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

Date and Time: Wednesday 4 May 2016, 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) Uccello's systematic attempts to represent scenes in perspective produced unrealistic structural effects. Give examples of such effects in one of his paintings (such as *St. George and the Dragon*).

[4]

(b)

(i) Discuss how keeping the vanishing point, for lines to be perceived as perpendicular to the picture plane, within the picture itself helps the viewer adopt a suitable viewing position to experience the relative size and depth.

[4]

(ii) In order to illustrate your answer, identify relevant properties in one of Massaccio's paintings.

[4]

(c) Consider a wire frame (i.e. only facet edges shown) 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 of the coordinate system. 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. For the calculations below use a diagram to show your workings.

(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.

[3]

(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.

[3]

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

[3]

(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=-3 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) During the first half of the 20th century, a number of painters experimented with abstract forms by using multiple perspectives.

(i) Name three artists that were related to or influenced by this movement. [3]

(ii) Name and describe a painting adhering to these principles, focusing on structure, theme and execution. [5]

(b) Describe what is meant by the term *curvilinear perspective*. How does it differ from *bi-directional linear perspective*? Include diagrams to illustrate your answer. [5]

(c) Name and briefly describe a painting that demonstrates the use of curvilinear perspective. [3]

(d) Given a set of red/cyan filter glasses and a single monitor, describe the process of constructing a stereoscopic image of a scene, using a camera and a software package such as Processing. What is a side effect of this representation approach? [4]

(e) 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]

3.

(a) The subject guide and the essential reading by Kemp refer to an object, with which both Uccello and Piero della Francesca experimented, creating drawings that can be considered as facetted representations of it. Name the object of interest and briefly discuss how working a line drawing representation could assist in the making of a perspective painting.

[3]

(b) Discuss the benefits and drawbacks of using a facetted vs an analytic representation of objects with curved surfaces, such as a sphere. Include a simple sketch to illustrate your point.

[5]

(c) What are the three basic spatial transformations that may be combined to manipulate an object, such as making an instance of it in ACTUAL space from its SETUP description, or in setting a viewpoint in OBSERVER space?

[3]

(d) Describe data structures for holding the data on a closed convex body made up of convex polygonal facets, where the colour of each facet is separately specified.

[5]

(e)

(i) 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.

[6]

(ii) 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) For one of the paintings included in the subject guide or the course text by Kemp, for which you name the painting and the artist, describe the composition in terms of light sources, light and shade effects therein and how directly and indirectly lit surfaces reflect.

[6]

(b) Explain why in the process of shading a flat-facetted object it is more appropriate to use flat rather than interpolated shading, such as Gouraud or Phong. What problem would arise if the illumination intensity was taken to be independent of the angle of incident light to a facet?

[6]

(c) Specify the interpolation calculations used in Gouraud shading to calculate the shade at a given point on a facet. Include a specification of any calculation of intermediate normals and shade values. You can use a diagram to show the parameters involved in the interpolation calculations.

[6]

(d) Briefly explain how additive and subtractive pigment mixing relate to the perceived colour in terms of the additive primary colours red, green and blue (RGB)

[4]

(e) For the colours, as represented in RGB colourspace, C_1=(255,255,0) and C_2=(0,255,0), show the RGB values that result from each of additive and subtractive colour mixing, stating the name of the colour that results in each case.

[3]

5.

(a) German expressionist filmmakers heighten the emotional response of the audience by evoking states such as uncertainty, disorientation or fear.

(i) Describe some of the viewpoint and compositional devices used to this end.

[4]

(ii) Name and briefly describe a work that demonstrates these techniques.

[4]

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

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

(ii) If the mouse button is pressed the colour of the rectangle is changed to a random one and it is rotated by pi/6 radians around the center of the screen

(iii) Creates a trailing animation effect

Briefly explain each line of code with an inline comment.

[8]

(c) Describe how a weighted median filter is different from a weighted mean (averaging) filter. Explain why the former generally produces more sharply delineated features, with larger expanses of uniform tone, than the ones produced by the latter.

[3]

(d) Consider the filter mask $\begin{pmatrix} 1 & 1 & 1 \\ 1 & 3 & 1 \\ 1 & 1 & 1 \end{pmatrix}$ and the grey level pixel array

$$\begin{pmatrix} 2 & 1 & 15 & 11 \\ 4 & 1 & 15 & 13 \\ 1 & 1 & 13 & 12 \\ 6 & 3 & 13 & 15 \end{pmatrix}$$

Calculate the integer values of the 4 internal (non-edge) pixels in the array resulting from applying the mask separately with each of:

- a weighted mean filter, rounding as required,
- a weighted median filter.

[6]

END OF PAPER