DUBLIN CITY UNIVERSITY

Summer Resit EXAMINATIONS 2017/2018

MODULE: CA4007 - Computer Graphics and Image Processing

PROGRAMME(S):

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

YEAR OF STUDY: 4,O

EXAMINER(S):

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Prof. Brendan Tangney	(External)
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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]***

Please put all your answers for this question into a Word doc called Q1.doc

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

Load the image `london2`, which contains a satellite image of the area of London around the Millennium Dome, which is clearly visible in the lower right of the image. There is another smaller, circular object in the upper part of the image centred on the pixel in row 47 and column 142.

Set to zero all parts of the image `london2` except the Dome. Fourier Transform the image and display the Fourier Transform (FT) (not the log of the FT) on your screen using the default `colormap`. Remember to scale it. Copy the FT into Q1.doc.

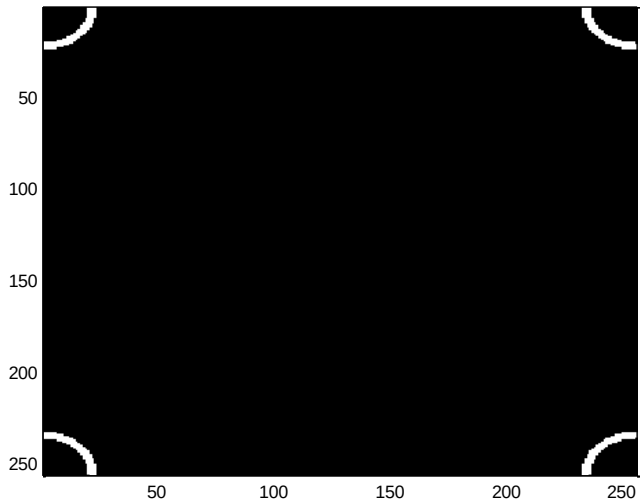
Now set to zero all parts of the image `london2` except the smaller, circular object. Fourier Transform the image and display the Fourier Transform (FT) (not the log of the FT) on your screen using the default `colormap`. Remember to scale it. Copy the FT into Q1.doc.

Explain the differences between the two FTs.

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

The code below constructs a mask such as the one below, known as a circular band-pass filter, where `r1` is the inner radius and `r2` is the outer radius. The centre of the circles is the point `(1,1)`.

```
load dist;
mask = dist > r1 & dist < r2;
```



You can construct a mask consisting of multiple band-pass filters like this

```
mask = (dist > r1 & dist < r2) + (dist > r3 & dist < r4) ...;
```

Construct a multiple band-pass filter which lets through parts of the FT of `london2` which contain mainly data due to the smaller, circular object and excludes data due to the Dome.

Copy the Matlab commands into Q1.doc

Display your mask and copy it into Q1.doc

Explain why you chose the particular bands in your mask.

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

Multiply the FT of `london2` by the band-pass filter and Inverse Transform it. Display the filtered image and copy it into Q1.doc.

Copy the Matlab commands into Q1.doc.

Explain the structure of the filtered image.

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

Compute the Impulse Response corresponding to your mask.

Copy the Matlab commands into Q1.doc.

Display the real part of the Impulse Response using surf. Copy it into Q1.doc

Use the stem command to plot the first row of the Impulse Response. Copy it into Q1.doc

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

Explain why convolving the `london2` image with this Impulse Response would have the effect shown in part (c).

[End of Question 1]

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

Please put all your answers for this question into a Word doc called Q2.doc

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

Load the image `fuzhou`, which contains an image of a street scene around a building in the city of Fuzhou.

Fourier Transform the image and display the log of the FT on your screen using the `gray(256) colormap`. Copy the FT into Q2.doc

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

In Q2.doc indicate using arrows or boxes on the FT which structures correspond to the left-hand and right-hand sides of the main building.

Explain why these structures lie in those particular locations.

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

Using Matlab construct a mask that will let through one of these structures

Display the mask on your screen and copy it into Q2.doc

Multiply the FT of the `fuzhou` image by your mask and Inverse Transform it. Display the filtered image and copy it into Q2.doc.

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

In Q2.doc indicate using arrows or boxes on the FT which structures correspond to the following parts of the `fuzhou` image.

I. the fence along the top of the left-hand face of the main building
II. the right-hand zebra crossing at the bottom of the image
III. the tower at the left-hand edge of the image

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

Construct masks which will filter out each of these structures. Display your masks on the screen and copy it into Q2.doc.

In Matlab multiply the FT by the masks and Inverse Transform them. Display the filtered images and copy them into Q2.doc. Explain the effect of the mask on the image.

[End of Question2]

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

Please put all your answers for this question into a Word doc called Q3.doc

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

Load the image `hexagon` into Matlab, which shows a hexagon which is made up of three parallelograms. Fourier Transform the image and display the log of the FT (not the FT) on your screen using the `gray(256) colormap`. Copy it into Q3.doc.

Q 3(b) **[15 Marks]**

For each of the three parallelograms, carry out the following tasks.

(For this part of the question, please ignore the fine structures located in the central region of the FT.)

(1) Explain which structures within the FT correspond to that parallelogram. Explain why those structures are located where they are and why they have that shape.

(2) Construct a mask that will select one of those structures. Display the mask on your screen and copy it into Q3.doc

(3) Multiply the FT by the mask, Inverse Transform it and display the filtered image on your screen. Copy it into Q3.doc

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

Now consider the fine structures in the central region of the FT. What do you think causes them? Explain your answer.

[End of Question3]

SECTION 2 GRAPHICS

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

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

Edit the example program `simple.c` so that it displays a sine wave which travels horizontally across the screen.

Save the program as `wave.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 allow you to change the frequency of the wave and the speed at which it travels.

Save the program as `wave.c`

[End of Question4]

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

Q 5(a) **[16 Marks]**

Edit the example program `cube.c` so that you can create multiple cubes at different points in 3D space using keyboard callbacks.

Save the program as `CreateCube.c`

Q 5(b) **[9 Marks]**

Now edit the above program so that you can change the viewpoint using the arrow keys.

Save the program as `CreateCube.c`

[End of Question5]

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

Q 6(a) **[13 Marks]**

Edit the example program `face.c` to create a human face with spheres for the eyes and cylinders for the nose and mouth

Save the program as `face.c`

Q 6(b) **[12 Marks]**

Now edit the above program so that you can rotate the face about the y and z axes using the mouse. The face should rotate about the y axis when you hold down the right mouse button and about the z axis when you hold down the left mouse button

Save the program as `face.c`

[End of Question6]

[END OF EXAM]