THIS PAPER IS NOT TO BE REMOVED FROM THE EXAMINATION HALLS

UNIVERSITY OF LONDON **CO3343 ZA**

BSc Examination

CREATIVE COMPUTING

Computing Art and Image Effects

Thursday 21 May 2015 : 10.00 – 12.15

Duration: 2 hours 15 minutes

There are FIVE questions on this paper. Candidates should answer **THREE** questions. All questions carry equal marks and full marks can be obtained for complete answers to **THREE** questions. The marks for each part of a question are indicated at the end of the part in [.] brackets.

Only your first **THREE** answers, in the order that they appear in your answer book, will be marked.

There are 75 marks available on this paper.

A hand held calculator may be used when answering questions on this paper but it must not be pre-programmed or able to display graphics, text or algebraic equations. The make and type of machine must be stated clearly on the front cover of the answer book.

1.

(a) Choose a work of Uccello or Piero della Francesca, discussed in the subject guide.

(i) Describe the painting in terms of *composition* and use of *perspective*, explaining how internally consistent the representation is. You may refer to how parts of the picture are connected by whole lines, implied lines (such as pointing gestures) or in other ways.

[5]

(ii) Create a simple line sketch to illustrate the main parallel lines of *recession* and the main lines of *connection* between different elements of the picture. Use different colours or line styles to distinguish between the lines.

[4]

(b) Based on the viewpoint they assume and the sense of depth they provide, compare perspective and orthographic projections. What extra information is needed to calculate the former compared to the latter?

[4]

(c) Draw a diagram to illustrate the observer's perspective view of a tiled floor. Include the horizon, the vanishing point and the distance points. Also include the construction lines from the vanishing and the distance points.

[5]

(d) Assume a given three-dimensional Cartesian coordinate position (x,y,z) and consider an observer's viewpoint at (0,0,0) and a projection plane perpendicular to the z axis, with distance d from the origin. Specify how to calculate the projected position (x_p,y_p,z_p) for each of the orthographic and perspective projections.

[3]

(e) Assuming perspective projection and an observer at the origin and looking along the negative z axis, calculate the (x_p,y_p) projected coordinates of a point at (-48,15,-6) with the view plane being at z=-2. Show your working.

[4]

2.

(a) Briefly describe the functionality of the camera obscura.

[3]

(b) How did Leonardo see the widespread use of mechanical devices for accurate perspective representation?

[2]

(c) Name and briefly describe two perspective aids that Vermeer used in his paintings, as suggested by analysts.

[4]

(d) Describe a painting that illustrates Vermeer's use of linear perspective.

[4]

(e) Name three technologies used for presenting stereoscopic images.

[2]

(f) Let A.jpg be a square image that consists of NxN blocks of pixels. Each block has size bxb pixels. Write Processing code that

(i) Reads the image.

(ii) Creates a new image such that the pixel values of each block with position (i,j) are set to be the pixel values of the initial block (i, N-j).

(iii) Displays both images side by side.

[6]

(g) Describe the effect of the image processing specified in (f) in terms of the difference between the input and the output images. Include an appropriate sketch to illustrate your answer. Explain what happens in the following cases: (i) b=1 and (ii) b=N.

[4]

3.

(a) With regard to the process of filtering out unnecessary parts of a complex 3D scene before rendering, describe three main categories of objects/surfaces that can be safely discarded, as they will not be visible to the observer. Sketch simple diagrams to illustrate your answer as appropriate.

[5]

(b)

(i) In the case of surface rendering, explain why drawing order is more important for the appearance of facetted objects compared to an edges-only representation.

[2]

(ii) Give a brief description of the Painter's algorithm for rendering opaque facets, referring to the problem it addresses

[2]

(iii) Describe what arrangements need to be made to the facet drawing order, so that the Painter's algorithm can be applied.

[2]

(iv) Discuss the problem that can occur when drawing intersecting facets using the Painter's algorithm and explain how it can be treated.

[2]

(c)

(i) Explain the basis of forming a body of revolution in terms of how a semi cross-section is defined and moved, including a description of how facets are generated with vertices stored in a consistent, clockwise order when seen from outside.

