CS/ECE 545 Digital Image Processing
Homework 4, Spring 2014 (Due April 9, 2014 by 6PM)

Note: Some of the problems below include questions for you to answer. Put your answers in a separate Word or PDF document and submit it in a zip file that also includes your code.

Programming Part

1. **Burger & Burge Exercise 9.4 (page 171) (30 points):** Implement as an ImageJ plugin, called **`Circular_Hough`**, the Hough Transform for finding circles and circular arcs with varying radii. Make use of a fast algorithm for generating circles, such as described in sec 9.4, in the accumulator array

   Find a suitable image to test your algorithm on the Internet and include at least one image with your submission. Also explain briefly how your algorithm works in your Readme file.

Submit ImageJ plugin (`Circular_Hough.java`)

Experimentation Part

2. **(20 points)** Answer the following questions using the Grayscale Morphology plugin to ImageJ from the link:

rsb.info.nih.gov/ij/plugins/gray-morphology.html

Download the image **mannequin-dots.png** and apply the **Mean Difference Threshold** filter to get a binary image. Describe a morphological operator that will remove the dots in the background of this image with the minimal amount of change to the mannequin. You answer should include the type of morphological operator, as well as the shape and size.

Written Part

3. **(10 points)** Write the lines $y = x - 2$, $y = 1 - x/2$ in (r, Θ) form.

4. **(12 points)** Use the Hough transform to detect the strongest line in the binary image shown below. Use the form $x \cos\Theta + y \sin\Theta = r$ with Θ in steps of 45 degrees from -45 degrees to 90 degrees and place the results in an accumulator array.

		x						
		-3	**-2**	**-1**	**0**	**1**	**2**	**3**
	-3	0	0	0	0	0	1	0
	-2	0	0	0	0	0	0	0
y	**-1**	0	1	0	1	0	1	0
	0	0	0	1	0	0	0	0
	1	0	0	0	0	0	0	0
	2	1	0	0	0	0	1	0
	3	0	0	0	0	0	0	0

5. **(12 points)** For the following image *A* =

   0 0 0 0 0 0 0 0
   0 0 0 1 1 1 1 0
   0 0 0 1 1 1 1 0
   0 1 1 1 1 1 1 0
   0 1 1 1 1 1 1 0
   0 1 1 1 1 0 0 0
   0 1 1 1 1 0 0 0
   0 0 0 0 0 0 0 0

   And structuring element *B* =
   1 0 0
   0 0 0
   0 0 1

   Calculate and show the results of the following morphological operations
   a. **Erosion** of *A* with *B*
   b. **Dilation** of *A* with *B*
   c. **Opening** of *A* with *B*
   d. **Closing** of *A* with *B*

6. **(6 points)** Suppose a square object was eroded by a circle whose radius was about one quarter the side of the square. Draw the result

7. **(10 points)** Using the 3x3 structuring element, compute the skeletons of:
   a. An L-shaped figure formed from an 8x8 square with a 3x3 square taken from a corner
   b. An H-shaped figure formed from a 15x15 square with 5x5 squares taken from the centers of the top and bottom

   Note: show all your work

Submitting Your Work

Submit plugin (`Circular_Hough`) and your README file in Word or PDF with all your **answers clearly typed up!!!**

Put everything into ONE zip file named *yourfirstname_yourlastname_hw4.zip* using turnin.

DON'T EMAIL ME YOUR HOMEWORK. ALSO, TEST YOUR CODE IN THE ZOOLAB BEFORE SUBMITTING!!