DUBLIN CITY UNIVERSITY

Semester 2 EXAMINATIONS 2019/2020

PROGRAMME(S):

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

YEAR OF STUDY: 4,O,X

EXAMINER(S):

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Dr. Hitesh Tewari	(External)	External
Prof. Brendan Tangney	(External)	External

TIME ALLOWED: 3 Hours 40 mins

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

You may use code from loop but you may not download code from the internet.

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 two highest scoring ones in each section.

SECTION 1 IMAGE PROCESSING

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

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

Load the image `diags`, which represents two groups of pins scattered randomly over a plane. Display the image on your screen.

Load the file `maskdiags`, which contains a mask which is designed to let through the parts of the Fourier Transform (FT) corresponding to one group of pins.

For your information you can display `maskdiags` on your screen. You can compare it to the FT of `diags`.

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

Multiply the FT of `diags` by `maskdiags` and Inverse Transform it. Display the filtered image using the `gray(256)` colormap and copy it into Q1.doc.

Copy the Matlab commands into Q1.doc.

Describe the structure of the filtered image. How does it differ from the original `diags` image? Explain the effect on each of the two groups of pins.

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

Compute the Impulse Response corresponding to `maskdiags`. The Impulse Response is the FT of `maskdiags`

Copy the Matlab commands into Q1.doc.

Display the real part of the Impulse Response using surf. You may wish to look at it from different viewpoints to get the full structure. Copy your different views into Q1.doc

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

Explain why convolving the `diags` image with this Impulse Response would have the effects shown in part (a). Explain the effect on each of the two groups of pins.

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

If the pins were twice as long, what effect would it have on the FT of diags?

If you were to multiply this new FT by `maskdiags` and Inverse Transform it, how would the effect on the pins differ from the effect in part (a). Explain your answer.

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

If you the pins were twice as long, what would be the effect of convolving them with the Impulse Response from part (b)? Explain your answer.

[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) **[4 Marks]**

Load the image `woodsman`, which contains an image of a man in a jacket carrying an axe. Display the image on your screen.

Fourier Transform (FT) 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) **[21 Marks]**

For each of the following parts of the image, identify which structures in the FT correspond to that part:

1. The fingers *[7 marks]*
2. The part of the jacket in the bottom left corner of the image (below row 800 and left of column 300) *[7 marks]*
3. The trousers *[7 marks]*

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

Construct masks to filter out each structure in the FT. Display the mask on your 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 why those structures lie in those particular locations in the FT. In your explanations you may use one or more of the following principles (if you think they are relevant) shifting and scaling, sampling and replication, and the convolution theorem.

Some of the parts of the image may contain wave-like patterns. If you think this is the case, you could estimate the frequencies of these waves and use them to explain the location of the corresponding structures in the FT.

[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 `chevrons` into Matlab, which contains a pattern of chevrons in the top left corner. Display the image on your screen.

This pattern contains sampling in different directions. What shapes are being sampled in each direction?

Q 3(b) **[2 Marks]**

Fourier Transform (FT) the image and display the FT (not the log of the FT) using the `default` colormap on your screen. Copy it into Q3.doc.

Q 3(c) **[8 Marks]**

Explain the structure of the FT using the Principle of Sampling and Replication. You should refer to your answer to part (a) above. You should fully explain which structures in the FT are caused by the sampling in the `chevrons` image.

Create masks and filtered images to support your answer. Display them on your screen and copy them into Q3.doc

Q 3(d) **[4 Marks]**

The `chevrons` pattern can be regarded as a convolution, in which the Impulse Response is a 3x3 square. Deconvolve the `chevrons` pattern using this Impulse Response and display the deconvolved image in your screen.

Copy your Matlab commands into Q3.doc. And copy the deconvolved image into Q3.doc.

Q 3(e) **[6 Marks]**

Explain how convolving the image from part (d) with a 3x3 square leads to the `chevrons` pattern.

What effect of this convolution is apparent in the FT of `chevrons`? Explain why.

[End of Question3]

SECTION 2 GRAPHICS

QUESTION 4 *[TOTAL MARKS: 25]*

Q 4(a) **[15 Marks]**

Edit the example program `simple.c` so that when you push the left mouse down within 2 pixels of the bottom-left corner, a black dot should appear on that corner, and when you release the button, the dot disappears

Save the program as `mouse.c`

Q 4(b) **[10 Marks]**

Now edit the above program so that if you drag the mouse while there is a black dot on the corner, the corner of the square moves with the mouse.

Now edit the program so that it applies to all four corners.

Save the program as `mouse.c`

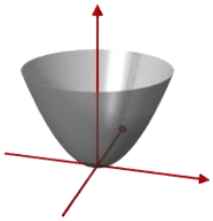
[End of Question4]

QUESTION 5 *[TOTAL MARKS: 25]*

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

Edit the example program `cone2.c` to replace the cone with a solid paraboloid, which consists of the parabola $y=x^2$ (for $y < 1.0$) which has been rotated around the y-axis. The paraboloid should have *10* horizontal stacks and *10* rotational slices.

Save the program as `paraboloid.c`



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

Now edit the above program to add another window. The window should be a 2D sketchpad on which you can click with the mouse. You should be able to create a 2D curve by clicking with the mouse on 10 successive points. This curve should replace the parabola in the above program in order to generate a 3D rotational object.

Save the program as `sketchpad.c`

[End of Question5]

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

Q 6(a) **[17 Marks]**

Edit the example program `cube.c` so that you can create a windmill like the one in the picture below. The windmill should consist of

(1) a vertical, cuboidal tower with a cylindrical base and a cone on top

(2) four rectangular sails arranged in a cross-shape. Each sail should consist of a lattice like the ones in the picture

Save the program as `windmill.c`

Q 6(b) **[8 Marks]**

Now add an Idle Function to the above program so that windmill (with the sails attached) rotates about the axis of the tower. And the sails rotate about the centre of the cross.

Save the program as `windmill.c`

[End of Question6]

[END OF EXAM]