

Optimization of Anaglyph Stereo Rendering

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1. INTRODUCTION

Anaglyph stereo rendering is the only method that stereoscopic images can be viewed on ordinary television sets or computer screens with no special hardware other than inexpensive colored glasses. It allows the perception of depth when observed through colored glasses such as the familiar red/blue glasses. Although it sounds to result in a large non-ideality, previous study¹ has shown the surprisingly good quality from questionnaires.

The implementation of anaglyph rendering historically has been mostly empirical before an optimization method² which takes into consideration the spectral absorption curves of the glasses (color filters), the spectral density functions of the display primaries and the colorimetric properties of the human observer.

In this project, we will first investigate this optimization method, tune the parameters for our hardware (display and anaglyph glasses), and then apply it to a created 3-D scene.

2. THEORETIC ANALYSIS

The basic principle for stereo rendering is to present two offset images separately to the left and right eye to create depth illusion in features of an image. In anaglyph rendering, the separation of the stereo pair presented on screen² $Q_l(\lambda, x)$ and $Q_r(\lambda, x)$ is through colored glasses acting as filters with spectral absorption functions $f_l(\lambda)$ and $f_r(\lambda)$.

Ideally, the left eye only sees $Q_l(\lambda, x)$ with perceived signal given by

$$\begin{aligned} \tilde{V}_{lk} &= \int Q_l(\lambda, x) \bar{p}_k(\lambda) d\lambda \\ &= \sum_{j=1}^3 V_{lj}(x) \int \bar{p}_k(\lambda) d_j(\lambda) d\lambda \\ &= \sum_{j=1}^3 c_{kj} V_{lj}(x), k = 1, 2, 3, \end{aligned} \quad (1)$$

where $\bar{p}_k(\lambda)$ is the color-matching functions and $d_j(\lambda)$ is the spectral density functions of the RGB display phosphors. The ideally perceived signal of the right eye \tilde{V}_{rk} is obtained similarly. In reality, however, the left and right eye, through the filters, see the fused signal of $Q(\lambda, x) = \mathcal{F}(Q_l(\lambda, x), Q_r(\lambda, x))$ (and $V_{aj}(x) =$

$\mathcal{G}(V_{lj}(x), V_{rj}(x))$), where \mathcal{F} and \mathcal{G} denotes the function to fuse left and right image. Therefore, the perceived signal of left eye is given by

$$\begin{aligned} \tilde{U}_{lk} &= \int Q(\lambda, x) f_l(\lambda) \bar{p}_k(\lambda) d\lambda \\ &= \sum_{j=1}^3 V_{aj}(x) \int \bar{p}_k(\lambda) d_j(\lambda) f_l(\lambda) d\lambda \\ &= \sum_{j=1}^3 a_{lkj} V_{aj}(x), k = 1, 2, 3. \end{aligned} \quad (2)$$

The perceived signal of the right eye \tilde{U}_{rk} has similar form. The objective of anaglyph rendering is thus that, \tilde{U}_{lk} and \tilde{U}_{rk} are close to \tilde{V}_{lk} and \tilde{V}_{rk} , respectively.

3. IMPLEMENTATION DETAILS AND TIMELINE

In order to achieve the aforementioned goal, we need first to measure or search in the specification the screen and anaglyph glass characteristics. With these constants, the main variable we can change² is the fuse function \mathcal{G} . The first stage of the project (**1.5 week**) is to re-implement this optimization method² in our screen and compare the difference with the simple method as introduced in the assignment. The next step (**1 week**) is to improve the optimization method and compare the results. Then we will apply this updated method to a created 3-D scene (**1 week**) before the write-up (**0.5 week**).

4. EVALUATION CRITERIA

Assessing the objective quality of 3-D images with human input is still a somewhat open problem. The perception of quality is affected by the viewing environment (including display and illumination), image size, and even factors inherently associated with the human observer such as fatigue, color blindness or visual acuity. A recently proposed systematic method³ is to perform regression on the results of questionnaires and then to extract a sets of characterization metrics. However, due to the time limitation, we will simply use the feedback from other students to assess the quality of the 3-D scene and compare results of different anaglyph rendering methods.

REFERENCES

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