

# CS 465 Homework 1

out: Friday 26 August 2005

**due: Friday 2 September 2005**

## Problem 1: Image formats

1. Suppose a PC is connected digitally to a 1600 by 1200 pixel color LCD display. The display is operating at 60Hz, has a gamma of 2.2, and always takes 8 bits per color channel per pixel.
  - (a) What data rate is flowing across the cable to the display?
  - (b) How much of the graphics card's memory is occupied by the framebuffer for each of the following pixel formats:
    - i. 16 bits per pixel (4 red, 5 green, 4 blue)?
    - ii. 8 bit RGB?
    - iii. 8 bit RGB with 8 bit alpha?
2. The image on the screen was computed by a ray tracer that (like the Ray I assignment) stores the RGB image it is computing as an array of double-precision floating point numbers, with the value of 1.0 corresponding to the maximum displayable intensity  $I_{\max}$ , and lower values mapping linearly to fractions of that intensity.
  - (a) How much of the PC's main memory is occupied by the image?
  - (b) What processing has to be done to the pixels before they are written into the framebuffer? Give a specific expression that could appear in the code used to do the processing.
  - (c) Suppose the software thinks the display gamma is 1.5. Would the displayed image look darker or lighter than it should?
  - (d) Assuming a black level of 1% of  $I_{\max}$ , what will be the observed intensities corresponding to the five darkest gray values that can be sent to the display? Which steps are visibly different from one another?
  - (e) Suppose the display is linear (i.e. its gamma is 1.0), and answer the previous two questions.
3. The same image is to be printed on a black-and-white laser printer that has a resolution of 600 dots per inch. It will appear on the page at the size 8 inches by 6 inches. There are two steps of processing that have to be done on the image before it can be printed.
  - (a) What are the two steps? Give a specific expression for the first step, and name a general class of algorithms for the second step.

- (b) How much data needs to be transmitted over the network to the printer if:
- i. both steps are done in the computer?
  - ii. one step is done in the computer and one in the printer?
  - iii. both are done in the printer?

Assume no data compression is used (this is rather unrealistic for option (a)).

Give data sizes in kilobytes, megabytes, or gigabytes as appropriate; give data rates in kilobits, megabits, or gigabits per second. Recall that these units traditionally refer to multiples of 1024, not multiples of 1000.