Homework 1

COMP 575/770 Spring 2016

Due: Jan 27, 2016

Instructions Please work on the problems on your own. It is okay to discuss the problems with other students, but please write your answer independently. If you are able to find any part of the solution in a book or some source on the Internet, please acknowledge that source.

1. Find out the transfer function of your display. You can find a gamma correction applet at:

   `http://gamma.cs.unc.edu/graphicscourse/gammapprox.html`

   The applet displays an area of alternating black and white horizontal stripes surrounded by a gray patch. The applet has a slider for each area. Fix the intensity of the gray patch to the half of the intensity range. Look from a distance where the black and white stripes blend together, and slide the control until the patch can hardly be distinguished from the surrounding area.

   (a) What is the pixel value of the inner patch?

   (b) Assuming that your display's transfer function fits the standard gamma model, what is the gamma for your display? For simplicity, assume the pixel value is the same one used when sending to the display.

2. Consider an 8-bit display with $\gamma = 2$, with a maximum displayable intensity of I_{max} and a viewing flare of I_{min}. This means you will observe an intensity of I_{min} when the pixel value is 0, while the maximum intensity is $I_{min}+I_{max}$. The display intensity for a pixel value of a is given by $I(a) = I_{max} \cdot (\frac{a}{255})^{\gamma} + I_{min}$. Assuming that a relative difference in intensity of $\geq 2\%$ is visually noticeable, which of the 255 steps from one pixel value to the next are noticeable under the following conditions:

   (a) $I_{min} = 0$ (i.e., no viewing flare)

   (b) $I_{min} = 0.01 I_{max}$ (i.e., 1% viewing flare)

   (c) Repeat (a) and (b) for a non-gamma-corrected display ($\gamma = 1$). For instance, if pixel value 123 produces intensity x, then the step between 123 and 124 is visible if pixel value 124 produces intensity at least $1.02x$.

3. For a given quantization method, we define the "precision" of the method to be the maximum relative difference between two sequential intensity levels, paying attention only to the levels that are at least 1% of the maximum intensity. For this problem, disregard viewing flare in the computations.

   (a) What is the "precision" of an 8-bit $\gamma = 2.2$ encoding?

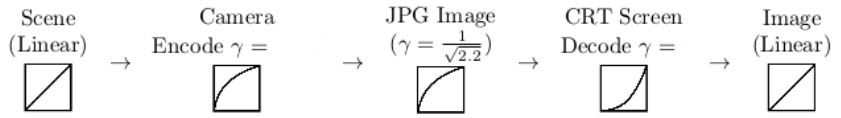
   (b) How many bits per pixel do we need, with a linear quantization, to be as "precise" as the above gamma encoding?

4. Given the following formulas:

$$\text{gamma encode}: \; V_{out} = A V_{in}^{\frac{1}{\gamma}}$$
$$\text{gamma decode}: \; V_{out} = A V_{in}^{\gamma}$$

   fill in the blanks with the appropriate gamma values in the following image processing workflows:

(a)



(b)

(c) In (b), the image was converted to linear luminance before any image processing took place. Why would someone choose to do this?