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) \( B \ominus S \)
   (b) \( B \oplus S \)
   (c) \((B \ominus S) \oplus S\)
   (d) \((B \oplus S) \ominus S\)

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 \( \times \) 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 Im-
ages 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 con-
struct your overlay. Grade level B for any four of six elements. Grade level
A requires all six elements.