International Institute of Information Technology, Hyderabad
(Deemed to be University)

Digital Image Processing (CSE/ECE 478) - Monsoon-2018

Mid-semester Examination 2

Maximum Time : 90 Minutes Total Marks : 100

Roll No. _____ Programme _____ Date _____

Room No. _____ Seat No. _____ Invigilator Sign. _____

Marks secured

Multiple Choice Questions

Question:	1	2	3	4	5	6	7	8	Total
Points:	4	2	2	4	4	2	1	1	20
Score:									

Long Questions

Question:	9	10	11	12	13	Total
Points:	20	10	20	10	20	80
Score:						

General Instructions to the students

1. Place your Permanent / Temporary Student ID card on the desk during the examination for verification by the Invigilator.
2. **QUESTION BOOKLET NEEDS TO BE RETURNED ALONG WITH ANSWER SHEETS. PLEASE TIE TOGETHER YOUR ANSWER SHEETS AND QUESTION BOOKLET, WITH THE BOOKLET ON TOP.**
3. Multiple-choice questions can be answered within the question booklet itself.
4. **No questions will be answered during the exam. Make necessary assumptions and proceed.**

Best of Luck

Multiple Choice Questions

For the following questions, circle ALL the correct answers. (Note: Partial marks will not be given for partially correct answers.)

1. (4 points) Let I be a 8-bit grayscale image and let $n(X)$ denote the negative image of X, i.e. $n(X) = 255 - X$. Let $s(X)$ denote the effect of segmentation method s on image X. For which of the following segmentation methods is it true that $s(n(I)) = n(s(I))$?

   A. Using a threshold value of 127 (i.e. if $I(x, y) > 127$, set output to 1 else set output to 0).

   B. Basic global thresholding (see Figure 1)

   C. Adaptive local threshold (i.e. divide image into sub-windows and use a threshold value of 127 on each window)

   D. None of the above

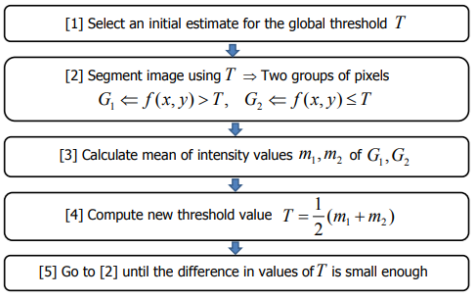
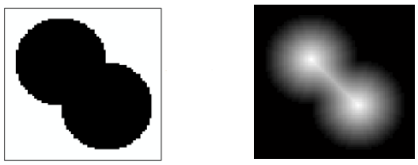


Figure 1:

2. (2 points) The grayscale image on the right is obtained from the binary image on the left by applying



   A. Erosion with a circular structuring element

   B. Dilation with a circular structuring element

   C. a contrast enhancement method

   D. a distance transform on the negative of the binary image and rescaling the output to the range $[0, 255]$

3. (2 points) In Figure 2, a skeletonization procedure is applied to the black filled hexagonal shape. Which of the images below the black filled shape corresponds to the final skeleton ?

   A. A B. B C. C D. D

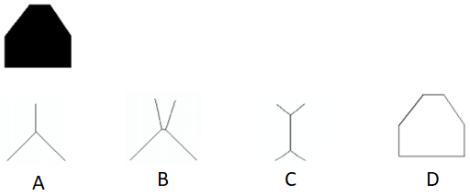


Figure 2:

4. (4 points) In Figure 3, choices a,b,c,d correspond to outputs after a morphological operation with a 3×3 square structuring element is applied on binary image S. Write a,b,c,d appropriately in the blank space before each operation.

_____ Opening
_____ Dilation
_____ Erosion
_____ Closing

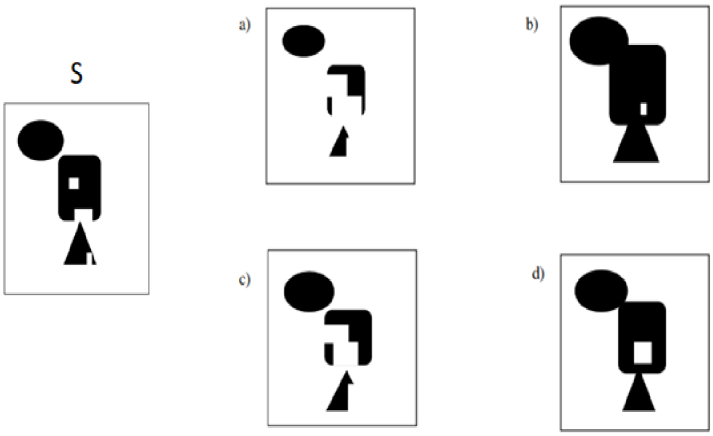


Figure 3:

5. (4 points) Suppose f is an image and S is a structuring element. Suppose $NEG(I)$ denotes the negative of image I. Which of the following is/are TRUE ?

