DUBLIN CITY UNIVERSITY

SEMESTER 2 EXAMINATIONS 2016/2017

MODULE: CA4007 – Computer Graphics and Image Processing

PROGRAMME(S):

CASE	BSc in Computer Applications (Sft.Eng.)
ECSA	Study Abroad (Engineering & Computing)
CPSSD	BSc in ComputationalProblem Solv&SW Dev
ECSAO	Study Abroad (Engineering & Computing)

YEAR OF STUDY: 4,O,X

EXAMINERS:

Prof. David Bustard
Dr. Ian Pitt
Dr. Alistair Sutherland (x5511)

TIME ALLOWED: 3 Hours

INSTRUCTIONS: Answer two questions from Section 1 and two questions from Section 2. All questions carry equal marks.

PLEASE DO NOT TURN OVER THIS PAGE UNTIL YOU ARE INSTRUCTED TO DO SO
The use of programmable or text storing calculators is expressly forbidden.
Please note that where a candidate answers more than the required number of questions, the examiner will mark all questions attempted and then select the highest scoring ones.

There are no additional requirements for this paper.

SECTION 1 IMAGE PROCESSING

QUESTION 1 ***[TOTAL MARKS: 25]***

Q 1(a) **[5 Marks]**

In Matlab create a 256x256 image containing a rectangle of dimensions 10 rows by 100 columns against a black background.

Compute the Fourier Transform (FT) of the image and display the Fourier Transform (not the log of the Fourier Transform!) on your screen. Remember to scale the brightness of the FT. Sketch the FT in your exam booklet.

Q 1(b) **[5 Marks]**

Now create another 256x256 image containing a rectangle of dimensions 10 rows by 30 columns against a black background.

Compute the Fourier Transform of this image and display it on your screen as above. Sketch the FT in your exam booklet.

Explain the differences between the two Fourier Transforms.

Q 1(c) **[8 Marks]**

Construct a mask which will let through as much as possible of the Fourier Transform of the rectangle from part 1(a) and exclude as much as possible of the Fourier Transform from part 1(b). Write the Matlab commands in your exam booklet.

Sketch the mask in your exam booklet.

Explain the choices you made in constructing the mask.

Q 1(d) **[7 Marks]**

Load the image `objects`, which contains a set of rectangles of different dimensions including ones with the same dimensions as in part (a) and part (b)

Multiply the Fourier Transform of `objects` by your mask and Inverse Transform it. Sketch the filtered image in your exam booklet. Write the Matlab commands in your exam booklet.

What effect has your mask had on the image? How have the different rectangles been affected – in particular the rectangles from part (a) and part (b)? How have the edges of the different rectangles been affected? Explain why.

[End of Question 1]

QUESTION 2 ***[TOTAL MARKS: 25]***

Q 2(a) **[5 Marks]**

Load the image `textures`, which consists of a set of patches of cloth with different textures

Fourier Transform the image and display the log of Fourier Transform (FT) on your screen. You can use the gray(256) colormap. Remember to scale the brightness of the FT. Sketch the FT in your exam booklet.

Q 2(b) **[5 Marks]**

Explain the structure of the FT. Explain which part of the FT corresponds to which patch and why.

Q 2(c) **[5 Marks]**

Create a binary mask which will filter out one of the patches. Write the Matlab commands in your exam booklet.

Sketch the mask in your exam booklet.

Multiply the FT by your mask and Inverse Transform it. Sketch the filtered image in your exam booklet. Write the Matlab commands in your exam booklet.

Q 2(d) **[5 Marks]**

Compute the Impulse Response corresponding to this mask. Display the real part of the Impulse Response using surf. Sketch it in your exam booklet.

Q 2(e) **[5 Marks]**

Explain how convolving the `textures` image with this Impulse Response leads to the filtered image in part (c).

[End of Question 2]

QUESTION 3 ***[TOTAL MARKS: 25]***

Q 3(a) **[5 Marks]**

Using Matlab load the file `checkerboard`

The image contains an 8x8 checkerboard in the top left corner.

Compute the Fourier Transform (FT) of this image and display it (not the log of the FT!) on the screen. It is probably better to use the default colormap. Remember to scale the brightness of the Fourier Transform. Sketch it in your exam booklet.

Q 3(b) **[5 Marks]**

You could express the checkerboard image in the following form

$$(x \bullet y) \times z$$

where ● means 'convolution' and × means 'multiply'

What are *x, y* and *z*?

Q 3(c) **[5 Marks]**

Using the Convolution Theorem, how would you express the Fourier Transform of $(x \bullet y) \times z$?

You can use *F(x), F(y)* and *F(z)* to mean the Fourier Transforms of *x, y* and *z*

Q 3(d) **[10 Marks]**

Please explain based on your answer to part (c), how *F(x), F(y)* and *F(z)* appear in the Fourier Transform of the checkerboard image.

[End of Question 3]

SECTION 2 COMPUTER GRAPHICS

QUESTION 4 ***[TOTAL MARKS: 25]***

Q 4(a) **[14 Marks]**

Edit the example program `simple.c` so that you can draw a polygon with four corners. You select the position of each corner by clicking with the left mouse button.

Save the program as `polygon.c`

Q 4(b) **[11 Marks]**

Add a menu to the previous program. The menu should be attached to the right mouse button. The menu should have three entries allowing you to choose the number of corners of the polygon from 3 to 5.

Save the program as `polygon.c`

[End of Question 4]

QUESTION 5 ***[TOTAL MARKS: 25]***

Q 5(a) **[10 Marks]**

Edit the example program `simple.c` so that the colour of each pixel of the square depends on its x and y coordinates within the square. The red component of each pixel should vary from 0.0 on the left hand side of the square to 1.0 on the right hand side. The green component should vary from 0.0 at the bottom to 1.0 at the top of the square. The blue component should stay at 0.0 for all pixels.

Save the program as `colour.c`

Q 5(b) **[15 Marks]**

Edit the previous program so that when you move the mouse with left button held down within the square, the background colour becomes the same as the pixel under the mouse.

Save the program as `colour.c`

[End of Question 5]

QUESTION 6 ***[TOTAL MARKS: 25]***

Q 6(a) **[11 Marks]**

Edit the example program `cube.c` and create a cylinder of radius 0.5 and height 1.0 with the centre of its bottom face at the origin and its axis along the y-axis. Save the program as `Cylinder.c`

Q 6(b) **[14 Marks]**

Now create an array containing a checkerboard pattern and texture map it onto the cylinder.

Save the program as `Cylinder.c`

[End of Question 6]

[END OF EXAM]