EE 637 Midterm Exam #2

Session 35

April 5, Spring 2002

Name: _____

Instructions:

- Follow all instructions carefully!
- This is a 50 minute exam containing **two** problems.
- You may **only** use your brain and a pencil (or pen) to complete this exam. You **may not** use your book, notes or a calculator.

Good Luck.

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Problem 1.(50pt)

Consider two images $g(x, y)$ and $f(x, y)$ where x and y are the horizontal and vertical coordinates in inches and both functions take on postive values, are proportional to energy, and are scaled to the range $[0, 1]$ with 1 representing the maximum allowed luminance. Both images are viewed at a distance of d inches, and have a length and width of $2 * d$ inches. The intention is for the two images to look the same.

To assess the fidelity of the reproduction, the following three quality metrics are used

Metric A

$$D_a(f, g) = \frac{1}{4d^2} \int_{[-d,d]\times[-d,d]} ||f(x, y) - g(x, y)||^2 dx\, dy$$

Metric B

$$D_b(f, g) = \frac{1}{4d^2} \int_{[-d,d]\times[-d,d]} ||(f(x, y))^{1/3} - (g(x, y))^{1/3}||^2 dx\, dy$$

Metric C

$$D_c(f, g) = \frac{1}{4d^2} \int_{[-d,d]\times[-d,d]} ||(h(x, y) * f(x, y))^{1/3} - (h(x, y) * g(x, y))^{1/3}||^2 dx\, dy$$

where $h(x, y)$ is the impulse response of the linear space invariant filter and $*$ denotes 2-D convolution.

a) Give an example of a two images $g(x, y)$ and $f(x, y)$ which differ (primarily) at a spatial frequency of 5 cycles per degree.

b) Give an example of a two images $g(x, y)$ and $f(x, y)$ for which $D_a(f, g) > 0.1$, but which can be made to look arbitrarily similar.

c) What is the advantage of Metric B?

d) Suggest a method for choosing the impulse response $h(x, y)$.

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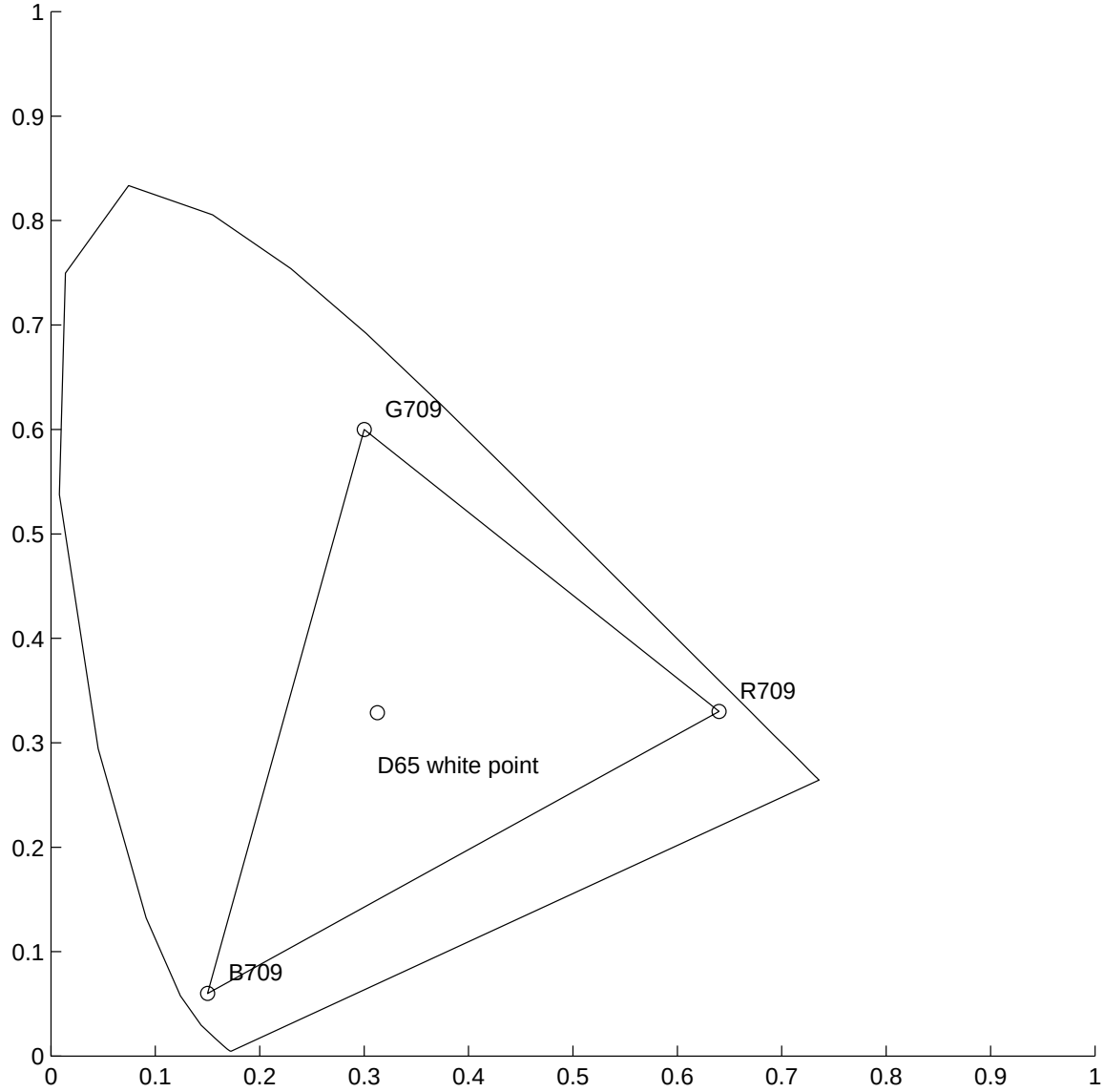
Problem 2.(50pt)



Consider an imaging rendering system with **4** primary colors corresponding to red (**R**), green (**G**), blue-green (**A**), and blue (**B**). The red, green, and blue primaries use standard 709 chromaticies, and the blue-green primary is given by

$$A = (0.7G + 0.3B) - 0.25R$$

a) Sketch and label the location of the blue-green primary on the chromaticity diagram.

b) Sketch and label the color gammut of the device.

c) Sketch and label the location of the XYZ color primaries on the chromaticity diagram.

d) Sketch and label the color gammut of the XYZ color primaries.

Consider a color formed by

$$[\mathbf{R}, \mathbf{G}, \mathbf{A}, \mathbf{B}] \begin{bmatrix} r \\ g \\ a \\ b \end{bmatrix}$$

e) Is the color specification for $[r, g, a, b]$ unique for all colors in the gammut of the device, not unique for all colors in the gammut of the device, or never unique? Be specific and justify your answer.

f) What is the potential advantage of using 4 primary colors rather than 3?

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