Two hours - online

The exam will be taken on line.
This paper version is made available as a backup.

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Advanced Computer Graphics

Date: Wednesday 17th January 2018
Time: 09:45 - 11:45

Please answer all 12 Questions.

This is a CLOSED book examination
The use of electronic calculators is NOT permitted
Answer all questions

1. What characterises a shape which is categorised as ‘fractal’? As part of your answer describe two different kinds of fractal objects or phenomena. (3 marks)

2. In grammar-based generative modelling, explain how branching effects can be defined, and how they are implemented in the engine which processes the grammar. (3 marks)

3. Explain how the principle of duality relates to laser scanning, and in your answer refer to two real-world scenarios. (2 marks)

4. A company has created a very large and very high resolution geometrical model of an aeroplane, using simple CAD tools and a large team of modellers. Comment on the constraints of this approach to creating very large models. (2 marks)

5. The company in the previous question wishes to make a version of the model available for remote clients to explore, but without providing client access to the full model database. Describe an approach for achieving this, and discuss its advantages and disadvantages. (4 marks)
6. Figure 1 shows a triangle mesh. Describe a method for simplifying this mesh. In your answer discuss what constraints should be applied as part of the simplification.

![Figure 1.](image)

(3 marks)

7. Explain how automatic feature detection is used in the calibration of video sequences.

(3 marks)

8. Explain the purpose of the Rendering Equation. With reference to Figure 2, what do the expressions marked A and B represent? (You do not need to define each individual variable)

\[
L_0(x, \omega, \lambda, t) = L_0(x, \omega, \lambda, t) + \int_{\Omega} f_r(x, \omega', \omega, \lambda, t) L_1(x, \omega', \lambda, t)(-\omega' \cdot n)\delta \omega'
\]

![Figure 2.](image)

(5 marks)
9. A big company has commissioned a new building, the foyer of which is made from polished marble and steel and leads to offices that have glass walls. They want to create a video of a walkthrough from the outside of the building, through the foyer and into one of the offices. A polygonal model describing the geometry and material already exists. They have heard about Ray Tracing, Radiosity and Volume Rendering and approach you for advice on which to use for this scenario. Which technique would you suggest they use? Justify your choice with respect to the alternatives. (3 marks)

10. Explain how the rendering process you chose in the previous question operates, and how it models the physical properties of glass and polished marble. (4 marks)
11. Using one of the parts (a to d) in Figure 3, describe an appropriate data structure that could be used to optimise the rendering process you have chosen in the previous two questions. Describe how the data structure would be populated from the company’s building model, and explain how it helps accelerate the rendering process.

Figure 3.

(4 marks)
12. At the last minute, the company decide they would like to include models of the soft furnishing and lighting in the social space of their building. Explain any computational problems with using your current approach to model the diffuse materials in this space. Describe and justify an alternative approach that could be used to capture the properties of soft furnishings, and explain how this might be combined with your original proposal. 

(4 marks)