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 -2

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. An image `f(x,y)` is binarized to produce a black-and-white image `b(x,y)` that has equal number of black pixels (gray-level 0) and white pixels gray-level 255).
   The resultant binary image is passed through 2 kernels.

   - a 3 X 3 blurring kernel with coefficients equal to 1/5 as shown below:

0	1/5	0
1/5	1/5	1/5
0	1/5	0

   - a 3 x 3 median filter

   to produce output `o(x,y)`.

   (a) Assuming that blurring kernel was applied before median kernel, what are the possible output pixel values?

   (b) Give a binary image `b(x,y)` where the order of application of these two kernels won't matter, that is, you can apply any of the two kernels before the other and the result would still be the same. Use a function to represent this image.

Note:
If you look closely, not all values in the range 0-255 are possible solutions for part (a).
The solution for part (b) is not unique. You can write as many possibilities as you can think of (more possibilities -> more credit).

2. Consider a gray-scale image `f(x,y)` with its histogram(Fig1) sketched below:

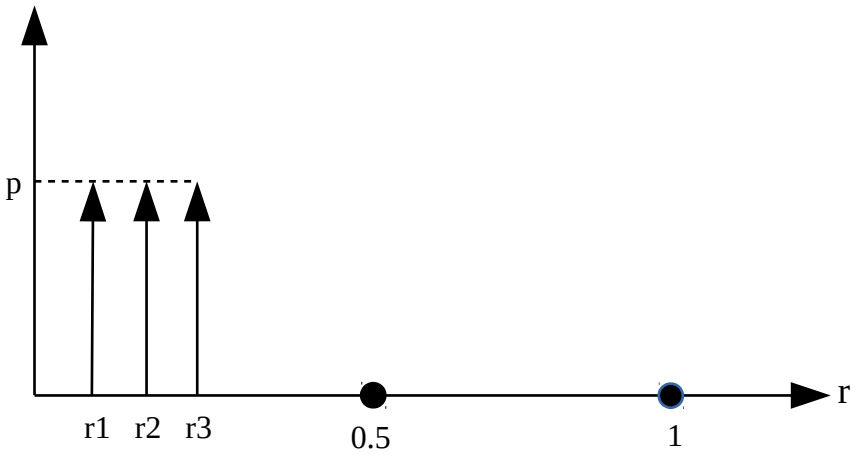

Fig1. Histogram of an image `f(x,y)`

   (a) What can you say about the image `f(x,y)`?

(b) Propose an intensity transformation function that can be used to enhance the contrast of the image. Also, sketch the histogram.

(c) Will you consider a histogram with no pixels at some intensities equalized? Why/Why not?

3. Consider the code fragment below and answer the questions that follow.

```
1. library(imager)
2. im <- load.image("/home/sakeena_shahid/Desktop/R_documentation/color.jpg")
3. im <- grayscale(im)
4. m <- nrow(im)
5. n <- ncol(im)
6. im <- as.matrix(im)
7. randommat <- matrix(runif((m*n), min=0,max=255), ncol= n)
8. for(i in 1:dim(randommat)[1])
9.   for(j in 1:dim(randommat)[2])
10.          if(randommat[i,j] < 4){
11.                  im[i,j]=0
12.          }
13. im <- as.cimg(im)
14. plot(im)
```

(a) What is the code fragment shown above doing?

(b) What will happen if I modify line 10 to `if(randommat[i,j] < 40)` ? What will happen if I use a even bigger number than 40?

(c) Write series of steps to convert Fig2 to Fig3.

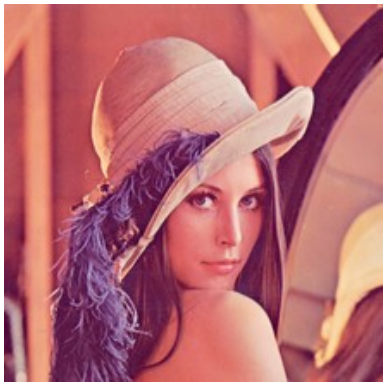

Fig2. lena.png

Fig3. lena_modified.png

4. The following binary image in Fig4. represents theta (Θ), where shaded region represents foreground pixels.

(a) What morphological operation will you use to convert it to decimal number zero?

(b) What structuring element (3 X 3) will you use and why? Draw the SE with the origin marked. Please show the outputs of morphological operation(s).

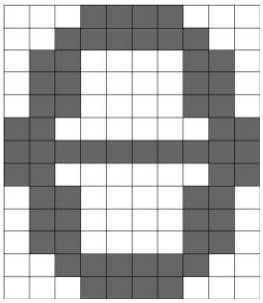

Fig4. Theta Binary

5. Analyze and Answer:

(a) Let `B = {(0,0), (0,1), (1,0), (1,1)}` be a structuring element with origin at `(1,0)` shown in Fig5. Give an example of any image `X` which, when opened using `B`, is unchanged. In other words, the opening of `X` using this `B` is just `X` itself. Then generalizing, state a set of necessary and sufficient conditions on an arbitrary image `X` for the opening of `X` using the `B` below to be just `X` itself.

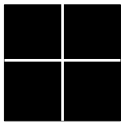

Fig5. B (Structuring Element for 5(b))

(b) Let `h(x,y)` be a 3 X 3 filter. It is convolved with an image `f(x,y)`, resulting in `g(x, y) = h(x, y) * f(x, y)`. Is `g(x, y)` more blurry or sharper than `f(x, y)`, or is `g(x, y)` the response of edge/corner detection in `f(x, y)`? Explain your reasoning.

$$h(x,y) = \begin{pmatrix} -1 & -1 & -1 \\ -1 & 9 & -1 \\ -1 & -1 & -1 \end{pmatrix}$$

(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.