Two hours

The exam will be taken online.
This paper version is made available as a backup
In this event please use a separate answerbook for each section.

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Advanced Computer Graphics

Date: Tuesday 17th January 2017
Time: 09:45 - 11:45

Please answer BOTH Questions

This is a CLOSED book examination

The use of electronic calculators is NOT permitted
Section A

1. a) Figure 1 shows a possible triangulation of 8 points A-H. What are three undesirable properties of this triangulation, and why are they undesirable? (3 marks)

![Figure 1](image)

b) Describe the basic principles of a technique for creating a triangulation of a point cloud that helps to eliminate the properties you described in the previous question. (2 marks)

c) What is the ‘occlusion problem’ in laser scanning? (1 mark)

d) Describe two different techniques for attempting to solve the occlusion problem. (4 marks)

e) You are building a real-time computer graphics simulation of lightning hitting a tree. Describe suitable techniques for modelling and rendering the scene. (4 marks)

f) What is meant by the term ‘calibrated camera’ in the context of estimating 3D geometry from photographs? (3 marks)

g) Explain how automatic feature detection is used in the estimation of 3D geometry from a video sequence. (3 marks)
2. a) In classical Whitted Ray Tracing, why is it common to trace rays by starting from the eyepoint and ending at light-sources and not the other way round? (1 mark)

b) What is the role of shadow feelers in Whitted Ray Tracing? (1 mark)

c) In a scene that is lit by a single spotlight facing towards all the objects, describe what happens when a primary ray encounters a silver mirror. (2 marks)

d) In the same scene, what happens when a ray encounters a sphere made of green glass? (2 marks)

e) In the same scene, what happens when a ray encounters a cube covered in a matt material such as velvet? (2 marks)

f) Why is it difficult to render velvet effectively using Ray Tracing? Which alternative photo-realistic rendering technique might be used to give a better result? Briefly explain why. (3 marks)

g) Select and name one of the data structures from Figure 2, and explain how it could be used to accelerate the process of Ray Tracing. (2 marks)

h) Which two of the data structures in Figure 2 would be appropriate for storing volumetric data to be used for Direct Volume Rendering? Explain which would work best for dense data resulting from a geological scan, and which for more sparse data such as a CT scan of an archaeological object inside a locked box. In each case, name the data structure and explain its use. (3 marks)
i) Briefly describe a process of Direct Volume Rendering and a process of Indirect Volume Rendering, then compare and contrast the pros and cons of these approaches when used in the context of a medical application such as the detection of a tumour within healthy tissue.

(4 marks)