41

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

MID SEMESTER EXAMINATION **WINTER SEMESTER, 2022-2023**

DURATION: 1 HOUR 30 MINUTES **FULL MARKS: 75**

CSE 4733: Digital Image Processing

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer **all 3 (three)** questions. Figures in the right margin indicate full marks of questions whereas corresponding CO and PO are written within parentheses.

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1. a) Image acquisition consists of two major operations, namely 'sensing' and 'digitization' during the process involved in obtaining a digital image $f(x, y)$ from any scene. How do they affect the size and color information of an image? Explain with necessary illustrations. — 10 (CO1) (PO1)

   b) What are the illumination and reflectance components of an image formation model? How is the intensity level defined from this model? — 3 + 3 (CO1) (PO1)

   c) Consider the two subsets, S_1 and S_2, shown in Figure 1 . For the intensity valid for traversal $V = \{1\}$, determine whether these two subsets are (i) 4-adjacent, (ii) 8-adjacent, or (iii) m-adjacent. Explain your answer(s). — 3 × 3 (CO1) (PO1)

	S_1				S_2				
0	0	0	0	0	0	0	1	1	0
1	0	0	1	0	0	1	0	0	1
1	0	0	1	0	1	1	0	0	0
0	0	1	1	1	0	0	0	0	0
0	0	1	1	1	0	0	1	1	1

Figure 1: Binary matrix for Question 1.c)

2. a) What are the differences between image averaging in time domain and space domain? — 5 (CO2) (PO1)

   b) Which two conditions should a transformation function $T(r)$ satisfy? What are guaranteed by these conditions? — 5 (CO1) (PO1)

   c) Write a short note on the following color models: — 5 + 5 (CO1) (PO1)
      i. HSI
      ii. CMY

d) Consider the 500×500 RGB color image in Figure 2, where the squares are pure red, green, and blue, and each of the colors is at maximum intensity [e.g., (1, 0, 0) for the red square]. An HSI image is generated from this image. 4 + 1 (CO1) (PO1)

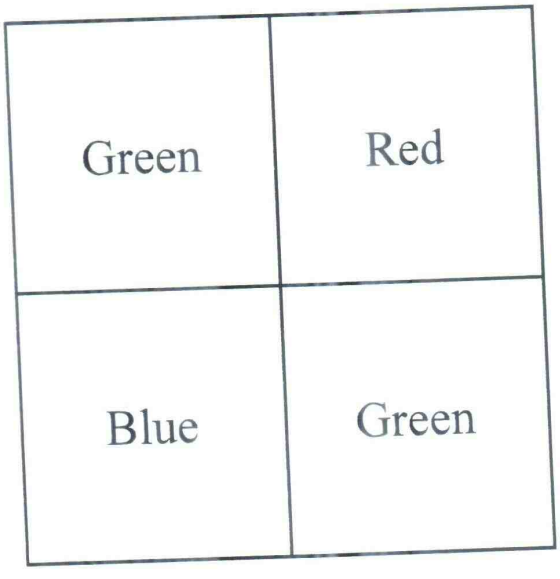

Figure 2: RGB Image for Question 2.d)

i. If we convert this image to HSI, blur the hue component of the image with a 25×25 averaging mask, convert back to RGB, what would the result look like?

ii. Repeat the process mentioned in 2.d)i., but instead of the hue component, we blur the saturation component **S** only. Explain the output.

3. a) Consider the gray-scale image in Figure 3. How can you extract the boundaries of the circular blobs? 6 (CO3) (PO3)

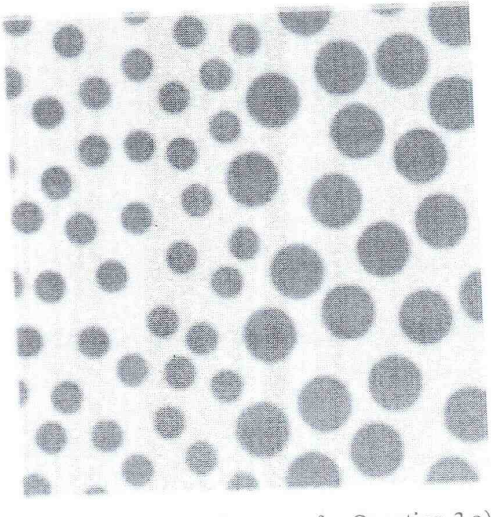

Figure 3: Gray-scale image for Question 3.a)

b) The algorithm for extracting connected components requires that a point to be known in each connected component in order to extract them all. Suppose that you are given a binary image containing an arbitrary (unknown) number of connected components. Propose 10 (CO3) (PO3)

a completely automated procedure for extracting all connected components. Assume that points belonging to connected components are labeled as 1 and background points are labeled as 0.

c) A preprocessing step in an application of microscopy is concerned with the issue of isolating individual round particles from similar particles that overlap in groups of two or more particles. Assume that all the particles are of same size as shown in Figure 4. 3×3 (CO3) (PO3)

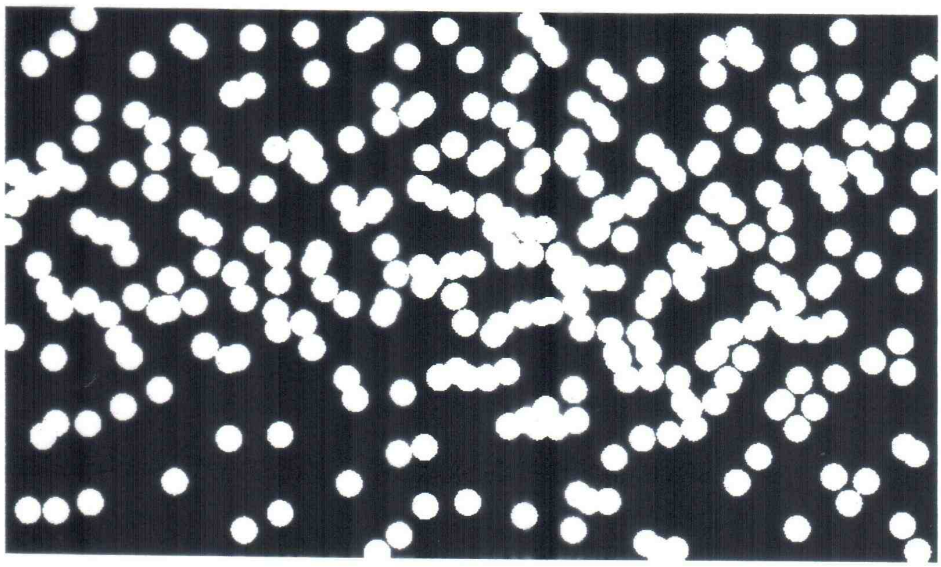

Figure 4: Image with round particles for Question 3.c)

Propose a morphological algorithm that produces three images consisting respectively of:

i. Only particles that have merged with the boundary of the image.
ii. Only overlapping particles.
iii. Only non-overlapping particles.

Note that, all non-overlapping particles ideally have a radius of 11 pixels.