THIS PAPER IS NOT TO BE REMOVED FROM THE EXAMINATION HALLS

UNIVERSITY OF LONDON **CO3343 ZB**

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 Massaccio or Vermeer, 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 (-28,49,-7) with the view plane being at z=-4. Show your working.

[4]

2.

(a) Which artist is considered to have had a strong influence on Picasso's work on perspective flattening? Name and describe one of his works that demonstrates this effect.

[4]

(b) Describe an early Cubist painting of your choice in terms of subject, composition and execution.

[4]

(c) Which artist also experimented beyond the representation of a single viewpoint, hundreds of years before the Cubists? Name and briefly describe a work of his that exemplifies this.

[3]

(d) What limitation in depth modeling stems from disregarding of stereoscopic vision by considering an observer with a single eye? How did early artists overcome this?

[2]

(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, of size bxb pixels each. 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 (N-i, 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) Discuss the benefits and drawbacks of using a facetted vs an analytic representation for objects with curved surfaces, such as a sphere. Include a simple sketch to illustrate your point.

[5]

(b)

(i) Describe the process of defining data for a three-dimensional facetted body in SETUP position. A correct answer is expected to specify how facet data (such as vertices and edges) are properly stored in corresponding arrays.

[4]

(ii) Name the three basic spatial transformations that can be used in ACTUAL space to derive multiple instances of an object described in SETUP space. Explain how this is done, including data structure definitions.

[4]

(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 4 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 2 and the y-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 horizontal sections. Calculate the (x,y,z) values of each of the 6 distinct vertices in the first two horizontal sections, that in turn define the first vertical segment of 3 facets (first and third triangular, second quadrilateral).

[4]

4.

(a) Provide an explanation for Seurat's rationale for colouring shadows with a complementary colour. Does the colouring principle correspond to what you might expect if you measure colour component intensities in an actual shadow area? Explain what considerations apply and how they influence the colour actually reflected from a surface illuminated from the given direct light source, such as the sun.

[5]

(b) What compromise has been made in the software provided with the subject guide with respect to indirect illumination? How is this compensated by the Phong reflectance model and what are the side effects of this compromise?

[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]

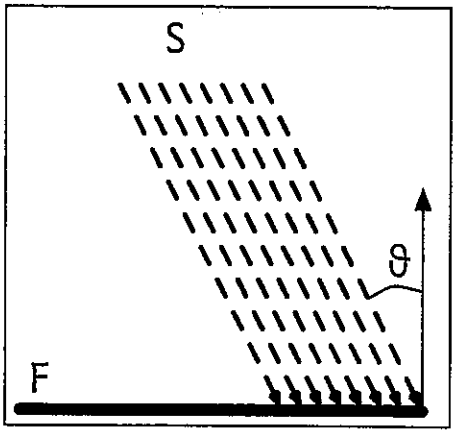
(e) Consider a light source S of colour $C_S=(R_S,G_S,B_S)$ and a matt facet F of colour $C_F=(R_F,G_F,B_F)$, as represented in RGB with each component in the range [0,1]. Let a part of the facet be directly illuminated by the light source, with an angle of light incidence of θ radians to the facet normal. 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 $C_F=(0.4,0.9,0.9)$, $C_S=(0.8,0.8,0)$, $\alpha= 0.5$, and $\theta=\pi/6$.

[3]

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

5.

(a) List the main characteristics of impressionist painting and describe how they are illustrated in an appropriate painting discussed in the subject guide or the essential reading.

[4]

(b) Briefly describe the main elements of a set of paintings that are representative of Arcimboldo's representational technique.

[3]

(c)

(i) What is the maximum frequency, in oscillations per frame, that can be shown in an animation sequence? What is this frequency called?

[2]

(ii) Briefly explain how frequencies higher than the aforementioned one can appear as aliased, lower frequency vibrations.

[2]

(d) 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 second and the fourth of every ten frames of the sequence. Thus, the desired display order is 2, 4, 12, 14, 22, 24 etc.

[7]

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

[2]

(f) Consider the grey level pixel array: $\begin{pmatrix} 10 & 10 & 3 & 3 \\ 18 & 18 & 1 & 3 \\ 16 & 18 & 3 & 2 \\ 10 & 10 & 3 & 1 \end{pmatrix}$.
Calculate the integer values of the 4 internal (non-edge) pixels in the array resulting from applying the Sobel mask.

[5]

END OF PAPER