CS 422/522: Digital Image Processing
Homework 2 (Fall '12)

1 Theory

1. Using graph-paper (or the equivalent), and with respect to Figure 1, show the following sets:

   (a) $\mathbf{B} \ominus \mathbf{S}$

   (b) $\mathbf{B} \oplus \mathbf{S}$

   (c) $(\mathbf{B} \ominus \mathbf{S}) \oplus \mathbf{S}$

   (d) $(\mathbf{B} \oplus \mathbf{S}) \ominus \mathbf{S}$

2. There is a link called *Color Matching Curves* on the class webpage to a Matlab file which defines seven vectors. The vectors R, G, and B represent the values of the spectral sensitivity functions of the red, green, and blue cones of the human visual system at 69 equally spaced wavelengths between 390 nm and 730 nm. The vectors X, Y, and Z represent the values of the CIE 1931 standard color matching functions, and the fourth vector, P, represents the reflectance distribution of a petunia (all at the same 69 wavelengths).

   (a) Compute the 3×3 color matching matrix using the three cone spectral sensitivity functions, S_r, S_g, and S_b for the human visual system and the three CIE standard primary sources, $\lambda_r = 700$ nm, $\lambda_g = 546.1$ nm, $\lambda_b = 435.8$ nm. Give the values of v_r, v_g, and v_b needed to reproduce the color of the aspen leaf with the primary sources.

   (b) Compute the tristimulus values (*i.e.,* X, Y and Z) for the petunia using the CIE 1931 color matching functions.

   (c) Compute the chromaticities (*i.e.,* x, y and z) for the petunia, from the tristimulus values.

   (d) Based on the CIE 1931 chromaticity diagram, what color is the petunia?

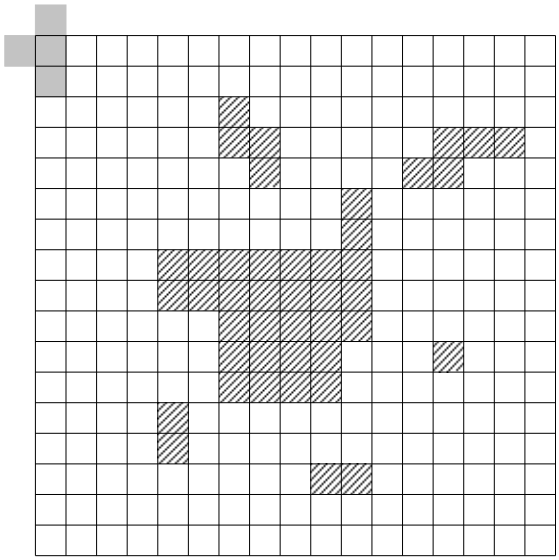

Figure 1: The upper left corner is $(0,0)$. The set S is the solid grey region. The set B is the union of the hatched regions.

2 Practice

1. Make a color composite image by combining one or more images of people (or things) imaged against blue (or green) screens with one or more color background images. You may use any of the images in the *Blue Screen Images* or *Green Screen Images* directories on the class webpage. I found these on the web. Alternatively, you can use one you find or make yourself (many of you own digital cameras and can find a piece of blue or green poster board). Show (with images and code) all intermediate steps you perform to construct your composite image. Grade level B+ is for technically correct but perfunctory solutions. Grade level A is reserved for solutions which are interesting, beautiful, complex, funny, or incorporate New Mexican themes. Hint: *image-crop* and *image-pad* are likely to be useful.

2. Define a function which, given one of the color images of coins (quarters, dimes, nickles, and pennies) lying on a green surface found in the *U.S. Coin Images* directory on the class webpage, returns the monetary value of the coins in the image. Give the value your program returns for each of the images in the directory. Grade level A requires 100 percent performance on the nine images. Hint: *distance-transform* is likely to be useful in solving this problem.

3. Given the *Printed Circuit Board 2* image found on the class webpage, and using methods similar to those used in class (See Ex. 2.1), create a color image overlay representing the outlines of the elements of the printed circuit board. Identify the following printed circuit board elements and outline them in the specified colors:

   - Large circular pads (red)
   - Small circular pads (green)
   - Square pads (blue)
   - Large pad holes (yellow)
   - Small pad holes (cyan)
   - Wires (violet)

   Show (with images and code) all intermediate steps you perform to construct your overlay. Grade level B for any four of six elements. Grade level A requires all six elements.