Two hours - online

The exam will be taken on line.
This paper version is made available as a backup
In this event, only MCQ answers written in the boxes on the exam paper will be marked.

Use a SEPARATE answerbook for Section B.

EXAM PAPER MUST NOT BE REMOVED FROM THE EXAM ROOM

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Computer Graphics and Image Processing

Date: Thursday 17th May 2018

Time: 09:45 - 11:45

Please answer all Questions.

This is a CLOSED book examination

The use of electronic calculators is NOT permitted

Section A contains multiple choice questions (MCQs) and is restricted for publication

Section B

Answer every question from Section B.

1. Describe the fundamental difference between fixed and programmable graphics pipelines. (1 mark)

2. Give two examples of the undesirable results caused by approximation in computer graphics. (1 mark)

3. With reference to Figure 1, explain the steps of first determining the coordinates of the centre P of the cow (all the vertices are stored in a file F), and then deriving a single composite transformation C that scales the cow by a 3D scale S with respect to P. In your answer you are not required to write the coefficients inside transformation matrices. (3 marks)

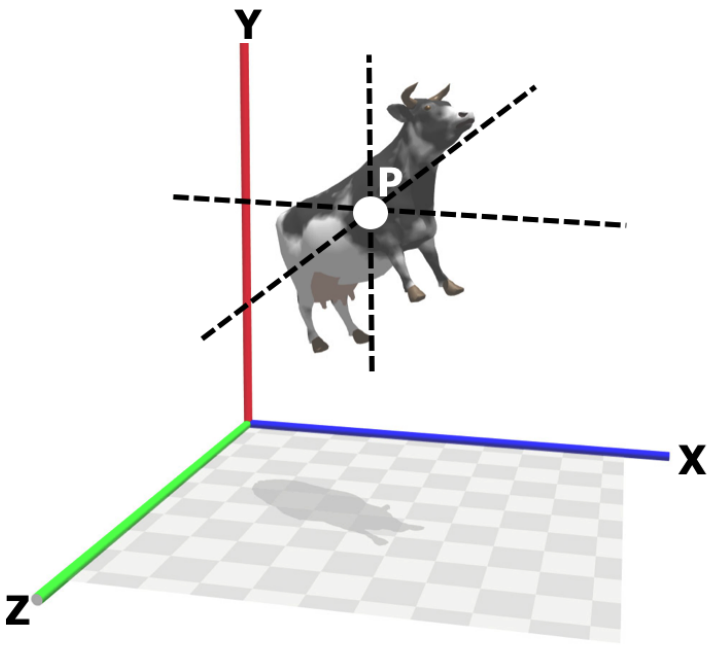

Figure 1

4. For each of the following, give an example of its application in computer graphics:

   (a) vector cross product

   (b) similar triangles

   (c) clipping

(3 marks)

5. Describe what is meant by tessellation, and when it is necessary. (2 marks)

6. Describe a hidden surface removal technique that operates in display-space. (3 marks)

7. Explain how the principle of duality is used to create a view of a 3D scene taken by an imaginary camera. In your answer focus on concepts, not detail. You are not required to derive any coordinate systems or write the coefficients inside transformation matrices. (2 marks)

8. With reference to the expression shown in Figure 2, explain the function of the part inside the square brackets, defining each term and its range of values. (7 marks)

$$I = k_a I_a + \frac{I_p}{d'}\left[k_d(\hat{\mathbf{N}} \cdot \hat{\mathbf{L}}) + k_s(\hat{\mathbf{R}} \cdot \hat{\mathbf{V}})^n \right]$$

Figure 2

9. Thresholding can be used to separate objects from background if the object's brightness or colour differs from the background.

   (a) Describe how an object of a different colour would be separated from the background.

   (b) How can this method be modified to cope with changes in apparent colour due to lighting changes?

   (c) The algorithm might well fail if there is an illumination gradient. What is this and how can the algorithm be modified?

(4 marks)

10. "Affective computing" is a term used to describe processes of determining a computer user's emotional state and hence making computer systems more responsive. One area of research is interpreting a facial image to recognise an emotion. Figure 3 shows a typical front face image. The area between the hairline and chin are important for expressing emotion.

    (a) What landmarks on the face will let you find the important area?

    (b) How would you identify these landmarks?

    (c) Having identified the landmarks, how will you define the region of interest?

    (d) What techniques could you use to recognise the expression associated with "happy"?

    (5 marks)

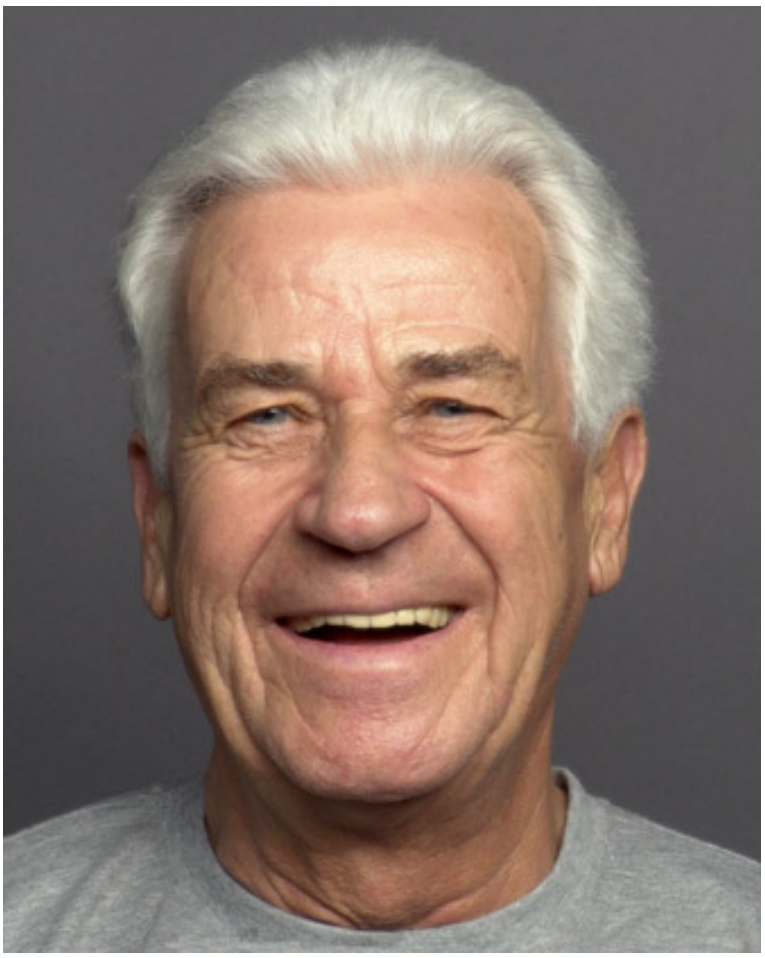

Figure 3

11. How is a scale space constructed? Why do you think a scale space is a useful tool for object detection? (4 marks)

12. Define an edge. Give one of two template-based techniques for detecting edges in the presence of noise. (2 marks)

13. You've been asked to design software to identify broken biscuits on a production line. You can assume that you have images taken from an overhead camera, whole biscuits are circular and biscuits do not overlap. The biscuits are on a differently coloured surface.

    (a) How will you decide which pixels are biscuits and which aren't?

    (b) How will you group the pixels that belong to individual biscuits?

    (c) What is a suitable description for the shape of the biscuit?

    (d) How will you compute the shape?

    (e) What output would you expect for a circular biscuit?

(5 marks)

END OF EXAMINATION