Special Assignment in lieu of Semester End Practical Examination May-June 2020
B.Sc. (Hons) Computer Science Semester VI
Paper Code: 32347610 **Paper Name: Digital Image Processing**

Set – 1

The questions below are fairly independent of the requirement of a computer system. However, it is advised that you use R to implement the solutions you propose. Not only will this help you make better analysis, but will also serve as an indicator of your understanding of the following problems.

1. While working on a Fourier transformation problem, it is quite probable for anybody to forget signs in the exponent part of the forward and inverse Fourier Transformation equations. Suppose, the signs were switched. That is, calculations were done using the following formulas:

$$F'(u,v)=\sum_{x=0}^{M-1} f(x,y)e^{+i2\Pi(\frac{ux}{M}+\frac{vy}{N})}$$ (This calculates forward DFT)

$$f'(x,y)=\frac{1}{MN}\sum_{u=0}^{M-1} F'(u,v)e^{-i2\Pi(\frac{ux}{M}+\frac{vy}{N})}$$ (This calculates the inverse DFT)

Answer the following questions:

(a) What effect will switching of signs have on the forward transform?

(b) How are `f'(x,y)` (output image from switched sign calculations) and `f(x,y)` (the original image) related?

(c) For what set of images will the incorrect forward-DFT `F'(u,v)` be equal to the correct forward-DFT `F(u,v)`?

<u>Note:</u>
I would suggest you work on the solution for 1-D DFT representation before directly solving for the above given equations. The correct notations for `F(u,v)` and `f(x,y)` can be found in your textbook.

2. *Chessboard effect* (also called pixelization) is caused by resolution reduction. The scheme for pixelization is given below:

Input Image → Increasing size of image → Decreasing size of image → Output Image

Decreasing the image size by a certain factor and increasing it by the same factor has an effect of decreasing the image resolution. The following code fragment uses in-built function ***imresize()*** from Imager package in R and uses a factor of 5 for resizing the images.

```
library(imager)
im <- load.image("/home/sakeena_shahid/Desktop/text.png")
small <- imresize(im, scale = 1/5, interpolation = 1)
big <- imresize(small, sacle = 5, interpolation = 1)
```

(a) What does the input parameter "`interpolation = 1`" signify? Can you have other values for this parameter? If yes, explain the use of each possible value.

(b) What can you say about the histograms of the two images `im` and `big` from the code above? Will they be same or different? Why?

(c) Write series of steps to convert Fig1 to Fig2.

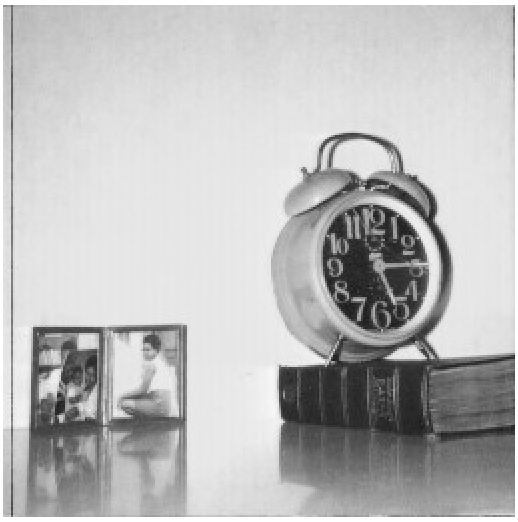

Fig1. clock.tiff

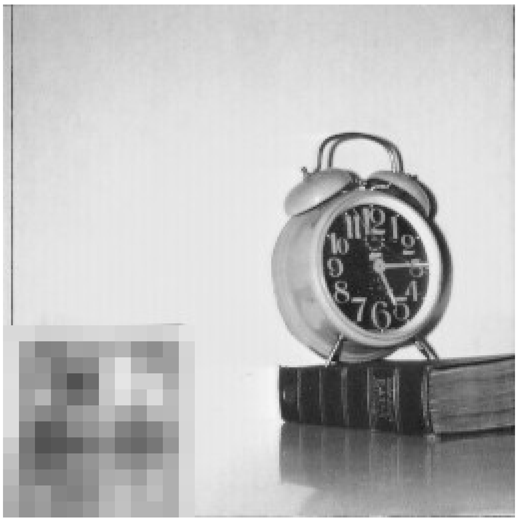

Fig2. clock_modified.png

3. Fig4 results from applying a filter to Fig3.
   (a) What filter do you think was applied to Fig3.? How can you say that?
   (b) Can the results be improved? If yes, How?

