Stanford University, EE 267: Virtual Reality

Advanced Anaglyph Stereo Rendering

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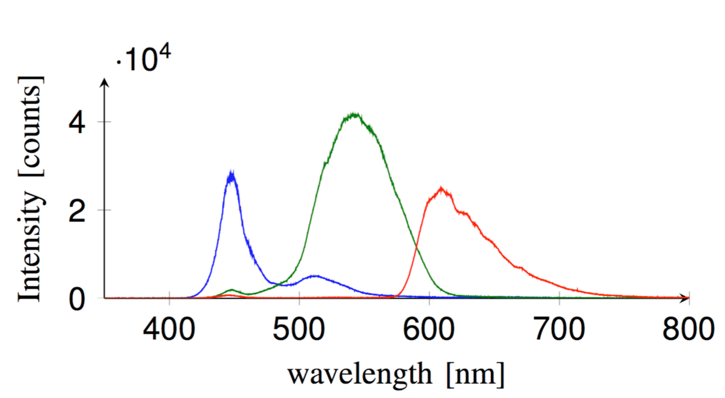
Abstract

Three dimensional (3D) displays are becoming popular consumer technologies. Among such 3D displays, anaglyph rendering is the most inexpensive way for creating a 3D effect. The display shows an image only with a red channel for the left eye and an image with both green and blue channels for a right eye. Although this simple setup provides a 3D effect, it lacks color preservation for both eyes due to the filters. Other disadvantages include retinal rivalry and ghosting effect.

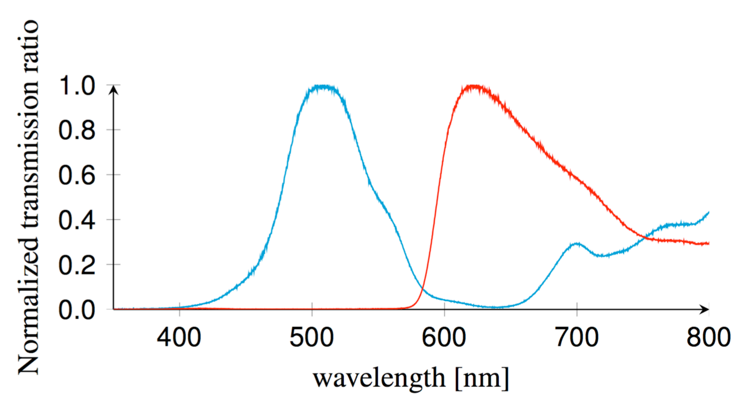
In this final project, among advanced anaglyph rendering algorithms, we reimplemented the algorithm introduced by Li et al. This method produced anaglyph images with suppressed retinal rivalry and ghosting effect but severely distorted red-like colors. To address this problem, we explored a way to improve color perception through a post processing step. We report a clue to recover such distorted color by encouraging our brain to recognize red-like color on selected regions with a left eye.

Spectral Measurements

Anaglyph renderings were optimized for viewing in the MacBook Pro (2015) Retina display with standard cardboard red-cyan anaglyph glasses. This required measurement of the display's RGB spectral output and glasses' absorption spectra.



(a) Display primaries



(b) Absorption spectra

(c) Experimental setup

Rendering Pipeline

- Color appearance matching is performed in HSL space.
- HSL has attributes of **lightness, saturation** & **hue**.
- These attrbutes have been shown to accurately descibe color perception of the **human visual system**.

