

# EE 267 - Project proposal

Hayato Ikoma, Alexa Siu

## 1 Motivation

Three dimensional (3D) displays are becoming popular consumer technologies. The 3D effect mainly comes from the projection of two respective images on right and left eyes. For example, some movie projectors superpose two different images on the same screen with orthogonal polarization states so that viewers wearing polarization glasses see different images with different eyes. Head-mounted displays exploit lenses with a near-eye display to directly display separate images to each eye. In the expense of their high-quality 3D effect, however, they require specialized hardware. Among such 3D technologies, anaglyph is the most inexpensive way for the projection of two different images. This method uses a conventional display or a printer and plastic red-cyan glasses for the separate projection. The display shows an image only with a red channel for a left eye and an image with green and blue channels for a right eye. The red-cyan glasses wore by the viewer block out the respective channels for each eye to decompose the superposed image. Although this simple setup provides a 3D effect, it lacks color preservation for both eyes due to the color filters. This lack is the main disadvantage of anaglyphs among others including color distortion, retinal rivalry and ghosting effect.

To suppress these disadvantages, several algorithms have been developed for generating anaglyph images. In 2001, Dubois developed a least square method to minimize the color discrepancy between original stereoscopic images and generated anaglyph images in the CIE XYZ color space [1]. This XYZ anaglyph method significantly improved the color distortion and has been considered to be the state-of-the art method until recently. Following this work, McAllister et. al. performed the minimization of Euclidian distance in the CIE  $L^*a^*b^*$  space, which produced better color perception due to the perceptual linearity in CIE  $L^*a^*b^*$  space [2]. However, this  $L^*a^*b^*$  anaglyph method is computationally expensive because it solves an iterative optimization problem for each pixel. To further improve the color perception, Li et al. proposed a method to minimize the color discrepancy in HSV color space [3]. In addition to its superior performance, their method significantly reduced the computational cost by finding an approximated closed-form solution for the minimization. Similarly, this type of color retaining algorithm has been developed for a projector in which color primaries are customized [4].

## 2 Plan

In this final project, we plan to develop a color conversion algorithm for anaglyph stereo rendering by following the works discussed above. Our idea is to formulate the anaglyph generation algorithm as a minimization of the color discrepancy metric, CIE94 (or CIEDE2000), with the anaglyph's color channel constraint. CIE94 is a smooth function with respect to RGB values, and we have proved that our algorithm is a convex program. We will try to find its exact or approximated closed-form solution to make our algorithm fast. Furthermore, this project also involves measurements of absorption spectra of the color filters and emission spectra of display primaries. From the measured spectra, we are going to compute the linear conversion formula

from the RGB space to the L\*a\*b space for our stereoscopic environment. This procedure allows us to suppress the ghosting artifact. Finally, we are going to implement our proposed algorithm and demonstrate it on the Big Buck Bunny movie (<http://bbb3d.renderfarming.net/>). Our result is going to be compared with conventional anaglyph rendering algorithms.

## References

- [1] E. Dubois, “A projection method to generate anaglyph stereo images,” in *Acoustics, Speech, and Signal Processing, 2001. Proceedings. (ICASSP '01). 2001 IEEE International Conference on*, vol. 3, pp. 1661–1664 vol.3, 2001.
- [2] D. F. McAllister, Y. Zhou, and S. Sullivan, “Methods for computing color anaglyphs,” 2010.
- [3] S. Li, L. Ma, and K. N. Ngan, “Anaglyph image generation by matching color appearance attributes,” *Signal Processing: Image Communication*, vol. 28, no. 6, pp. 597 – 607, 2013.
- [4] I. Kauvar, S. Yang, L. Shi, I. McDowall, and G. Wetzstein, “Adaptive Color Display via Perceptually-driven Factored Spectral Projection,” *ACM Trans. Graph. (SIGGRAPH Asia)*, 2015.