Two hours

QUESTION PAPER MUST NOT BE REMOVED FROM
THE EXAM ROOM AND MUST BE RETURNED

**UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE**

Computer Graphics and Image Processing

Date: Thursday 29th May 2014

Time: 14:00 - 16:00

Please answer each of the 20 multiple-choice questions in SECTION A writing your answers directly on the question paper.

**Also answer ONE Question from Section B
AND
also answer ONE Question from Section C**

Use a SEPARATE answerbook for each of Section B and Section C

This is a CLOSED book examination

The use of electronic calculators is permitted provided they are
not programmable and do not store text

*Section A is restricted and cannot be published*

Section B

Answer *one* question from Section B.

1. *Note: Illustrate all your answers with clearly-drawn diagrams and sketches.*

   a) Given the statement: "In Computer Graphics, everything is an approximation", explain what you understand by this, in terms of modelling and rendering.

   (4 marks)

   b) What is meant by the term "scan conversion"? Illustrate your answer by describing a method to efficiently scan-convert a triangle. (4 marks)

   c) Explain how the "z-buffer" is used for removing hidden surfaces from rendered views of 3D models. (4 marks)

   d) Explain what is meant by the following terms, and for each give an expression which enables numerical pixel values to be computed. Be sure to illustrate your answers with clear diagrams, and explain the meaning of any constants, variables and vectors you refer to.

   i) ambient illumination (2 marks)
   ii) diffuse reflection (2 marks)
   iii) specular reflection (2 marks)

   e) What are the limitations of a Local Illumination Model? (2 marks)

2. *Note: Illustrate all your answers with clearly-drawn diagrams and sketches.*

a) What is a limitation of using a 3×3 matrix to represent 3D transformations?

(1 mark)

b) Explain how the above limitation can be overcome, and illustrate your answer by writing down a matrix corresponding to an suitable transformation of your choice.

(2 marks)

c) In 3D computer graphics, what is the function of "the camera" ? In your answer, describe what is meant by the following terms, illustrated with clear diagrams. Note: you are expected, in your answer, to describe the matrices used to implement the camera, but you are **not expected** to write down the elements of those matrices.

(12 marks)

    i. the duality of viewing and modelling
    ii. the camera's coordinate system
    iii. perspective projection
    iv. the near and far clip planes

d) Look at the diagram below, and explain how to derive a single transformation matrix which scales the cow by (s, t, u) with respect to the vector B. B does not pass through the origin, and is not embedded in the XY, XZ or YZ planes. For each transformation you use, you need only describe its effect – you do not need to write down the elements of the matrix.

(5 marks)
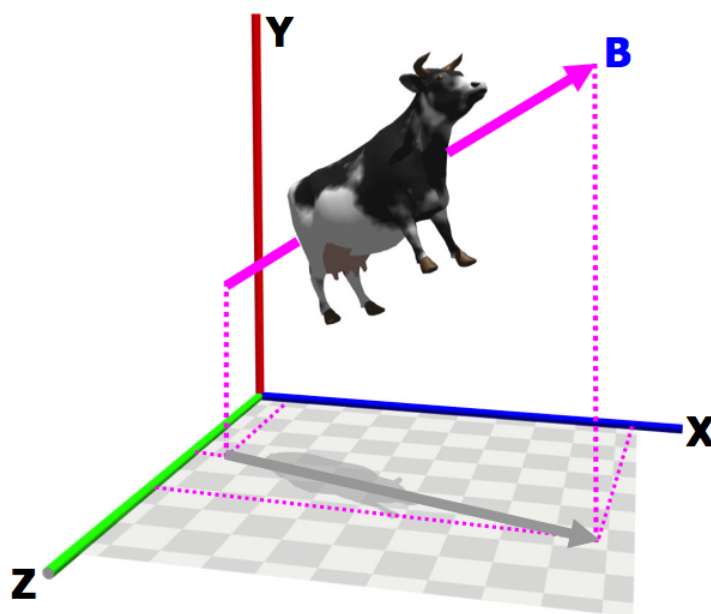
Section C

Answer *one* question from Section C

3. Your face can be used as a biometric identifier.

a) Discuss BRIEFLY what this means. (2 marks)

What features on a face are useful in the context of biometrics? (2 marks)

b) Describe the image processing techniques you could use to locate and recognise these features. (5 marks)

c) Once you have located the features, how will you make measurements that could be used biometrically? (5 marks)

d) How will the direction that the person is facing affect your measurements? If a correction is needed, how will you determine it? (4 marks)

e) How will you go about evaluating the accuracy of your system, that is determining what proportion of people are likely to be identified correctly, what is the probability of the system misrecognising an individual?

(2 marks)

4. You have been commissioned to design the software for a system that will monitor traffic crossing an urban intersection such as the Oxford Road / Booth Street crossroads between the Business School and RNCM buildings. The aim is to count the numbers of vehicles passing through all combinations of entries and exits of the junction, e.g. Oxford Road to Booth Street West, Oxford Road to Oxford Road, Oxford Road to Booth Street East and so on. We are also interested in investigating the paths vehicles take through the junction.

    Each part of the answer should include diagrams as appropriate and details of the algorithms you have selected.

    a) What criteria will you use to inform your choice of the, number of cameras and their position(s), focal length (remembering that this influences the field of view) and number of pixels in the image   (6 marks)

    b) Assuming that you have a suitable image, how will you identify the regions that correspond to the individual vehicles?   (4 marks)

    c) Further assuming that this has been done for an image captured at a short time earlier, how will you match the pairs of vehicles in the pair of images?
                                                                              (4 marks)

    d) You now have a sequence of blobs that represent the instantaneous locations of the vehicles. How will you reduce each of these to a point, and how will you then register the path the vehicle has taken through the junction?   (4 marks)

    e) Once this has been done for a large number of vehicles you will have a database of paths. How could you process this to find the most followed paths through the junction?   (2 marks)