CPSC 479/579 Problem Set #2

Due Tuesday February 11, 2014, 1:00 pm
Submit by uploading to classesv2.

Below you will find the problems for Problem Set 2. As in the previous problem set, please note the following:

1. All problems should be uploaded to ClassesV2 together in a single zip folder. For non-programming problems either prepare an electronic document, or scan in a handwritten solution.
2. Each problem should be in its own folder of the format "problem*n*". For example the solution to the first problem should be placed in a folder called "problem1"
3. All assignments will be graded in the Zoo, which is a Linux environment. This means that all file and folder names are case-sensitive! It also means that you should test your solution on the Zoo computers.
4. You can start Matlab on the Zoo by opening a terminal and typing in *matlab*.
5. An automatic grader *may* be used, which may not be forgiving of formatting errors.
6. Check ClassesV2 from time to time, as we will post updates and correct any errors in the assignment there.
7. All Matlab functions should have its own m file with the same name as the function (as per Matlab's convention)

1. (C/C++, 479 and 579) The CIE XYZ functions are given in tabular form in a csv file given with this assignment as spectral_values.zip. The spectra of standard "MacBeth" color checker patches are also given. Assuming illumination by a perfect white source (i.e. the same irradiance for all wavelengths) write a program that determines an RGB value to display for each of the color patches. Use the definitions of the standard RGB primaries described in the first chapter of Banterle and apply a gamma value of 2.2. Name your program spectrum_to_rgb.cpp. The output of the program should be three integer values representing R, G and B. Provide a readme.txt file describing how to run your program. You may reformat the input files however you like (your program does not have to read directly from a csv file.)

2. (479/579)
Give values of x and y for colors that we can see, but which are not displayable with the RGB primaries defined in the first chapter of Banterle. Explain your answer.

3. (479/579)
a) Suppose you have a camera located at [0, 1, 0], pointing at the center of an object, with the center located at [0, 0, 0]. The camera also has an up vector of [1, 1, 0]. Derive the transformation matrix to transform a point in world coordinate to the camera coordinate specified above.

b) Transform the points: (0.5, 2.0, 3.0), (1.0, 3.5, 7.0), and (2.0, 0.0, 1.0) by rotation of 90 degrees around the x-axis, translation of (1.0, 0.0, 0.0), and scale of 2.0 along all axes in that order (as applied to the vertices). Show ALL of your steps.

4.(479/579)
Here are four letter shapes that, in this particular font, are simple transformations of one another:

(dimensions labeled 10 are in mm)

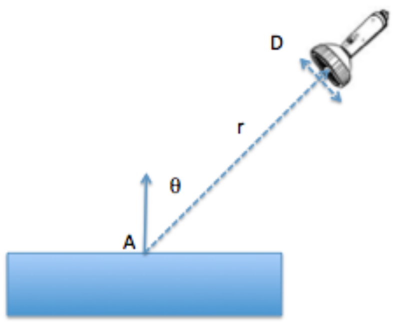
Each letter is positioned with its baseline at $y = 0$ and its left edge aligned with $x = 0$. Express the transformation required to turn p into each of q, b, and d as a single 3 x 3 homogeneous transformation matrix

5. (479/579)
Using the notation used in Szeliski, if the camera matrix is $K =$

$$\begin{bmatrix} 1000 & 0 & 320 \\ 0 & 1000 & 240 \\ 0 & 0 & 1 \end{bmatrix}$$

a) What is the focal length in pixels? b) What is the field of view?

6. (479/579)



A flashlight of diameter D equal to 5 cm is shines on a surface at point A that is r equal to 50 cm away. The flashlight emits 500 cd/m^2. The flashlight is aimed at an angle of θ equal to 30 degrees to the surface normal. The rest of the environment is black. What is the illuminance at point A?

7. Download the HDRToolkit associated with the Banterle et al. text from:
http://www.advancedhdrbook.com/
and clicking the option "this website"

Note that you will need to run installHDRToolbox each time you start up Matlab again.

Experiment with using BuildHDR function, which can be found in the source code under "Generation". When called with the option 'tabledDeb97', Debevec and Malik call the function gsolve to compute the function described in the paper (see the paper for the variable definitions.)
a) (479 and 579) For the sets of LDR images supplied with this problem, experiment with varying the value of lambda (the smoothness parameter) used by gsolve. Plot the results you get for g for the various values of lambda. What effect does this have? Does it vary for different images? Prepare a Readme file in doc or pdf file format discussing your observations illustrated with plots and images that your produce.

b) (479 and 579) Experiment with using different numbers of LDR images from each set for computing the HDR image – use the standard 'tabledDev97' with the default value of lambda. Look at the output of each experiment using three different tone mapping functions. What is the impact of using fewer images? If you need to use fewer images, what is the best way to choose them? Are the differences in the number of images used more or less apparent with particular tone mapping operators? Prepare a Readme file in doc or pdf file format discussing your observations illustrated with sample images that you produce.

c) (579 only) For sets of LDR images supplied with this problem, experiment with varying the weighting function used by gsolve. For example, instead of a linear function, just cut off low and high values. Construct another example of a possible weight function. What effect does this have? Does it vary for different images? Submit the new versions of the *.m files that you use, and prepare a Readme file in doc or pdf file format discussing your observations illustrated with sample images that you produce.

d) (479 and 579) We take pictures every 10 minutes of the Grove Street Cemetary from a window on the 4th floor. Download the most recent LDR image set using:
http://piranha.yu.yale.edu/get_latest_graveyard.php
Use the version of BuildHDR and a tone mapping operator that produces an image that is closest in appearance to what you see out the window. Prepare a Readme file in doc or pdf file format discussing your observations illustrated with sample images that you produce.

8. (579 only) In the tone mapping operator entitled DurandTMO.m, replace the bilateral separation with another, possibly simpler separation of spatial frequencies. Apply your new operator as well as the Durand operator on several HDR images and discuss the results. Submit the new implementation as NewTMO.m, and prepare a Readme file in doc or pdf file format discussing your observations illustrated with sample images that you produce.