CLRS720 – Computational Vision Science – Lab 3 – Display Characterization

Objective In this lab assignment you will build and test a display model that would be appropriate to use in a lab-based experiment to ensure colorimetric accuracy of stimuli presented to an observer.

Instructions You will turn in a PDF titled 'YourNameLab3.PDF' answering the questions below (thus, NOT a full lab report with section headers, references, etc.), plus the m-file titled 'YourNameLab3.m' used to answer the questions.

Normally you would use physical measurements of your own display (or the display you wish to characterize and calibrate). However, for this lab, you will use the measurements provided in **`cvs_lab3_dispdata.mat`**. This file includes two variables: **`rgb`** contains RGB digital counts (0-255) for 333 displayed colors. **`xyz`** contains XYZ measurements taken with a PR-655 spectroradiometer for those 333 colors. Rows 1-156 correspond to primary R,G,&B ramps (individually ranging from 0-255). Rows 157-208 correspond to a neutral(gray) ramp where RGB simultaneously and equally range from 0-255. Rows 209-333 correspond to additional combinations of RGB which will be used as your 'verification' colors to test your model.

1. Where are the black and white display values located (which rows of `rgb`)? What are the black and white XYZ tristimulus values?
2. What is the primary matrix of the display? What do these numbers indicate (where do the values in the rows and columns come from, and what do they mean)?
3. Use the neutral(gray) ramp and primary matrix to create EOTF curves (transform input RGB [0-255] to linear RGB [0-1], then interpolate from measured values to full 0-255 range). Plot the EOTF curves. These are your 3x1D LUTs.
4. Now use these to run a whole forward model for the 'verification' colors: RGB[0-255] -> linRGB[0-1] via LUT -> XYZpred via primaryMatrix (+blackXYZ). You will end up with predicted XYZ values for the verification colors. What do these mean (or why do we want these)?
5. Quantify the colorimetric error between the measured and predicted XYZs of these colors using deltaE00. Create a histogram of the color differences and report the overall mean, min, and max color difference. How well does your model fit the display measurements (would this be a good model to use for color-critical tasks)?
6. Create a new variable consisting of the following XYZ values:
   These are 6 new colors (in XYZ) that you want to accurately display on the monitor. Run a 'reverse model' that will give the predicted RGB inputs [0-255] for these colors for the display. What are the RGB inputs you get?

79	95	21
69	88	64
50	79	63
108	114	121
7	8	8
11	22	3

7. Using the code provided with the in-class demo as a starting point, make the following plots (4 separate plots) in xy chromaticity space (remember xyz[chromaticity coordinates] is different than XYZ[tristimulus values]):

    a. Plot the spectral locus using the `StdObsFuncs.xls` data. What does this spectral locus represent?

    b. Plot the measured xy chromaticity coordinates of the display's primaries. What do these points represent? If you were to draw a triangle connecting them, what does the triangle represent?

    c. Plot the measured xy chromaticity coordinates of the primary ramps (the individual R, G, and B ramps).

    d. Plot the measured xy chromaticity coordinates of all the verification colors.

8. Finally you will take your own measurements of a display (your monitor or someone else's. This can also be done in a group – e.g., everyone taking measurements of one person's monitor). Please coordinate with the TA to arrange a time to come in, and have them help setup the CR-250, drivers, and code needed to take measurements. You can use '`monitorMeasureLoop.m`' and the 'shorter version' (106 colors) of the rgb array to make your measurements.

    a. Once completed, include the RGB(input) and XYZ(measured) files in your submission on MyCourses.

    b. Create a plot for this new display data: it should contain 1) the spectral locus, 2) the xy chromaticity coordinates of the display's primaries, 3) a triangle connecting them.