CS4620 Homework 1

out: Monday 1 September 2008
due: Friday 5 September 2008

Explore your computer

1. What is the screen resolution and refresh rate of your display? What is the data rate flowing across the cable to the display? State any assumptions you had to make to answer.

2. Find out the transfer function of your display. You can find a gamma correction applet on the course website. The applet displays an area of alternating black and white horizontal stripes with a grey patch in the middle. A slider controls the pixel value of the grey patch. 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. What is the pixel value of the grey patch? Assuming that your display's transfer function fits the standard gamma model, what is gamma for your display? For the simplicity, assume the pixel value is the same one used when sending to the display.

Pixel formats

3. Consider an 8-bit display whose gamma is 2, with a maximum displayable intensity of $I_{\max}$ and viewing flare of $I_{\min}$. This means you will observe an intensity of $I_{\min}$ if the pixel value is 0, while the maximum intensity is $I_{\min} + I_{\max}$. Assuming that a relative difference in intensity of $\geq 2\%$ is visually noticeable, then which of the 255 steps from one pixel value to the next are noticeable under the following conditions:

   (a) $I_{\min} = 0$ (no viewing flare);
   (b) $I_{\min} = 0.01 I_{\max}$ (1% viewing flare);
   (c) do (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 $1.02x$.

4. Linear quantization vs. gamma correction. 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 the 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?