The Islamic University in Gaza Faculty of Information Technology Master of Information Technology Image Processing	الإمتحان النصفي الفصل الأول 2021/2022 ICTS 6338	الجامعة الإسلامية بغزة كلية تكنولوجيا المعلومات ماجستير تكنولوجيا المعلومات المساق: معالجة الصور Noor K. Balbol

Q1) Multiple Choice Questions (15 pts) 15

40 Pts

40

1. **The kernel [-1 2 -1] is meant to approximate _____ order derivative**
   (A) a low pass filter (B) second (C) first (D) Median filter

2. **The simplest image processing techniques is**
   (A) spatial transformation (B) intensity transformation
   (C) coordinates transformation (D) domain transformation

3. **Smoothing filters are mostly used in:**
   (A) contrast (B) blurring (C) noise reduction (D) B + C

4. **Digitizing image intensity amplitude is called:**
   (A) Enhancement (B) Sampling (C) Dynamic range (D) Quantization

5. **Which of the following is/are considered as types of lowpass filters?**
   (A) Ideal (B) Butterworth (C) Gaussian (D) All of the mentioned

6. **The simplest piecewise linear transformation function is**
   (A) linear stretching (B) contrast stretching (C) color stretching (D) intensity stretching

7. **The process of highlighting the specific range of intensities is called**
   (A) pixels slicing (B) color slicing (C) intensity level slicing (D) contrast stretching

8. ***Log transformation is given by the formula***
   (A) $s = c \log(r)$ (B) $s = c \log(r+1)$ (C) $s = c \log(2 + r)$ (D) $s = \log(1+r)$

9. **The inverse transformation from s to r is defined as:**
   (A) $s=T^{-1}(r)$ for $0<= s <=1$ (B) $r=T^{-1}(s)$ for $0<= r <=1$
   (C) $r=T^{-1}(s)$ for $0<= s <=1$ (D) $r=T^{-1}(s)$ for $0>= s >=1$

10. **Which of the following lowpass filters is/are covers the range of very smooth filter function?**
    a) Ideal lowpass filters b) Butterworth lowpass filter
    c) Gaussian lowpass filter d) All of the mentioned

11. **In a dark image, the components of histogram are concentrated on which side of the gray scale?**
    (A) high (B) Median (C) Low (D) Evenly distributed

12. **In spatial domain, which of the following operation is done on the pixels in sharpening the image?**
    (A) Integration (B) Average (C) Median (D) Differentiation

13. **The output of a smoothing, linear spatial filtering is a _____ of the pixels contained in the**
    (A) Sum (B) Product (C) Average (D) Dot Product

14. **Process that expands the range of intensity levels in image is called**
    (A) Linear stretching (B) contrast stretching (C) color stretching (D) elastic stretching

15. **Fourier stated that the periodic function is expressed as sum of**
    (A) sine (B) cosine (C) tangent (D) A + B

16. **Which of the following is the transfer function of the Butterworth Highpass Filter in the frequency domain.**
    (A) $H(u,v) = \frac{1}{1+[D_0/D(u,v)]^{2n}}$ (B) $H(u,v) = \begin{cases} 0 & if\ D(u,v) \le D_0 \\ 1 & if\ D(u,v) > D_0 \end{cases}$
    (C) $H(u,v) = 1-e^{-D^2(u,v)/2D_0^2}$ (D) none of the mentioned

Q2) Solve the following Questions

a) Give a 3*3 kernel for performing unsharp masking (low-pass filtering).

* unsharp filter : is a sharpening technique that assumes that high pass filter is the opposite of lowpass, so the highpass = 1 - low pass filter.

$\frac{1}{9} \times$

1	1	1
1	1	1
1	1	1

* The used filter for low pass is the box filter (smoothing filter)

b) If you want to sharpen an image in frequency domain, what type of filters do you use? Give an example of such a filter

There are 3 types of filters for high pass filtering that suppress low-frequencies and pass high ~~low~~ frequencies.

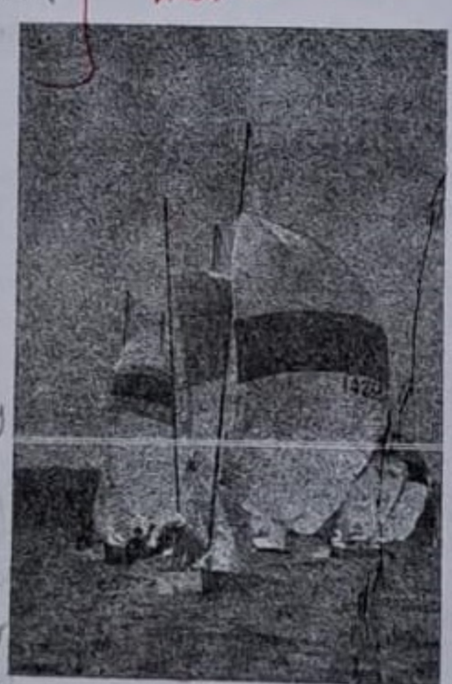
① Ideal high pass $H(u,v) = \begin{cases} 0 & \text{if } D(u,v) \le D_0 \\ 1 & \text{if } D(u,v) > D_0 \end{cases}$

② Butter worth $H(u,v) = \frac{1}{1 + (D_0 / D(u,v))^{2n}}$

③ Gaussian $H(u,v) = 1 - e^{-(D^2(u,v) / 2D_0^2)}$

c) Suggest two spatial filtering methods to enhance given noisy image shown below: Compare the performance of the two filters in terms of noise reduction and preserving edges in the original image.

