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EE 367 - Computational Imaging and Display
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Computational Imaging and Display Course Project Proposal

Motivation

The availability of low-cost Virtual Reality (VR) devices has generated a renewed interest in rendering light field content. Moreover, recent development of consumer-level light field cameras has increased the availability of light field photographs. Yet there is a dearth of consumer electronics for viewing the light fields. Light field display using parallax barriers is a well-established technique for showing three-dimensional (3D) content. We propose to build a simple parallax-barrier light field display on the popular iPhone platform. We aim to build our prototype in a way convenient for the interested readers to reproduce and build upon our work.

Related Work

Displaying 3D content has been widely investigated in literature. Eyeglasses based 3D displays are now commonplace in the consumer entertainment media sector. Many books and review papers, including the recent one [1], have been written covering the wide variety of 3D display technologies.

Broadly classifying display technologies into binocular stereoscopic and autostereoscopic 3D, we focus on the latter's subcategory of multi-view 3D light field displays. In a series of papers on autostereoscopic displays, Takaki [3] has investigated eye-glasses free super multi-view displays and discussed color interlacing. Recently, multi-view see-through 3D LCD displays are proposed using parallax barrier [4].

3D displays require that a 3D scene be captured from multiple views and be projected onto a 2D camera plane with a proper perspective. In an oft-referenced paper [2], Kooima described the calculations required for off-axis perspective projection. This non-traditional type of projection is required for rendering scenes to a display viewed from off-center, as will be necessary for each of the views rendered in this project.

Once the views have been rendered, they must be interlaced to be viewed properly through the parallax barrier. Hirsch et al. [5] have provided helpful guidance and examples for building 3D display hardware, rendering, and interlacing.

Project Overview

This project consists of a hardware component and a software component. To build the hardware, we will generate a pinhole mask image and have it professionally printed on a transparent sheet. Next we will align the mask with a test pattern on an iPhone display and affix the mask to the iPhone. We will use an acrylic sheet as a spacer to achieve the correct viewing angles for the optimal number of views.

In addition to the hardware, we will build an application for light field rendering. It will use the user friendly SceneKit framework provided by the iOS SDK. The application will make use of the SCNTechnique class to perform multiple render passes on a scene, drawing the scene from multiple points of view to viewports on the target buffer. A final post-processing pass will interlace the views to generate the required light field when observed through the parallax barrier. An important consideration for this software component will be a clean and well documented implementation for reproducibility.

After the light field rendering and its display through a parallax barrier, if the time permits, we will consider enhancing our project with additional functionality. Some potential “stretch goals” are:

- Use the basic face detection functionality built in to the iOS SDK as a rudimentary head tracking technique to increase the viewing volume.
- Add user input to the app, either through a Bluetooth keyboard or by putting a protective film over the parallax barrier to allow for touch input.
- Affix the parallax barrier in such a way that it is easily removable and replaceable while maintaining alignment.
- Properly display a light field photograph captured by a Lytro camera.
- Allow the user to load their own 3D models in the Collada format (the native format supported by SceneKit).
- Minimizing the cross talk between adjacent views by adapting a slanted lenticular sheet and adapting a color interlacing technique.

Milestones, Timelines, and Goals

Date	Milestone
2/18/2016	Order printed parallax barrier sheet
2/23/2016	Have SceneKit app running on an iOS device
2/25/2016	Have multiple viewport rendering working
2/27/2016	Complete basic interlacing pass
3/1/2016	Receive and apply printed parallax barrier sheet
3/5/2016	Adjust/Calibrate interlacing pass to generate correct light field
3/12/2016	Complete any stretch goals

References

[1] Geng, J. Three-dimensional display technologies. Advances in Optics and Photonics, 5(4), 456–535. http://doi.org/10.1364/AOP.5.000456. (2013)
[2] Kooima, R., "Generalized perspective projection," http://csc.lsu.edu/~kooima/articles/genperspective/ (2008).
[3] Yasuhiro Takaki, Kosuke Tanaka, and Junya Nakamura, "Super multi-view display with a lower resolution flat-panel display," Opt. Express 19, 4129-4139 (2011)
[4] Jong-Young Hong, Chang-Kun Lee, Soon-gi Park, Jonghyun Kim, Kyung-Hoon Cha, Ki Hyung Kang, Byoungho Lee. See-through multi-view 3D display with parallax barrier. Photonics West OPTO 9770. (2016)
[5] Matthew Hirsch and Douglas Lanman. Build your own 3D display. In ACM SIGGRAPH 2010 Courses (SIGGRAPH '10). ACM, New York, NY, USA, , Article 4 , 106 pages. DOI=http://dx.doi.org/10.1145/1837101.1837105 (2010)