apparatus is constructed from five LCD panels connected with a rigid internal chassis into a cubic arrangement. The bottom side of the cube is open for power and video cables. The display is driven by two multi-head graphics computers that appropriately render the same OpenGL scene on each side of the display. A coherent perspective is rendered for the viewer by using the [Deering 1992] projection matrix formulation transformed to each side of the display. In exhibition, the display is suspended from each corner by elastic shock cords connected to a fixed overhead truss. We use the Polhemus Liberty Latus wireless magnetic tracking device to measure the participant's head position and the cube's pose within a 3m³ workspace.

Cubee requires real-time physics-based simulation in order to achieve interaction between physical display motion and reactions in the virtual scene. Display motion maps into changes in gravity direction and collision forces on virtual objects. For this purpose, Cubee's dynamic simulation engine is powered by our ArtiSynth biomechanics software system [Fels et al. 2006] (www.artisynth.org). ArtiSynth is a Java API for physics-based modeling and simulation of human anatomy.

Vision

Real-time dynamic simulations of any variety, including multiple rigid-bodies, fluid, sand, smoke, or other natural phenomena are uniquely suited to this type of display. In the near future, Cubee displays could become the de facto standard test bed for examining and evaluating the realism of physics-based computer animation.

References

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