gCubik: Real-time Integral Image Rendering for a Cubic 3D Display

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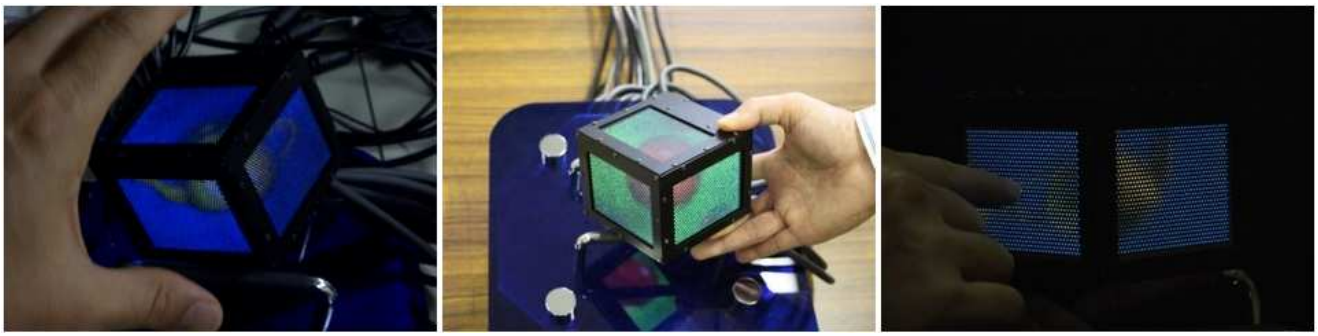

Figure 1: *gCubik is an autostereoscopic display, graspable, interactive and suitable for multiple users*

1 Abstract

gCubik provides a 3D visual experience, which is interactive and group-shared, by using a graspable cubic display. Users are presented with color, stereo and full motion parallax 3D scenes, viewable from any direction, without the need of special glasses. Newly designed wide field of view integral photography(IP) lens array are employed on each face of the display for its autostereoscopic effect. In our demonstration, real-time rendering of the IP images allows users to interactively manipulate the 3D objects in the scene via simple finger gestures.

2 Vision

Three-dimensional displays are a promising technology for naturally sharing 3D information among users. Besides visual feedback, direct and intuitive manipulation of the 3D scenes could have a significant impact on face-to-face collaborative tasks, with applications in education and entertainment[Jones et al. 2007].

Our goal is to provide a graspable, group-shared, glasses-free and interactive 3D display which allows multiple users to naturally share 3D images as they would do with real objects. Our prototyped display gives users the impression of holding, pointing and manipulating, in their hands, a 3D object inside a cube. We plan to propose a novel interaction paradigm that is unique and suitable for our 6-faced display.

3 Technical Innovations

Wide field of view integral photography. Our display utilizes a newly designed IP lens array with wide field of view, on each of the 6 faces of a cube, allowing users for simultaneous multi-face viewing from any direction. Each IP lens have a 120-degree field of view and provide 18×18 directional views with smooth image transition at a holding distance of 400mm[Lopez-Gulliver et al. 2008].

Real-time integral photography image rendering. The rendering algorithm utilizes OpenGL's off-screen rendering to a texture using framebuffer objects (FBO). Similar algorithms have been proposed[de Sorbier et al. 2008]. FBOs avoid context switching and copying from the framebuffer to the texture buffer thus improving performance. Also, the framebuffer object's dimensions are not limited by the screen's dimensions. In our implementation, for each of the 6 cube's faces, we allocate an FBO with texture attachments with (640x2) x (480x2) pixels' dimensions, up-sampling to avoid aliasing artifacts. And then render the 3D scene, into this texture, from each of the 1065 IP lens positions using a 120-degree field of view virtual camera onto a (18x2) x (18x2) pixel viewport corresponding to each elemental image. We use a stencil mask to avoid viewport overlapping with adjacent lens's position. We then simply draw a down-sampled 640x480 pixel textured quad on the window system provided framebuffer. Our display's 3D resolution is limited by the number of IP lenses in the array, 1065 per face.

In our tests, we achieved up to 12 fps for a single-material, non-textured, 3500-vertex, 6500-triangle, lit 3D model(teapot), using a 2.66Gz Quad Core2 Intel CPU with one NVidia GeForce 8800 GT graphics card.

Interactive manipulation of IP images. Thanks to the real-time IP image rendering described above, the display provides interactivity via touch-panels on each of the cube's faces. With this, users can manipulate the 3D objects inside the cube using a virtual trackball by simply dragging they fingers on the panels. By assigning specific actions to the corners of the panels, users can change the 3D model to be displayed, change its material, and more.

4 User Experience

In our demonstration, users can naturally share 3D images among a group of friends. Moreover, users can interactively manipulate and change the visual properties of the 3D objects in the scene using simple finger gestures(please refer to accompanied video). We believe interaction with our gCubik is a fun 3D visual experience.

References

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