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

Monday 19 May 2014 : 14.30 – 16.45

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) Explain how the position of a vanishing point and the corresponding distance points determine the optimal distance of the viewer from a painting.

[2]

(b) Paolo Uccello's attempt to use linear perspective resulted at times in unrealistic representations of his scenes. Describe a mistake that he made and give examples in how this affected one of his paintings.

[3]

(c) In the process of looking at a brick wall (and its lines of brick joints) receding away from us to both the left and right, we do not perceive it as the same size at the centre as away from it.

(i) Give a simple explanation of this effect, in terms of perspective

[3]

(ii) Briefly describe and compare two representation approaches that have been devised by artists to tackle this problem. Illustrate your answer with simple line diagrams for the effect with a pair of horizontal parallel lines.

[5]

(iii) Why these models are not complete? Which extra considerations need to be made for a complete model?

[2]

(d) Consider a wire frame cube of side length 8 units oriented to a viewer so that one pair of opposite facets is normal to the observer's line of sight, which passes through the centre of that pair of opposite facets. The observer's eye is at the origin. Let the nearest facet to the observer be at z=-8 and the furthest be at z=-16. Also let the ViewPort be of width 3.5 and height 2 at position z=-d, where d>0. The sides of the view window are aligned with the sides of the cube facets that are normal to the viewer's line of sight, so that the edges of these facets appear horizontal or vertical to the viewer.

(i) Calculate the minimum value of d so that two of the edges of the cube do not lie within the ViewPort in a perspective projection.

[2]

(ii) Calculate the maximum value of d so that only the four edges of the facet furthest from the observer still lie within the ViewPort in a perspective projection.

[2]

(iii) For the previous case calculate the projected ViewPort coordinates of the vertices of the visible facet.

[2]

(iv) Calculate the minimum value of d so that no edges of the cube lie within the ViewPort in a perspective projection.

[2]

(v) Now consider that the ViewPort distance is set at d=6 and the observer's eye is moved to position (0,0,-e). Calculate e such that it is the minimum value for which all edges of the cube lie within the Viewport.

[2]

2.

(a) Name a cubist work by Picasso included in the subject guide or the course text by Kemp. Describe it in terms of composition, subject and color. Identify the cubist properties of the painting.

[5]

(b) Briefly explain the benefits of stereoscopic viewing. Which limitation of single eye view can be overcome with respect to the distance of objects that can be modeled?

[2]

(c) Describe the process of constructing a stereoscopic image of a scene, using a camera and a software package such as Processing. The scene must be viewed on a single monitor using a set of red/cyan filter glasses. What is a side effect of this representation approach?

[4]

(d) Write a Processing program that does the following:
(i) Loads two input images.
(ii) Creates a stereoscopic image using appropriate filters.
(iii) Shows the result.

[5]

(e) The methods for triangle and quadrilateral copying as described in the subject guide are effectively methods of texture mapping between source and destination shapes in two-dimensional space. Describe the effects of the use of these methods in terms of distortion of (i) shape edges and (ii) straight line segments. Illustrate your answer.

[4]

(f) Consider a straight line that passes through the points $\underline{p_1} = (x_1, y_1)$ and $\underline{p_2} = (x_2, y_2)$.

(i) Derive or state the point-slope form for the line, expressed as $y-y_0=m(x-x_0)$ with x_0, y_0 and m written in terms of the coordinates of $\underline{p_1}$ and $\underline{p_2}$ (m represents the slope of the line).

[2]

(ii) if $\underline{p_1} = (-4,1)$ and $\underline{p_2} = (3,-1)$ and if $\underline{p_3} = (x_3, y_3)$ a point on the line, with $x_3=10$, find the corresponding values of m and y_3.

[2]

(iii) Is $\underline{p_4} = (4,-11)$ on the line?

[1]

3.

(a) An example of geometric representation through approximation is that of a 'mazzocchio', a doughnut-shaped headdress.

(i) Name two artists that have made such a representation.

[1]

(ii) Draw a sketch showing the construction of a mazzocchio.

[2]

(iii) Describe in which way this representation can be the basis of an analogous technique in computer graphics

[2]

(iv) Discuss the benefits and drawbacks of such a representation as opposed to an analytic or functional representation.

[3]

(b)

(i) Choose a basic three-dimensional facetted shape with at least five vertices. Define the setup data and write Processing code to define and draw an instance of the object, assuming that the actual and observer frames are the same, i.e. the observer is at the origin, looking along the negative z-axis.

[5]

(ii) Sketch the appearance of the scene you have defined, as viewed with an orthographic projection along the z-axis.

[3]

(c)

(i) Describe in a sentence how extrusion exploits a planar shape.

[1]

(ii) Explain the basis of forming a body of extrusion beginning with the definition of the basic cross-section, including a description of how facets are generated with vertices stored in a consistent, clockwise order when seen from outside.