① To remove the salt and pepper noise, we will use the median filter it's an order static filter (low pass filter). and this filter not blurred the edges very much } more effective



② We can use low pass filter (averaging) filter for bluring (box filter)

$\frac{1}{9}$

1	1	1
1	1	1
1	1	1

but this filter blured the edges more than median filter

Q3) A 4 x 4 gray-scale original image $f(x,y)$ is given as $f(x,y) =$

0	0	0	0	0	0
0	12	10	8	6	0
0	10	8	6	4	0
0	8	6	4	2	0
0	6	4	2	0	0
0	0	0	0	0	0

Compute the filtered output images (only the first two rows) after passing through:

a) The spatial linear filter as specified by the mask w_1 (by using zero-padding of the original image).

$$w_1 = \frac{1}{2}\begin{pmatrix} 0 & 1 & 0 \\ -1 & 2 & -1 \\ 0 & 1 & 0 \end{pmatrix}$$

$24 - 10 + 10 = \frac{24}{2} = 12$

$-12 + 20 - 8 + 8 = \frac{8}{2} = 4$

$-10 + 16 - 6 + 6 = \frac{6}{2} = 3$

$-8 + 12 + 4 = \frac{8}{2} = 4$

1st row

$12 + 20 - 8 + 8 = \frac{32}{2} = 16$

$10 - 10 + 16 - 6 + 6 = \frac{16}{2} = 8$

$8 - 8 + 12 - 4 + 4 = \frac{12}{2} = 6$

$6 - 6 + 8 + 2 = \frac{10}{2} = 5$

2nd row

12	4	3	4
16	8	6	5

b) A 3x3 median filter (by using zero-padding of the original image).

* 0,0,0,0,(0) 8,10,10,12
* 0,0,0,6,(8) 8,10,10,12
* 0,0,0,4,(6) 6,8,8,10
* 0,0,0,0,(0) 4,6,6,8
* 0,0,0,6,(8) 8,10,10,12
* 4,6,6,8,(8) 8,10,10,12
* 2,4,4,6,(6) 6,8,8,10
* 0,0,0,2,(4) 4,6,6,8

0	8	6	0
8	8	6	4

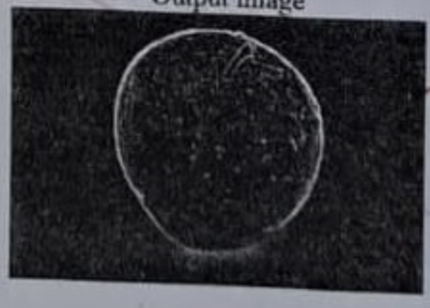
Q4) Solve the following Questions

a) Considering the processed (resulting) image on the right, what would be the most likely (3x3) spatial filter applied to the input image on the left, specify its mask.

High pass filter → Laplacian filter

Input image

Output image



0	1	0
1	-4	1
0	1	0

sharpening with pass

b) Edges play an important role in our perception of images as well as in the analysis of images. Describe one method which can detect lines/edges along x- and y- directions in an image (see output image)? Write down its mathematical operations on an input image f(x,y).

e use Sobel filter to enhance x, y edges.

enhance x edges

use this filter

1	-2	-1
0	0	0
1	2	1

orizental edges)

enhance y edge

use this filter (vertical edges)

-1	0	1
-2	0	2
-1	0	1

) For the following 5 x 5 image f(x,y) with integer intensities in the range from 0 to 7.

MN = 25

a) Compute the histogram of the original image f(x,y).

b) Find the transformed (equalized) histogram, g(x,y).

f(x,y)

0	7	3	2	3
0	0	0	6	7
7	7	2	2	0
1	1	0	4	1
0	0	7	4	1

t:

$$s_k = T(r_k) = (L-1)\sum_{j=0}^{k} p_r(r_j) \quad k = 0,1,2,\ldots,L-1$$

$$p_r(r_k) = \frac{n_k}{MN}$$

g(x,y)

2	7	5	4	5
2	2	2	6	7
7	7	4	4	2
3	3	2	5	3
2	2	7	5	3

r_k	0	1	2	3	4	5	6	7
(a) n_k	8	4	3	2	2	0	1	5
$p(r_k)$	,32	,16	,12	,08	,08	0	,04	,2
cdf	,32	,48	,6	,68	,76	,76	,8	1
s_k	2,24	3,36	4,2	4,76	5,32	5,32	5,6	7
	2	3	4	5	5	5	6	7

25

1

$s_2 = ,32$

$s_3 = ,16$

$s_4 = ,12$

$s_5 = ,08 + ,08 + 0 = ,16$

$s_6 = ,04$

$s_7 = ,2$