| PAPER CODE NO. | EXAMINER : Dr B. Diaz |
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THE UNIVERSITY
of LIVERPOOL

JANUARY 2004 EXAMINATIONS

Bachelor of Arts : Year 3
Bachelor of Engineering : Year 3
Bachelor of Science : Year 3
Bachelor of Science : Year 4
Master of Engineering : Year 3

IMAGE PROCESSING, COMPUTER VISION AND GRAPHICS

TIME ALLOWED : Two Hours and a Half

INSTRUCTIONS TO CANDIDATES

SECTION A: ANSWER ALL QUESTIONS
                    (Section A is worth 50%)

SECTION B: ANSWER ANY 2 OUT OF 4 QUESTIONS
                    (25 marks for each answer; Section B is worth 50%)

If you attempt to answer more than the required number of questions (in any section), the marks awarded for the excess questions will be discarded (starting with your lowest mark).

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Section A

Answer ALL questions in Section A. Section A is worth 50% of the marks available.

A1

In computer graphics what is a *stroke device*? What are the common problems associated with stroke devices?

(3 marks)

A2

An important image processing operator is the *Laplacian filter*. What is it used for? Explain why the following is not a Laplacian filter:

$$
\begin{array}{ccccc}
2 & -1 & -2 & -1 & 2 \\
-1 & -1 & 1 & -1 & -1 \\
-2 & 1 & 6 & 1 & -2 \\
-1 & -1 & 1 & -1 & -1 \\
2 & -1 & -2 & -1 & 2
\end{array}
$$

What is the minimum change required to make it into a Laplacian filter?

(3 marks)

A3

Write out the matrix required to turn the hour hand of an analogue computer clock (centred on the origin) from mid-day to one o'clock.

(3 marks)

A4

Briefly compare the use of the *bitblt* (or *RasterOP*) operator with the Postscript image operator.

(3 marks)

A5

What determines that a computer graphics system is interactive? Give three ways in which interaction is supported in a system with which you are familiar.

(3 marks)

A6

Draw the quadtree that would store a black and white chess-board and comment on whether this would be a sensible use of quadtree representation.

(3 marks)

A7

Where in the human vision system is the blind spot?

(3 marks)

A8

Given two overlapping cubes A and B sketch the result of performing the regularised Boolean set operation $A \cap B$.

(3 marks)

A9

What in computer graphics is meant by the term *geometric curve segment continuity*? Illustrate your answer by describing G^0 and G^1 geometric curve segment continuity.

(3 marks)

A10

Briefly contrast the computer graphics meaning of the term *window* and the operating system meaning of window.

(3 marks)

A11

(a) Sketch the retinal vertical nerve pathway showing in particular the amacrine and horizontal cell layers.

(5 marks)

(b) Explain what the amacrine and horizontal cell layers achieve and comment whether there is an analogue process in computer image processing.

(5 marks)

A12

Illustrate what is meant by raster and vector image representation and contrast their advantages and disadvantages.

(10 marks)

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Section B

Answer any 2 questions in Section B. Section B is worth 50% of the marks available.

B1

(a) Describe briefly the computer graphics rendering technique termed ray casting or ray tracing.

(10 marks)

(b) You are the graphics consultant to a company marketing ready-made kitchen units. The company wants to provide immediate 'computerised impressions' of the units their customers select. Describe the *z-buffer plus Phong shading* rendering pipeline and the *ray tracing* rendering pipeline and write the advice you would give the company on which would be the most appropriate for their application.

(15 marks)

B2

(a) What in computer graphics are *segments*? What are the different functions for handling segments that are defined in the GKS standard?

(5 marks)

(b) Give an example to show how segment transformations might be used.

(5 marks)

(c) Show why the the GKS segmentation scheme is limited when an object consisting of several parts (e.g. a robot arm and hand) is modelled.

(5 marks)

(d) Give an example of an alternative scheme which would handle such an object and illustrate its advantages.

(10 marks)

B3

(a) What is the CIE chromaticity diagram and how is it generated?

(10 marks)

(b) What are the key features of the diagram?

(4 marks)

(c) Describe three ways in which the diagram may be used in computer graphics.

(6 marks)

(d) In the context of the CIE chromaticity diagram what is a colour gamut and how may it be used?

(5 marks)

B4

(a) Describe the Craik-Cornsweet-O'Brien optical illusion and outline a plausible explanation for it.

(15 marks)

(b) Why should designers of rendering algorithms be concerned with this visual phenomenon?

(10 marks)