   A. dilate(f,S) = NEG(erode(NEG(f),S))

   B. erode(f,S) = NEG(dilate(NEG(f),S))

   C. f = erode(dilate(f,S),S)

   D. f = dilate(erode(f,S),S)

6. (2 points) Suppose the minimum and maximum intensities in a 8-bit grayscale image are $m \notin \{0, 255\}$ and $M \notin \{0, 255\}$. Suppose we wish to choose an initial value t of threshold for basic global thresholding (step 1 in Figure 1). Which of the following intensity ranges are bad choices for selecting t ?

   A. $[0, m-1]$

   B. $[M+1, 255]$

C. $[m+1, M-1]$

D. $[a, a]$ where a is the average of all intensities in the image

7. (1 point) HSI is a conical color space. In this color space, which component takes an angular value? A. Hue B. Saturation C. Intensity D. All

8. (1 point) Which of the following color model is perceptually uniform?
A. RGB B. CIE XYZ C. HSI D. CIE Lab

Long Questions

Write detailed answers. Adequately explain your assumptions and thought process.

9. (20 points) 1. Suppose the structuring element B shown in Figure 4 is used to perform erosion on binary image X. Draw the resulting image in terms of shaded and non-shaded circles (similar in structure to X).

   2. Repeat the same as above, but instead of erosion, assume that the operation is dilation.

   NOTE: Assume that filled circle stands for 1 and unfilled circle stands for 0 in both B and X.

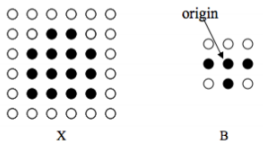


Figure 4:

10. (10 points) 1. Suppose r, c represents the row and column location of an edge pixel. Write down the equation of the curve this location corresponds to in the ρ, θ parameter space. (2 points)

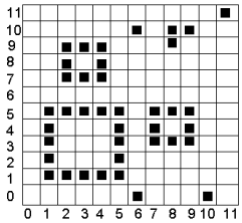


Figure 5:

   2. Suppose the Hough transform with ρ, θ parameterization is performed on the 12×12 image in Figure 5. Assume that the black filled squares correspond to edge locations. Also assume that the $\Delta\rho$ (step size for ρ in pixel units) and $\Delta\theta$ (step size for angle θ in **degrees**) in the accumulator array is both 1. What is the maximum value M for accumulator cell in ρ, θ space ? (6 points)

3. Continuing the above question, what are the values of ρ, θ corresponding to the maximum value M ? (2 points)

11. (20 points) 1. For the binary image in Figure 6, perform connected component analysis using the two-pass algorithm. Depict the resulting 2-D array after the first pass of the algorithm and the union-find label tree. Depict the 2-D array at the end of the second pass. Assume 4-connectivity. (10 points)

    2. Repeat the above, but with 8-connectivity. (10 points) NOTE: For 4-connectivity, the labels at locations one pixel to the left and the pixel above are considered. For 8-connectivity, the labels at locations diagonally above and to the left and diagonally above to the right are also considered, i.e. In 4-connectivity, (possibly labeled) locations $(r, c-1)$ and $(r-1, c)$ are considered for current unlabeled location (r, c). In 8-connectivity, (possibly labeled) locations $(r-1, c-1)$ and $(r-1, c+1)$ are also considered.

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

Figure 6:

12. (10 points) Figure 7, the pie charts are actually in color and easily distinguishable. However, as you can see in the left plot, when black-and-white print unsafe color choices are made, printing them in grayscale shows them as colors that have poor distinguishability (contrast). The pie chart on the right uses black-and-white print safe colors, leading to better contrast between the label areas. Write an algorithm that takes as input K – the number of colors required, and returns a color palette consisting of K colors that is safe to display/print in grayscale.

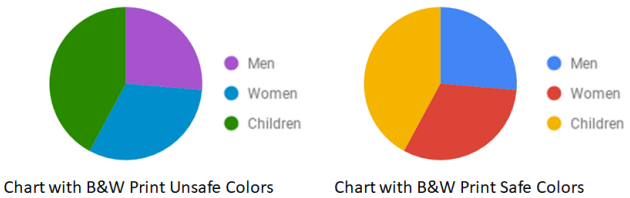


Figure 7:

13. (20 points) Consider a boundary image of apple logo shown in the left of Figure 8 below. Write procedures/ algorithms to do the following and write answers for the given boundary image as input as per the described procedures.

    1. Resample the boundary as per the grid overlaid on the boundary. (5 points)

2. Compute chain code for the resampled boundary starting with top left pixel as per 8-direction encoding (right figure). (10 points)
3. Identify total number of concavities in the resampled boundary shape (you may use the output of chain code computation procedure). (5 points)

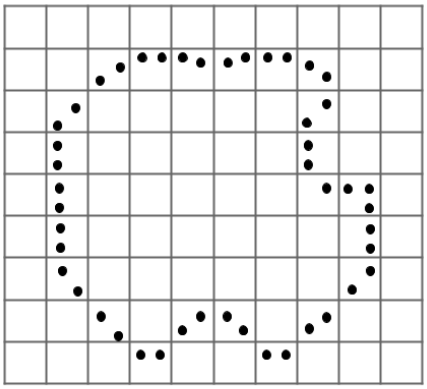


Figure 8: