UNIVERSITY OF LONDON

GOLDSMITHS COLLEGE

B. Sc. Examination Sample

CREATIVE COMPUTING

IS52020A (CC227) Creative Computing 2

Duration: 3 hours

Date and time:

There are six questions in this paper; you should answer no more than FOUR questions. Full marks will be awarded for complete answers to a total of FOUR questions. Each question carries 25 marks; the marks for each part of a question are indicated at the end of the part in [.] brackets.

There are 100 marks available on this paper.

This is a practical exam; each answer requiring code should be saved in a Processing sketch named by question number, part and sub-part: for example, `Q5_b_2.pde` *for part (b) sub-part (ii) of question 5. Save your answer to the exam submission folder. You are responsible for ensuring that your answers have been saved in the correct location.*

Question 1 Computers and Images

(a) (i) How are images represented in *Processing*? [2]

(ii) Take the accompanying image and, using *Processing*, produce

i. the image reflected through a horizontal line; [2]

ii. the image from part a(ii)i, with opacity 50%, overlaid on the original image; [2]

iii. the image created from averaging the original image with your image from part a(ii)i; [2]

iv. the image resulting from the convolution with the matrix

$$\begin{pmatrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{pmatrix}$$

[3]

(iii) What operation does the convolution with the matrix in part a(ii)iv perform? [1]

(b) Describe the effect of computers and the Internet on the processing and publishing of photographs. [13]

Question 2 3D Animation

(a) For this question, there are two kinds of object: spheres and cubes. Cubes are immobile, while spheres are attracted towards cubes: the acceleration of a sphere towards a cube is given by the distance between the centre of the sphere and the centre of the cube divided by 100.

(i) Write down the update equations for the positions `x`, `y` in terms of the velocities `vx` and `vy`, and the velocities `vx` and `vy` in terms of the positions `x` and `y`. [4]

(ii) Create a static scene with a cube of side 10 centred at (0,0,0), and a sphere of diameter 10 with center at (40,0,0). Place the camera on the z-axis, such that both of these objects are clearly visible and distinguishable. [4]

(iii) Now animate this scene, such that the initial velocity of the sphere is given by `vx = 0`, `vy = 4`. [6]

(iv) Add the ability to pan the camera, moving it in the x-y plane without changing its orientation in response to cursor keys. [5]

(v) Finally, add a second cube of side 10 centered at (80,0,0); its influence on the sphere will need to be added to the first. [6]

Question 3 Hearing and Sound

(a) Describe the mechanisms involved in hearing. Include a discussion on how the ear amplifies the effect of an incident pressure wave. [6]

(b) Intensity of sound is perceived approximately logarithmically.

(i) Explain what is meant by this statement. [3]

(ii) Describe how to measure the difference between sound pressures in decibels on a suitable scale. [3]

(iii) 2×10^{-5}Pa is the sound pressure for the auditory threshold at 2kHz; this can be the reference point for the loudness scale. Compute the loudness in decibels for a sound pressure of 3×10^{-3}Pa and for 6×10^{-1} Pa. [6]

(iv) Explain why 190dB is a limiting point for loudness on Earth. [2]

(c) Describe the sensitivity of human hearing to frequency. [5]

Question 4 Colour

(a) Describe the RGB and HSB colour spaces, and how it is possible to convert from a point in RGB to a point in HSB. (You do not need to include the full mathematical treatment, but at least a clear diagrammatic representation is necessary.) [6]

(b) Assuming that the RGB space is Euclidean, with (0,0,0) representing black and (1,1,1) representing white, write a function `RGBDist()` to compute the distance between points in that RGB space, and use it to compute the distance between

(i) black and white;

(ii) red and cyan;

(iii) red and magenta;

(iv) red and green.

[7]

(c) The HSB space can be represented as a cone, with base radius 1 and height $\frac{\sqrt{3}}{2}$, such that white is at the centre of the base and black at the apex, while the hues are distributed around the circle. Implement a function `HSBDist()`, and use it to compute the distances between

(i) black and white;

(ii) red and cyan;

(iii) red and magenta;

(iv) red and green.

[8]

(d) Comment on the differences between parts b and c. [4]

Question 5 Compression and Perception

(a) Discuss how perceptual effects allow compression of musical audio streams without degrading the perceived quality of listening to a great extent. (Include detail about particular kinds of data that are removed, and typical compression factors). [10]

(b) An image is being transmitted to a viewer who is red-green colourblind; for the purposes of this question, assume that the perception is as if both the red and green channels are perceived as being the minimum intensity of the two. Suggest a way of compressing the image for this viewer, and implement your idea in functions `compressImage()` and `decompressImage()`. [10]

(c) Test your implementation on the provided image. By how much is space usage reduced? [5]

Question 6 Feature detection

(a) Given that a point with coordinate (x, y) lies within an axis-aligned rectangle filled with a non-white colour (on a white background), write a function to identify the top-left and bottom-right corners of the rectangle. (You may wish to draw a diagram to accompany your solution). [5]

(b) Given that a point with coordinate (x, y) lies within a circle filled with a non-white colour (on a white background), write a function to identify the centre point and radius of the circle. (You may wish to draw a diagram to accompany your solution). [7]

(c) If a given non-white pixel is within either a circle or an axis-aligned rectangle, suggest a way of determining which of the cases holds, and implement a function to do so. [10]

(d) Use your function to count the number of rectangles and circles within the provided image file. [3]