University of Bath

DEPARTMENT OF MATHEMATICAL SCIENCES
EXAMINATION

Advanced Computer Graphics

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wwwww, ddd January 1998, tttt–tttt

No calculators may be brought in and used.

Full marks will be given for correct answers to THREE questions.
Only the best three answers will contribute towards the assessment.

Examiners will attach importance to the number of
well-answered questions.

1. Describe the use of mesh models as a means to producing realistic pictures. Pay particular attention to

   (a) data representations,

   (b) hidden surface removal,

   (c) lighting models.

   (a) is a data structure description, which should show that (e.g.) vertex values are held just once, though shared by several triangles. A diagram is essential.

   (b) expects a coarse cull (triangles facing away from the viewer) followed by a ordered rendering, such as an incremental scan-line approach. The latter should be fully described, given that this is a major part of the whole question.

   (c) expects Gouraud and Phong to be described, in the context of a scan-line renderer. You should explain the lighting model physics and the implementation of each.

   How efficient is such an approach?

   scan-line methods are quite efficient, in particular we can combine rendering the basic geometry, rendering the effect of lighting and hidden surface in a single pass. They are low on memory usage.

2. What is *temporal aliasing*, and why does it occur?

   A sampling problem due to frames being at discrete time positions. It manifest itself in smooth linear movements appearing jerky; or in rotational movements appearing to go at the wrong rate. Extreme variants result in linearly-moving objects never being seen; and in rotations appearing to go backwards.

   It occurs if the times are point-sampled, when they should be interval sampled.

   Describe in detail Cook's method for reducing temporal aliasing.

   This is straight from the notes but needs some care to get it right.

   Explain what trade-off is made in Cook's method, and outline ways it might be reduced.

   Trades more noise in the picture for less temporal aliasing. In effect the 'incorrect' data is still there but it is scattered as noise energy, which is less objectionable to the eye. All aliasing problems can be reduced by prior filtering to limit the frequency range to be within that of the sampling method.

3. Write an essay on projective geometry and its application to graphics.

Start by explaining projective geometry, why Euclidean is not good enough. A sketch of the projective plane idea: a disk with extra points around the edge, with the opposite points being the same. Relate this to parallel lines meeting at infinity and how the intersection point of two non-parallel lines moves to infinity and back again from the 'other' side as the lines rotate.

Now relate to graphics, in particular homogeneous coordinates, perspective, 1/2/3 point perspectives etc.

4. Describe each of the following colour models

(a) RGB,

(b) HSV,

(c) CMYK,

(d) YUV.

Straight from notes.

Show how to convert from RGB to each of these models.

Straight from notes.

Why are there so many ways of describing colour?

Colour is a mixture of physics, psychology, the eye and cultural effects. Applications range widely, with different characterstics being important in each case. The way we manipulate colour also varies. Brief examples to make these points e.g. frequency makes sense for spectra but not for a web-page designer.