Fig3. panda.jpg

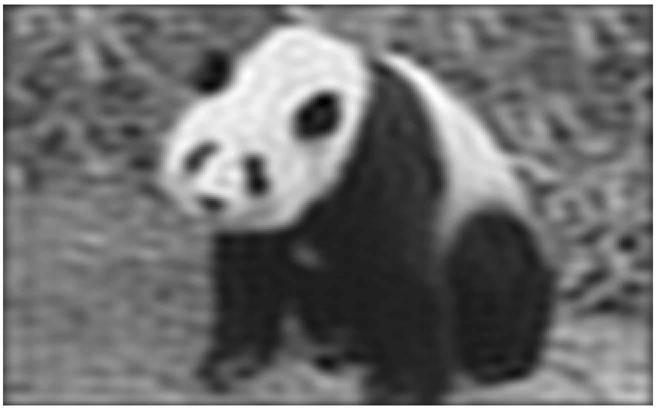

Fig4. panda_modified.jpg

4. Consider a structuring element, `SE = {(0,0) (1,0) (2,0) (0,-1) (0,-2)}`. We create an image Y by dilating SE by SE, that is, `Y = SE ⊕ SE`
   (a) Sketch Y. Show foreground pixels as shaded.
   (b) What is the smallest object X that survives 3 erosions by SE? ‘Smallest’ here means least number of pixels, and ‘survives’ means that after X is eroded by SE, and the resulting image eroded by SE again, and the resulting image eroded by SE again, the result is still 1 pixel thick. Show your answer graphically. For best credit, explain your reasoning step by step.

5. Analyze and Answer:
   (a) Laplacian operator uses the 2^{nd} order derivative to estimate the magnitude of the spatial variation at a point. A popular method based on Laplacian for enhancing the image quality is called *high-frequency emphasis*. It can be modeled by the following equation:

$$g = f - \nabla^2 f$$

i. Laplacian operator is often implemented in the spatial domain with the mask given below. Derive the corresponding spatial-domain mask that can be used to compute `g` .

$$\begin{bmatrix} \mathbf{1} & \mathbf{-2} & \mathbf{1} \end{bmatrix}$$

Note the origin corresponds to the center of the mask.

ii. If the input signal `f(x)` has the shape as given in Fig5, use the spatial-domain mask derived in (i) to compute the output of the high-frequency emphasis process. Plot the output of Laplacian and high-frequency emphasis indicating all the important values.

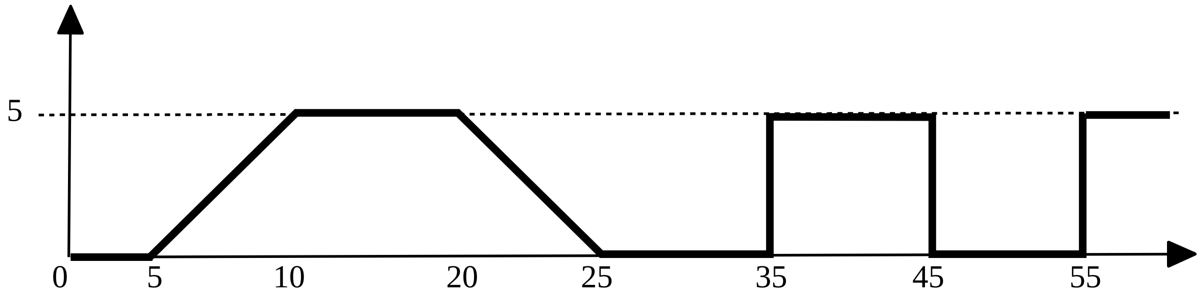

Fig5. Scan line for `f(x)`

(b) Let M be a 3 X 3 mask whose values are all -1 except the center pixel whose value is +8. The origin of the mask is its center pixel. Suppose we apply M to a binary image given below(Fig6), then we threshold the output so that only pixels +8 or higher are marked as foreground pixels. What image features in the original binary image are detected?

0	0	0	0	0	0
0	0	0	0	1	0
0	0	0	0	0	0
0	1	1	0	0	0
0	1	1	0	0	0
0	0	0	0	0	0

Fig6. Binary image

(c) How will the resulting histogram change of an image if the following modifications are made?

i. Add 50 to every pixel value

ii. Negate the image

iii. Apply a threshold value of 0.5

Deliverables:

Make sure you send files/bundles named as UPC_RollNo. Ensure you have the following:

(a) R scripts, if any.
(b) Scanned copies of solutions.
(c) Images, if used any apart from the ones provided in folder.
(d) Output screenshots, if any.
(e) Documentation, if any.
(f) Header information.

Failure to follow rules mentioned in Schedule Notification for sending completed assignments will cause deduction in marks.