HOW CAN HYPERSPECTRAL PROJECTION ENHANCE CHOROMOSTEREOSCOPY?

Background & Research Question

Chromostereopsis is an optical illusion caused by different wavelengths of light refracting at a different angle through the eye lens[1]. Because of this refraction, certain colors can be perceived as being closer than others, e.g. red is perceived as being closer to the viewer than blue.

A commercial product (ChromaDepth® glasses) improving the depth perception of the chormostereoscopic effect was used during the research.

The research simulated a stronger depth effect by pre-shifting certain wavelengths of light in the direction each eye would shift them in order to study how a more accurate control over the color spectra can improve the effect.

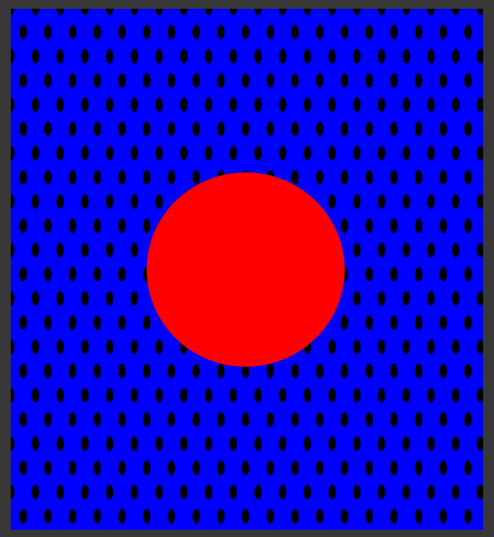

Figure 1. Example of chromostereoscopic image.

Experiment and Results

Steps to create the image to be projected:

1. Choose the image to be projected
2. Create two copies of the image
3. In each copy, spatially shift the red RGB values, to the left and to the right, corresponding to each eye.
4. Project the images on top of each other

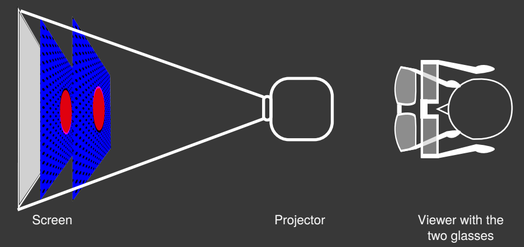

Figure 4. Projector setup used during the experiment.

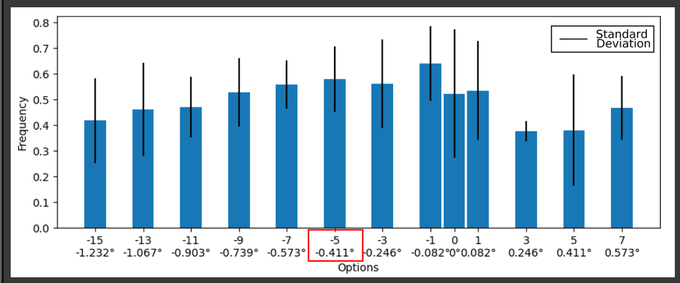

Figure 5. Experiment results.

After creating and projecting the image, it can be perceived by the viewer by wearing both pairs glasses in front of each other.
Participants were asked to choose the preffered depth between 300 pairs of images shifted at different intensities. The result were then aggregated and they were used to further answer the research question.

Limitations

Given the nature of the illusion, different people may perceive different intensities of the chromostereoscopic effect.

Another limitation is that since the binocular nature of the effects, the people perceiving the images must have binocular vision.

The research was based on simulating hyperspectral projections, so further research should be done with actual hyperspectral projections.

Active Shutter 3D glasses & 3D Projector

Active shutter 3D glasses aid in displaying stereoscopic 3D images by showing each eye a different image. The glasses synchronize with the stereoscopic projector and intermitently display the projected images to generate a depth effect, by blocking the projected image on one eye or the other. The projected intertwined images are slightly different, in order to create the illusion of depth between the elements in the image.

Figure 2. Active Shutter 3D glasses.

ChromaDepth® Glasses

ChromaDepth® glasses aid in displaying 3D images by increasing the strength of the depth effect caused by chromostereopsis. The glasses amplify the chromatic abberation of the eye lens, this way improving the depth perception of the colors.

Figure 3. ChromaDepth Glasses.

Discussion

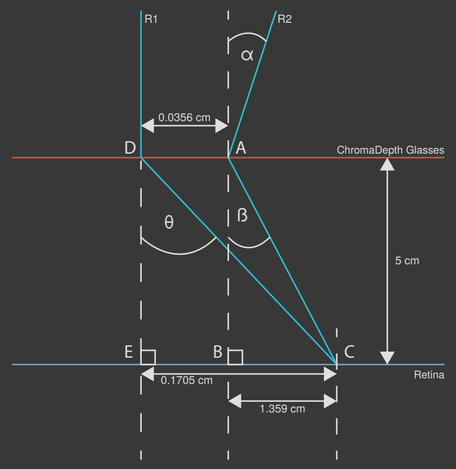

Figure 6. Experiment results.

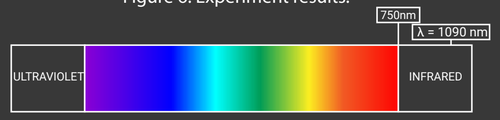

Figure 7. Placement of the studied wavelength on the light spectrum.

The experiment yielded a preffered shift that caused the depth perception of the image to be improved. From this shift, a wavelength of light that would result in the same perception on the retina was calculated. The calculation found out that this wavelength was

λ = 1090 nm

This wavelength lies outside of the visible spectrum of light, specifically in the infrared range. While this finding is not directly aplicable to displaying chromostereoscopic projections, we can deduce that any visible wavelength of light can be used in order to enhance the depth perception of the image since creating too strong of a visual disparity between the two eyes is not possible.
Besides this, the full range of color can still be used to display a very detailed depth resolution, as every wavelength will have a different depth intensity.

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References:

[1] R. A. Steenblik, "The Chromostereoscopic Process:
A Novel Single Image Stereoscopic Process," SPIE Proceedings, Jun. 1987, doi: 10.1117/12.940117.