38

UNIVERSITY OF COLOMBO, SRI LANKA

UNIVERSITY OF COLOMBO SCHOOL OF COMPUTING

BACHELOR OF SCIENCE IN COMPUTER SCIENCE
BACHELOR OF SCIENCE HONOURS IN COMPUTER SCIENCE
BACHELOR OF SCIENCE HONOURS IN SOFTWARE ENGINEERING

Academic Year 2020/2021 – Third Year Examination – Semester I – 2021

SCS3205– Computer Graphics I

TWO (2) HOURS

Important Instructions to candidates:

1. The medium of instruction and questions is **English**.
2. If a page or a part of this question paper is not printed, please inform the supervisor immediately.
3. Note that questions appear on both sides of the paper. If a page is not printed, please inform the supervisor immediately.
4. Write your index number on each and every page of the answer paper.
5. This paper has **4** questions and **05** pages.
6. Answer **ALL** questions. All questions carry equal marks (**25** marks).
7. Any electronic device capable of storing and retrieving text including electronic dictionaries and mobile phones are not allowed.
8. calculators are **not allowed**.

1.

(a). In a 2D graphics application, a window end points are given as (0,0), (0,5), (5,5) and (5,0). For line clipping using Cohen-Sutherland algorithm, explain how the region codes can be obtained.

[07 Marks]

(b). Explain how the two lines with end points (1,2) (4.3) and (6,3) (10,5) are handled in this line clipping algorithm using the above window.

[06 Marks]

(c). Geometric transformations are carryout using Homogeneous Coordinates in Computer Graphics. Explain the reasons for this.

[04 Marks]

(d). Prove that a straight line remains as a straight line after the three basic transformations.

[08 Marks]

2.

(a). Describe advantages of using parametric representation of curves and surfaces in Computer Graphics over mathematical representation of equations. [04 Marks]

(b). Describe Bezier curves giving mathematical details. [06 Marks]

(c). Obtain a cubic Bezier curve function for four 3D control points. Prove that the curve passes through the starting and ending control points. [06 Marks]

(d). Explain the following graphics rendering techniques

(i) Flat shading

(ii) Gauraud shading

(iii) Pong shading

[09 Marks]

3.

(a) Briefly explain the difference between *Vector* and *Raster* graphics. [4 marks]

(b)

(i) Spatial filtering is a filtering mechanism that directly perform on the pixels in an image. List **two (2)** nonlinear spatial filters for smoothing. [2 marks]

(ii) List **two (2)** disadvantages in linear filtering mechanism on image smoothing. [2 marks]

(c) Intensity matrix of a segment of an 8-bit gray scale image is given below. Calculate the output of the image processing operations given below only for the highlighted area in the following image. Use 3x3 matrix windows and the replication of intensity values for borders. Show calculations in your answers.

24	34	38	42	44
15	30	45	48	52
40	32	40	45	52
52	40	42	56	58
45	32	48	58	60

(i) Apply MidPoint filter [1 mark]
(ii) Apply Median filter [1 mark]

(d)

(i) List **three (3)** objectives of the Canny edge detection algorithm. [3 marks]

(ii) Following image (figure 1) represent the result of Canny Operator with low and high thresholding. There are two colour variation on edges. The black thick lines represent the strong edges and the thin lines represent the weak edges. By considering the hysteresis thresholding, identify the all-strong edges and justify your selections. [6 marks]

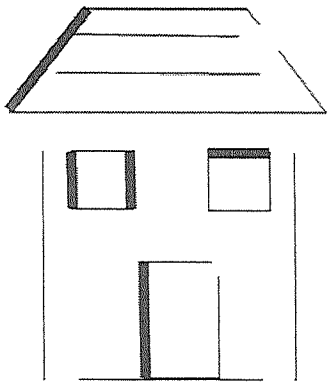


Figure 1

(e) Briefly explain how to perform the first derivative-based edge detection through the derivative values. [6 marks]

4.

(a) Does the intensity histogram of a digital image give some useful clues about the shape of the objects in the image? Justify your answer. [2 marks]

(b) Considering the following two statements specify whether there are **true** or **false** with a brief justification. [4 marks]

(i) "In contrast stretching, there is a one-to-many relationship of the intensity values between the source image and the target image"

(ii) "The original image can be restored from the contrast-stretched image"

(c) Suppose that a 5*5 is a resolution of an 8-bit gray level image f(x,y) with pixel values in {0,1..,7}.

$$f(x,y) = \begin{matrix} 0 & 0 & 1 & 1 & 2 \\ 0 & 1 & 1 & 2 & 4 \\ 1 & 1 & 2 & 4 & 5 \\ 1 & 3 & 4 & 5 & 6 \\ 3 & 3 & 5 & 6 & 7 \end{matrix}$$

(i) Compute the histogram for the original image f(x,y). [2 marks]

(ii) Find the gray level transformation required for the histogram equalization of f(x,y) and plot the histogram of processed image. [4 marks]

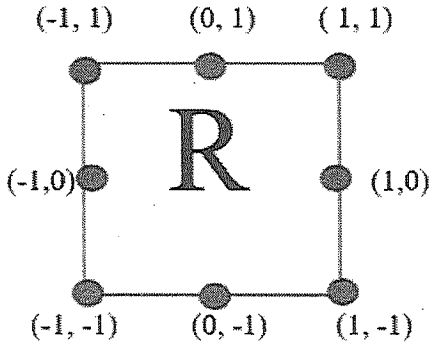
(d) Identify **two (2)** types of image transformations and specify one feature of each one. [3 marks]

(e) I(x,y) and J(x,y) represent the pixel values in the original and translated image respectively. If J(x,y) or the translated image is obtained by moving original image or I(x,y) to the right by 2 pixels with respect to the horizontal axis. And move down in the vertical axis by 6 pixels.

(i) Formulate function for the co-ordinates in translated image J(x,y) by considering the original image co-ordinates. [2 marks]

(ii) For reflection transformation of the translated image on y axis, formulate the corresponding co-ordinates and represent them in a matrix format. [2 marks]

(iii)Following image contains 8 coordinate values. If x direction shearing factor is "b", then apply x direction shearing for the original image and obtain the transformed image. You have to specify all the coordinate points in your answer. [6 marks]



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