[5]

(ii) Write Processing code that generates 5 uniformly spaced points on a vertical semi-circle in the x-y plane, where the circle is centered at the origin, has a radius of 1 and the x-values are non-negative.

[3]

(iii) Consider that the semi-circle from (ii) is used to generate an approximation to a sphere in ACTUAL space, with 4 equal increments in angle between vertical sections. Calculate the (x,y,z) values of each of the 8 distinct vertices in the first two vertical sections, that in turn define the first vertical segment of 4 facets (first and fourth triangular, second and third quadrilateral).

[4]

4.

(a) Compare the work of Vermeer and Seurat with respect to the use of colour and the technique of paint application to express highlights and shadows in their paintings.

[5]

(b) Assume that you want to represent (a) a flat-facetted surface and (b) a facetted sphere. If you are given the choice between flat and Phong shading, which one would you use in each case and why?

[4]

(c)

(i) What simplifications are made regarding the calculations of shadow casting in the subject guide?

[2]

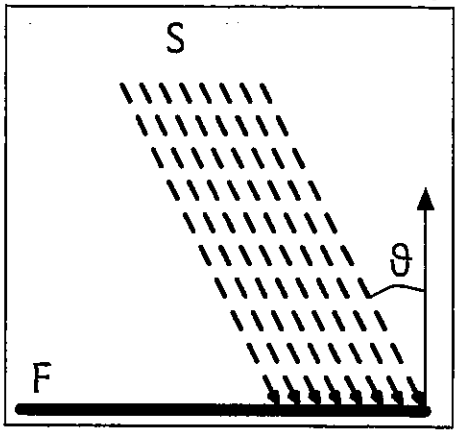
(ii) Explain how, given those simplifications, the overall calculation reduces to an extension of the hidden surface problem.

[3]

(d) Provide the expression that models the variation of light intensity on a matt surface depending on the angle of incidence of the light.

[1]

(e) Consider a light source S of colour $C_S=(R_S,G_S,B_S)$ and a matt facet F of colour $C_F=(R_F,G_F,B_F)$, as represented in RGB with each component in the range [0,1]. Let a part of the facet be directly illuminated by the light source, with an angle of light incidence of θ radians to the facet normal. This part of the facet is illuminated by S in proportion $(1-\alpha)$, while ambient light contributes the remaining proportion α, with α within [0,1].



(i) Derive an expression for the reflected colour of the part of the facet that is directly illuminated.

[4]

(ii) Derive an expression for the reflected colour of the part of the facet that is in the shadow.

[3]

(iii) For the facet of part (e), calculate the reflected colour for both the illuminated and the non-illuminated parts, if $C_F=(0.8,0.7,0.7)$, $C_S=(0.1,0.3,1)$, $\alpha= 0.5$, and $\theta=\pi/3$.

[3]

For your calculations, consider the light source to be distant to the facet.

5.

(a) Explain how the invention of photography in the nineteenth century influenced the way artists worked at that time. What aspects of image making draw the attention of Monet and Munch? Which techniques did they use to approach these aspects?

[6]

(b) Explain why lower image detail is acceptable in moving, as opposed to still, imagery. How is this exploited in the production of movies and animation?

[4]

(c) Given a set of images generated as an animation and stored in files named sequence-0001.tif to sequence-0200.tif, write a Processing draw() method that animates the sequence, in the frame order specified below, by both loading and displaying the appropriate image in each iteration. Briefly explain each line of active code with an in-line comment. Show the declarations of any variables that need to be made outside draw().
Display the first and the fifth of every five frames of the sequence.
Thus, the desired display order is 1, 5, 6, 10, 11, 15 etc.

[7]

(d) For the images and program in (c), if the images had been saved in .jpg format with the same width and height, what would be the effect, in general terms, on a) stored file size and b) playback animation rate?

[1]

(e) Specify the mask and the operation of the Sobel operator.

[2]

(f) Consider the grey level pixel array: $\begin{pmatrix} 18 & 18 & 3 & 3 \\ 10 & 10 & 1 & 3 \\ 10 & 10 & 3 & 2 \\ 16 & 18 & 3 & 1 \end{pmatrix}$.

Calculate the integer values of the 4 internal (non-edge) pixels in the array resulting from applying the Sobel mask.

[5]

END OF PAPER