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THE UNIVERSITY
of LIVERPOOL

JANUARY 2005 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
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 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.

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Section A

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

A1

Describe the features of a head mounted virtual reality graphics system that might allow us to classify it as *interactive*.

(3 marks)

A2

In computer graphics what is meant by a subtractive colour mixing system and where may we see it used?

(3 marks)

A3

In image processing what does a *Sobel detector* detect? Why are two Sobel detectors sometimes required?

(3 marks)

A4

What is meant by the term *thresholding* in image processing? Why is it often the first image processing step?

(3 marks)

A5

Where in the human visual system is the *fovea*, and what type of cells are found there?

(3 marks)

A6

Describe the process by which two images (one usually smaller than the other) may be combined. What is the general name for the process?

(3 marks)

A7

In the Marr Hypothesis what is the importance of the 2½D sketch?

(3 marks)

A8

Draw the octtree that represents a 4 by 4 by 4 tower of children's yellow wooden bricks in which one top corner brick has been replaced by a red one.

(3 marks)

A9

Illustrate the *normalisation transformation* and *workstation transformation* features found in GKS.

(3 marks)

A10

Describe the *Necker cube* optical illusion. What two computer graphics methods could be used to avoid it?

(3 marks)

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A11

Postscript is described as a graphical programming language. Contrast its features with a conventional procedural approach to computer graphics.

(10 marks)

A12

Contrast briefly two graphics pipelines with which you are familiar. Which would generate the best result, and why?

(10 marks)

Section B

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

B1 You are required to design and write the program for a simple 3D computer graphics clock which has a square face, two hands, and a day to the week seven sided cylinder with the day of the week written on each facet. The day of the week is visible in a horizontal slot half way between the hands pivot and the bottom of the clock face.

(a) Sketch the clock and outline the *segmentation strategy* you will use to store all elements of the clock.

(7 marks)

(c) Describe the *transformations* you will need to apply to each of the clock segments.
(Assume that the clock moves every minute, and the roller turns at midnight).

(8 marks)

(b) Using an imperative programming language such as C or Pascal, and calls to a graphical subroutine library with which you are familiar, sketch a program that would realise the clock.
(Assume that `system()` is a system function that returns the integer number of minutes since Sunday midnight)

(10 marks)

B2

(a) What in human vision is meant by the term *lateral inhibition*? Illustrate your answer with suitable diagrams.

(15 marks)

(b) Why should lateral inhibition be a concern in virtual reality scene synthesis, and how could it be resolved?

(10 marks)

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B3

(a) Describe the principal features you might expect in a commercial image processing system intended for satellite images.

(10 marks)

(b) Would such a system be suitable for analysing image sequences such as those produced by an in-store video system?

(5 marks)

(c) Briefly outline what is meant by recursive filtering. Given a sequence of face images would it be appropriate (in image processing terms) to use *recursive filtering* to improve the face?

(10 marks)

B4

(a) Describe three ways in which 3D objects may be modelled in computer graphics commenting especially on how smooth surfaces are modelled using each technique.

(12 marks)

(b) Define G^0 and G^1 continuity, and comment on their relevance to the three models you described in (a) above.

(5 marks)

(c) Discuss the problems and costs associated with generating smooth surfaces commenting especially on application areas where smoothness may be critical.

(8 marks)