[5]

(iii) Give an example of how a simple path of extrusion may be set and the cross-section shape varied along the path, including a simple sketch of the result.

[3]

4.

(a) The use of strong contrasts between light and dark has been practiced by artists in pictorial representation (painting, photography and cinematography) in order to achieve various dramatic effects.

(i) Identify the name of this technique, as mentioned in the subject guide.

[1]

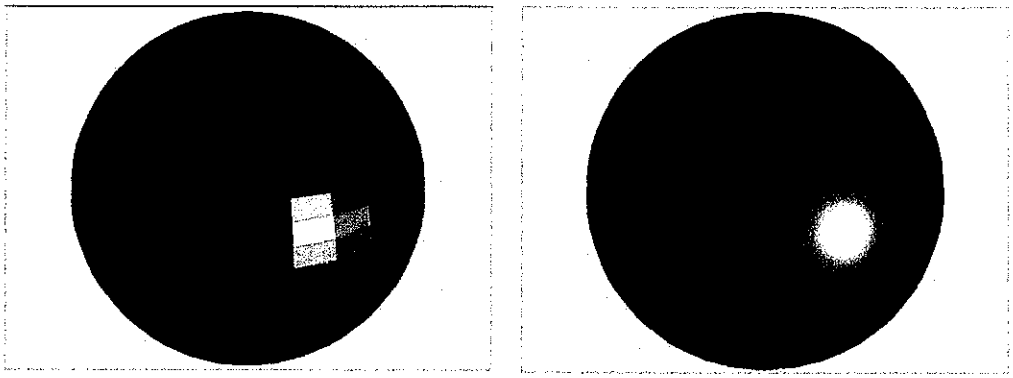
(ii) For one of the paintings included in the subject guide or the course text by Kemp, name it and describe the composition focusing on the use of light and the effects achieved.

[5]

(b)

(i) The images A and B as shown below, depict a facetted approximation of a sphere. Under the same lighting conditions and while both maintain the same colour, reflectivity and shine properties, one of them was generated using Phong shading, while the other one with constant shading. State for which image Phong shading has been used, giving reasons for your choice.

[2]



A B

(ii) Specify the interpolation calculations used in Phong shading to calculate the shade at a given point on a facet. Include a specification of any calculation of intermediate normals and shade values.

[5]

(c) Briefly describe how light coming from a reflection on a matt surface can affect the perceived colour of another object.

[2]

(d) For a point source of light close to a facet with matt surface, illustrate and give an algebraic expression for how illumination intensity varies across the facet according to the incident angle of the light at any point on the facet, ignoring the intensity variation effect with distance.

[3]

(e) Consider a matt surface S_1 of intrinsic colour C_1=(1, 0.5, 0), represented in RGB with each component in the range [0,1], and a source of light I_0 with intensity (I_R, I_G, I_B). Also consider a point P_1 belonging to S_1 and positioned 25cm from the light source and 20cm from the point of S_1 nearest to the light source.

(i) Derive an expression for the reflected colour of P_1.

[3]

(ii) Now consider the source I_0 being itself light resulting from specular reflection of a white light source I_2 with intensity (1,1,1) on a surface S_0, parallel to S_1. Calculate the reflected colour of P_1 if S_0 is a matt surface.

[2]

(iii) Repeat your calculation if S_0 is a perfect mirror.

[2]

Show your working and include an illustration. In all calculations ignore the intensity variation effect with distance and disregard ambient light.

5.

(a) Select a work (painting or sculpture) by Umberto Boccioni and describe it, explaining the ways it conveys a sense of motion.

[4]

(b) German Expressionist filmmakers in their works evoked states such as mystery, fear, hallucination and dreams. Briefly describe some of the viewpoint and compositional ways they used to achieve this.

[4]

(c) Write a Processing draw() method that in every iteration

(i) Draws a circle, centered on the mouse position

(ii) If the mouse button is pressed the colour of the circle is changed to a random one

(iii) Creates a trailing animation effect

Briefly explain each line of code with an inline comment. Assume that necessary variables such as the radius and initial colour of the circle have been set outside draw().

[6]

(d) Histogram equalization seeks to improve image contrast by flattening, or equalizing, the histogram of an image.

(i) To which degree can image histogram equalization be useful for the photographer who over-exposed or under-exposed a picture?

[2]

(ii) How much improvement can be achieved by applying the operation twice?

[1]

(iii) Name a possible adverse effect of histogram equalization.

[1]

(iv) Consider a grey image of 64x64 pixels, with each pixel having a value in the range [0, 255]. There are only 8 distinct values in the image:

Grey level value	Number of pixels
0 to 160	0
161	594
162	130
163	50
164	850
165	440
166	400
167 to 175	0
176	1198
177	434
178 to 255	0

Perform histogram equalization and calculate the number of pixels at each grey level for the resulting image, showing your working.

[7]

END OF PAPER