Image Processing / NCTU Fall 2019 Exam #1 (11/8/2019) Name:_____ ID:_____

Prob#	1	2	3	4	5	6	7	**Total**
Score								

1. [20%] Answer the following questions.

(a) False contour is a common problem when an image is quantized with few quantization levels. Give a brief explanation.

(b) Describe the purpose of unsharp masking, and how it works.

(c) Explain why we use CMY or CMYK color model, instead of RGB, for printing devices.

(d) Give an example to illustrate the following statement: If gamma transform is applied to the RGB values separately, the hue may change even though the same gamma value is used. You can use the formulas in Problem #7.

(e) Give an example to illustrate the following statement: Median filters cause less blurring than box filters at image edges.

2. [10 points] Assume that the histogram of an 8-level gray-scale image is given by the following table:

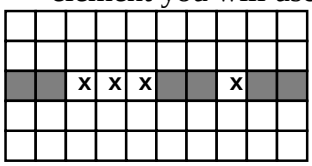
gray-level value	0	1	2	3	4	5	6	7
count	0	5	20	50	25	0	0	0

Determine the gray-level transformation given by histogram equalization. Show your computation.

3. [20%] The image below is obtained by thresholding a gray-scale image that contains thin dark lines. However, after thresholding, some pixels (marked by x's) are missing. Your goal is to reconnect the broken line segments. Let the gray levels of white and dark pixels be 255 and 0, respectively.

(a) Describe how you can achieve the goal with a smoothing filter, followed by thresholding. Describe the filter you will use and how you determine your threshold.

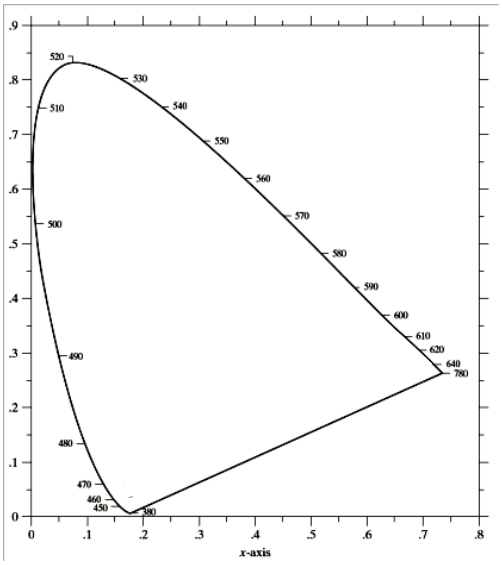
(b) Describe how you can achieve the goal using morphological operations. Describe the structuring element you will use.



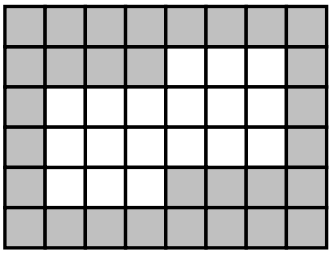
4. [10%] To the right is a CIE chromaticity diagram; the horizontal and vertical axes are *x* (red) and *y* (green), respectively.

(a) Give the definition of "color gamut" of a device.

(b) On this diagram, draw a typical color gamut for a common display device such as a TV set. Mark the R, G, and B points of the color gamut. Explain the reason of its shape.



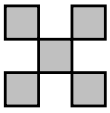
6. [15%] In the binary image, the white pixels are the foreground pixels.



(a) Using a 3x3 structuring element consisting of the center pixel and its 4 neighbors, mark in the image the foreground pixels after the given morphological operation. Here set *A* contains the foreground pixels and set *B* is the structuring element. The operation ⊕ is dilation.

$$(A \oplus B) - A$$

(b) Give the two structuring elements needed for using hit-or-miss transform to detect the shape to the right. Note: The detected shape cannot be 8-connected to any other foreground pixels.



(c) Briefly describe the procedure of shape detection using hit-or-miss transform. You can use (b) as an example.

6. [12%] Consider a 5x5 image with the origin at the center. There are only 4 foreground pixels at (2,2), (0,0), (-1,-1) and (2,-2). Use Hough transform to find the equation of the most significant straight line. Note: For the resolution of your accumulation bins, just use θ values centered at 0^o, 45^o , 90^o, and 135^o, and -3~3 for ρ in one-pixel steps. Use $\cos(45^o)=\sin(45^o)=0.7$. The line equation in polar coordinates is $x\cos\theta + y\sin\theta = \rho$.

7. [13%] The RGB to HSL transform is given below:

$$MIN = \min(R,G,B)$$
$$MAX = \max(R,G,B)$$
$$L = (MAX + MIN)/2$$
$$S = \begin{cases} 0 & \text{if } L = 0 \\ (MAX - MIN)/(2L) & \text{if } 0 < L \le 0.5 \\ (MAX - MIN)/(2 - 2L) & \text{if } L > 0.5 \end{cases}$$

$$H = \begin{cases} \text{undefined}, & \text{if } MAX = MIN \\ 60° \times \dfrac{G-B}{MAX-MIN}, & \text{if } MAX = R \text{ and } G \ge B \\ 60° \times \dfrac{G-B}{MAX-MIN} + 360°, & \text{if } MAX = R \text{ and } G < B \\ 60° \times \dfrac{B-R}{MAX-MIN} + 120°, & \text{if } MAX = G \\ 60° \times \dfrac{R-G}{MAX-MIN} + 240°, & \text{if } MAX = B \end{cases}$$

Now consider the RGB color (1.0, 0.5, 0). All RGB values are in the 0-1 range.
(a) Give the common name of this color.
(b) Give the HSL values for this color.
(c) Give the RGB values if we reduce S by half while keeping H and L unchanged.