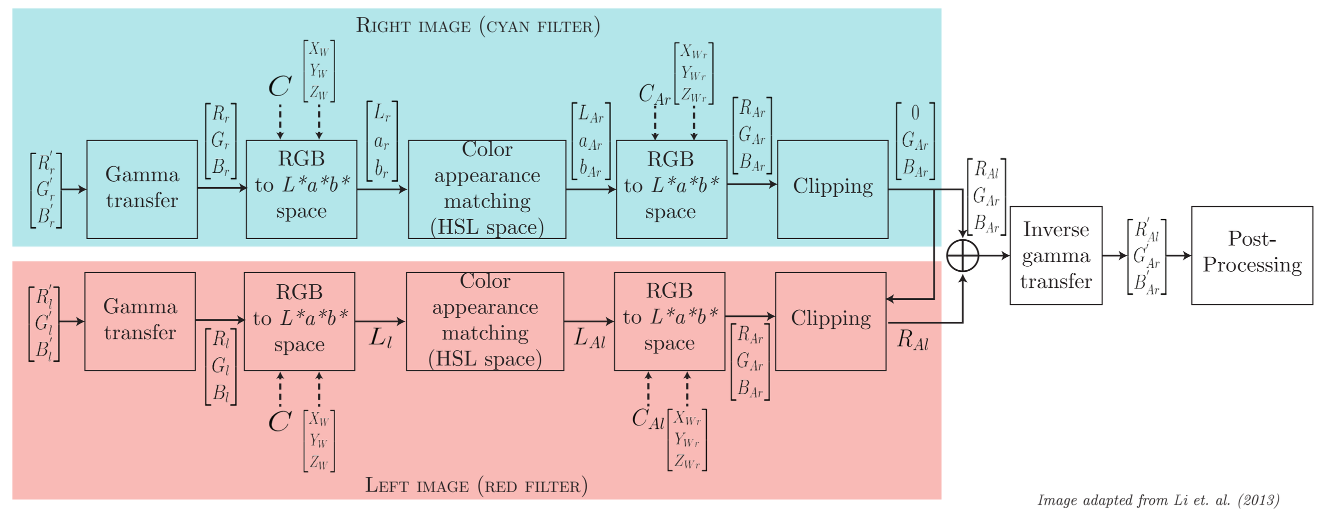
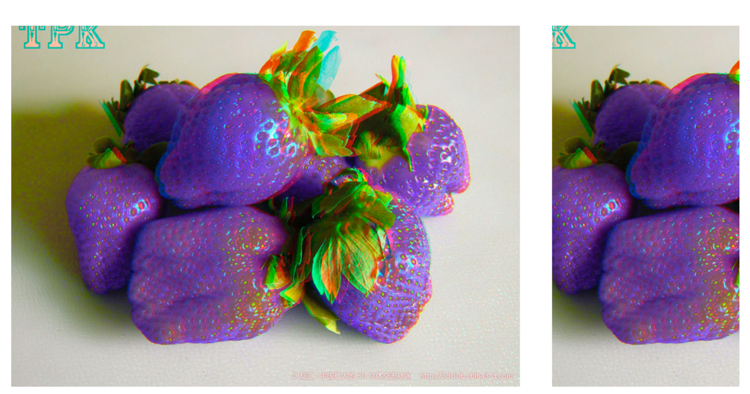


Image adapted from Li et. al. (2013)

Processed Images[3]

(a) original right (b) conventional method (c) Dubois' method (d) Li's method

Post-Processing[4]



(a) before processing

(b) after processing

- Li's method was not able to retain chrominance accuracy for primarily red-like colors.
- To achieve greater accuracy we explored a combination of selective color intensity reduction and color defocusing as a post-processing step.

Common Issues

The three common issues in anaglyphs:
1. Color distortion
2. Retinal rivalry
3. Ghosting effect

original stereo perceived anaglyph

Conclusion

Achieving high fidelity anaglyph images is still an open challenge. Color appearance matching is a crucial step to minimize color distortion in rendered anaglyph images. While our post-processing algorithm for color enhancement is not a universal method, we demonstrate that the combination of monovision and lightness discrepancy is a key to consistently let our brain recognize color from the right eye on red-dominant regions.

References

[1] Li, S., Ma, L., & Ngi Ngan, K. (2013). Anaglyph image generation by matching color appearance attributes. Signal Processing: Image Communication, 28(6), 597–607.
[2] Dubois, E. (2009). The Structure and Properties of Color Spaces and the Representation of Color Images. Morgan & Claypool.
[3] Big Buck Bunny Movie, https://peach.blender.org/
[4] 3D China, http://www.china3-d.com/3dclub/