Homework #2 Color Science

Assigned: September 13, 2016
Due: September 22, 2016

1. The Display of Color (12 points)

The following is the color triangle for matching stimuli of wavelengths 650, 530 and 460 nm showing the locus of spectral colors. Assume a color in the blue-green range has the coordinates of $r = -0.12$, $g = +0.82$ (the dot in the diagram below).

A. Describe the causes of the problems associated with displaying this color.

B. If you were to display this color on a color TV set, with these same primary illumination sources, what values for each of the three electron voltages (red, green and blue) would you use to most closely represent this color? (Express as a percentage of full intensity.)

C. Explain the rationale for your solution.

The color triangle for matching stimuli of wavelengths 650, 530, and 460nm, showing the locus and the white point W. The units are such that equal quantities of the three stimuli are needed to match the equal power white.
2. Different Monitors- (18 points)

Assume that you are working on your Apple laptop which has a color gamut defined by the three primaries of 650, 530, and 460 nm. However, your project is to be displayed using a Panasonic projector which uses a different set of three primaries, e.g., 700, 546.1 and 435 nm. It is certainly possible to duplicate Grassman’s experiments and determine the conversion from one set of primary lights to another but this is difficult, laborious, and very time consuming.

Describe what you should do to best project your work in class in order to maintain the exquisite color design that you have constructed on your Apple laptop. (You do not have to specify the exact numerical procedures.)

![Converting RGB primaries to XYZ](image1)

![Converting sRGB primaries to XYZ](image2)
Part III: The Interaction of Color (40 points total)

“Only appearances are not deceptive.”

- Josef Albers

“In Alber’s understanding, color has an unstable identity. Its appearance is deeply unreliable, it alters its complexion from one moment to the next. When we look at it, we see that what is directly supplied to our perception is actually impalpable and mysterious.”

- Heinz Liesbrock

“For it is alchemy when the identical red appears one way in one setting and very different in another, when a perfectly flat expanse of color appears shaded from light to dark…”

- Nicholas Weber

We now understand how to predict on a physical basis the energy which reaches the eye. This depends on the wavelength distributions of the emitted, reflected, or transmitted light. We also understand that the eye responds to a large range of colors despite the fact that it has only three different color receptors (cones). Based on the color matching experiments we know how to determine the color matching functions of the human visual system for a given set of primary colors. Note that these experiments were based on conducting the color matches in isolation from its surround and in a dark environment.

The artist Joseph Albers has illustrated very clearly the fact that despite our predictions on a physical basis our impression of color is very different depending on the surrounding environment. His art and paintings which depict many aspects of the global as contrasted to local behavior of the human visual system are well known. The original painting and prints are not readily available to see (Cornell actually has one copy in the rare books portion of Mann Library) but a relatively cheap paperback entitled, Interaction of Color by Joseph Albers, has been published.

This portion of the homework assignment consists of two parts.

A. (20 points) Design a unique Alber’s illustration demonstrating that the same colors can “look differently” when placed in different surroundings on the same painting.

This part is to be submitted on 8 ½ x 11 paper. You are to use colored sheets of paper to make your collage. If you wish, these could be foldouts but all should fit in the same 8 ½ x11 format. The design and execution of this illustration is important. The design should be physically interactive in that the viewer would see two different colors, but interactively prove that the two are the same. Neatness, execution, and creativity will be part of the grade. (It would be very nice if we could also use these collages as illustration for next year’s class).

B. (20 points) On two printed pages maximum using text and diagrams explain why we get these perceptual impressions. Note that this phenomena has not yet been fully explained in lecture. (No handwritten text)
Part IV: Why No One Agrees on the Color of This Dress (30 points)

In February of this year, the single picture shown in the central image above polarized the Internet into two aggressive camps. People across social media argued as to whether the picture depicted the perfectly nice bodycon dress as blue with black lace fringe (right) or white with gold lace fringe (left).

How can this be? What is the cause? Color scientists, perception researchers, and neuroscientists are still debating the cause(s), although a consensus has not yet been reached. In fact, an entire issue of the Journal of Vision will be dedicated to this unique phenomenon. (See advertisement below).

As part of a team which will submit an article to this Journal of Vision issue, you should describe your group’s hypothesis as to the cause of this phenomenon and how to prove your conjecture. (Two pages, single spaced maximum). Please note that this example is still controversial and under debate. We (faculty and teaching assistants included) cannot judge your answer to be correct or incorrect). Grading will be based on your logic, your understanding of the problem, your discussion, and the coherency of your arguments.

Advertisement:

[visionlist] Journal of Vision - Special Issue on The Dress

David Brainard brainard at psych.upenn.edu
Thu Mar 12 19:54:50 GMT 2015

Journal of Vision Special Issue: A Dress Rehearsal for Vision Science

In late February and early March 2015, an image of a dress circulated widely on the internet. Different people saw very different colors in the dress (white-gold, blue-
black, and blue-brown were among the most commonly reported); some reported that the colors changed from time to time with continued viewing.

The dress image triggered enthusiastic but informal discussion in the vision community (over 140 messages on CVNET in 10 days) concerning the marked individual differences and bi-stability reported.

Now it is time to address the dress. What can we learn from this particular image? To what extent can we predict what individuals will see given known individual differences in color vision? Which aspects of the spatial and spectral structure of the image contribute to the phenomena? Can we develop a range of images that exhibit similar phenomena? How can we use such images to test existing vision theory? This special issue will feature papers on these and related topics. Particularly encouraged are studies that leverage measurements and understanding of how the dress and related images are perceived to identify and clarify general principles of color vision.

Submissions to the special issue will open immediately and remain open for some time to allow full development of novel work, until July 1, 2016. Each paper will be published in the Journal of Vision upon acceptance, and the special issue papers will be collected together for ready access through a single indexing portal supported by the journal.

Guest Editors

Sarah Allred (white-gold)
Bart Anderson (bistable)
David H. Brainard (depends on the display)
Karl Gegenfurtner (white-gold)
Laurence T. Maloney (blue-brown)