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THE UNIVERSITY
of LIVERPOOL

JANUARY 2006 EXAMINATIONS

Bachelor of Arts : Year 3
Bachelor of Engineering : Year 3
Bachelor of Science : Year 2
Bachelor of Science : Year 3
Bachelor of Science : Year 4
Master of Engineering : Year 3
Master of Engineering : Year 4
No qualification aimed for : Year 1

COMP307 : 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 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 Section B, the marks awarded for the excess questions will be discarded starting with the lowest mark.

Section A

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

A1

Compare and contrast *bitmaps* and *pixmaps*.

(3 marks)

A2

In computer graphics what is meant by a *viewport*?

(3 marks)

A3

Using rotation and scaling in 2D as examples explain the use of homogeneous transformation in computer graphics.

(3 marks)

A4

Illustrate all the possible results of Boolean intersection of two identical cubes.

(3 marks)

A5

In image processing why does image convolution result in a shrinking of the image size? Describe two ways of avoiding the problem.

(3 marks)

A6

Sketch and label the key elements of the *optic pathway* using colour to identify the pathways from the left and right eye.

(3 marks)

A7

Where in the eye are cone receptors most likely to be found? In what ways do they differ from other light receptive cells that might be found in the eye?

(3 marks)

A8

What are *specular reflections* and how are they dealt with in computer graphics?

(3 marks)

A9

Describe briefly what the CIE chromaticity diagram is, and explain two ways in which it may be used.

(3 marks)

A10

In image processing, describe where histogram splitting and histogram bunching operations might be useful.

(3 marks)

A11

Contrast the key features of a programming language approach, a procedural approach, and an applications package approach to computer graphics.

(10 marks)

A12

Describe with examples the common features of graphical input devices and discuss how they are exploited in a graphics subroutine library with which you are familiar.

(10 marks)

Section B

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

B1

(a) What in computer graphics are segments? What are the standard functions for handling segments to be found in a GKS like graphics system?

(5 marks)

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

(5 marks)

(c) Show why 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)

B2

(a) What are *zero crossings* and why are they an important feature of the Marr hypothesis?

(10 marks)

(b) How does an understanding of human vision explain the computer graphics phenomenon known as Mach banding?

(10 marks)

(c) What techniques may be used to overcome Mach banding?

(5 marks)

B3

(a) Sketch the result when a square tiling and regular 4-shape hierarchy is used with a Morton order tile labelling strategy to place the tiles labelled "0" (zero), "a", "b", and "c" respectively on the atomic tiles of each molecular tile.

(7 marks)

(b) Derive a tesseral addition table for the tiling described in (a) and use this to calculate a result for cab + a0. What in terms of the tiling is the meaning of this addition?

(8 marks)

(c) Contrast the properties that might be useful in computer graphics and image processing of using septrees based on the hexagon rather than the tree produced in (a) above.

(10 marks)

B4

(a) In the computer graphics context what are NURBS?

(5 marks)

(b) Why are NURBS particularly useful in computer graphics?

(8 marks)

(c) Explain with examples the control a user has over NURBS.

(12 marks)