Advanced Computer Graphics

Date: Monday 21st January 2013
Time: 09:45 - 11:45

Please answer any TWO Questions from the FOUR Questions provided.

Use a SEPARATE answer book for each SECTION.

This is a CLOSED book examination

The use of electronic calculators is NOT permitted
Section A

1. Illustrate your answers with diagrams and sketches throughout.

   a) Explain the principles of 3D laser scanning, and in your answer address the following:

      i) the geometry of the laser/camera system (2 marks)
      ii) derivation of the range (distance) values (2 marks)

   b) Discuss approaches to the process of converting raw laser scanner data into sets of triangles for rendering. In your answer, address the following issues:

      i) Alignment of data from multiple scans (4 marks)
      ii) Simplification of data sets (2 marks)
      iii) Choosing appropriate triangulations (2 marks)
      iv) Repairing holes in the mesh caused by occlusions and missing data (3 marks)

   c) For what kinds of model are polygonal representations unsuitable, and why? (2 marks)

   d) Explain the concepts behind modelling using L-systems. Illustrate your answer with a worked example. (3 marks)
2. Illustrate your answers with diagrams and sketches throughout.

a) What are the advantages and disadvantages, compared to manual interactive approaches, of methods which allow the semi-automatic construction of geometric models by processing images?  
(2 marks)

b) In the context of camera calibration, explain what is meant by the following terms:

i) intrinsic camera parameters  
(3 marks)

ii) extrinsic camera parameters  
(3 marks)

iii) lens distortion  
(3 marks)

c) What is the camera calibration matrix?  
(3 marks)

d) Describe two different methods by which we can estimate the camera calibration matrix.  
(2 marks)

e) Explain how feature detection is used when calibrating a video sequence  
(4 marks)
Section B

3. a) Explain how global illumination techniques differ in their aims from local illumination models

(3 marks)

b) Using a suitable diagram (a 2D scene is sufficient for full marks), describe the principles and process of ‘classic’ Whitted of Ray Tracing. Include in your description the role of primary, reflection/refraction and shadow feeler rays

(6 marks)

c) Describe the process principles and process of Radiosity. In your answer refer to the role of patches, the form factor and a mechanism of calculating occlusion between patches.

(6 marks)

d) Discuss the pros and cons of Radiosity and Ray Tracing, referring in particular to how they deal with shadows. In both cases, propose a mechanism for improving the representation of shadows.

(5 marks)
4. a) What is the purpose of spatial enumeration? Give an example of its use in the context of a realistic rendering technique, and another example of an interactive computer game. (4 marks)

b) With the aid of suitable diagrams, describe the following spatial enumeration techniques. For each comment on their space and time complexity.

   i) Gridcell (3 marks)
   ii) Octree (3 marks)
   iii) Hierarchical Bounding Volume (3 marks)
   iv) Binary Space Partitioning (3 marks)

c) Describe a spatial enumeration technique suitable for improving the real-time performance of rendering a large city-like environment. Assume that the user is constrained to travelling around the city at ground level, and that the buildings are largely cuboid in shape. (4 marks)