CITY UNIVERSITY OF HONG KONG

Course code & title	:	EE4211 Computer Vision
Session	:	Midterm for Semester B 2021/22
Time allowed	:	Two hours

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*This is an **open-book, open-notes** examination.*

Name:

Student ID:

Question 1-10 (randomly choose 10 of them)

(1) In order to perform smoothing filtering on an image that is affected by the isolated noise points, which of the following filters can achieve this goal? (AB)
A median filter
B neighborhood averaging filter
C high frequency filter
D sharpening filter

(2) When the power transformation is used for grayscale transformation, when the power is greater than 1, the transformation is for which of the following (B).
A The whole image is darker
B The whole image is brighter
C The image details are drowned in the dark background
D The whole image is blurred

(3) Which of the following statement is correct? (BD)
A Image enhancement method based on pixel is a kind of linear gray level transformation
B Image enhancement method based on pixel is one of the image enhancement methods based on spatial domain
C Because the image enhancement methods based on frequency domain commonly use the Fourier transform and inverse Fourier transform, they are always more complex than the methods based on image domain
D The effect of image enhancement method based on frequency domain can be the same as that based on spatial domain

(4) Which of the following argument is right? (ACD)
A In a dark image, the components of histogram are concentrated on the Low side of the grey scale
B Histogram equalization ignore the local information
C Histogram equalization could enhance images
D Histogram equalization also refers to image normalization

(5) High pass filtering can be used to (A)
A sharpen edges
B denoise
C object recognition
D increase brightness

(6) The following algorithm related to point processing is (B)
A gradient sharpening
B binaryzation
C Fourier transform
D Median filtering

(7) The following algorithms related to edge enhancement processing is (AD)
A gradient sharpening
B histogram equalization
C median filtering
D Laplacian enhancement

(8) Which of the following filter is used to hight the brightest point in the image (A)
A max filter
B min filter
C Median filter
D Midpoint filter

(9) In general, which of the following assures of no ringing in the output? (A)
A Gaussian Lowpass Filter
B Ideal Lowpass Filter
C Butterworth Lowpass Filter
D All of the mentioned

(10) The edges and other abrupt changes in gray-level of an image are associated with (AD)
A High frequency components
B Low frequency components
C Edges with high frequency and other abrupt changes in gray-level with low frequency components
D boundary values in the obtained frequency transforms

(11) The following algorithms related to edge enhancement processing is (AD).

A gradient sharpening
B histogram equalization
C median filtering
D Laplacian enhancement

(12) Hit-or-Miss transformation is used for shape (B).

A removal
B detection
C compression
D filling

True or False

(1) Applying dilation to an entire image is denoted opening. (×)

(2) If we use the transformation $T(x)=x^2/255$ to transform the histogram of a grayscale 8-bit image, the resulting image is darker. (√)

(3) Power-law function maps a narrow range of low gray-level values in the input image into a wider range of output levels. (×)

(4) After image translation, the phase and amplitude characteristics of the Fourier transform are both changed (×)

(5) The idea behind contrast stretching is to increase the dynamic range of the gray levels in the image being processed (√)

(6) Contraharmonic Mean Filter only can be used to remove pepper noise and cannot work well for salt noise. (×)

(7) Low frequencies are mainly responsible for overall gray level display in smooth areas (√)

(8) Closing contracts an object (×)

(9) Alpha-trimmed Mean Filter can work well on both with salt&pepper noise and gaussian noise. (√)

(10) The energy of CT imaging is higher than MRI imaging. (√)

(11) Contrast Stretching transform highlights a specific range of intensities in an image. (×)

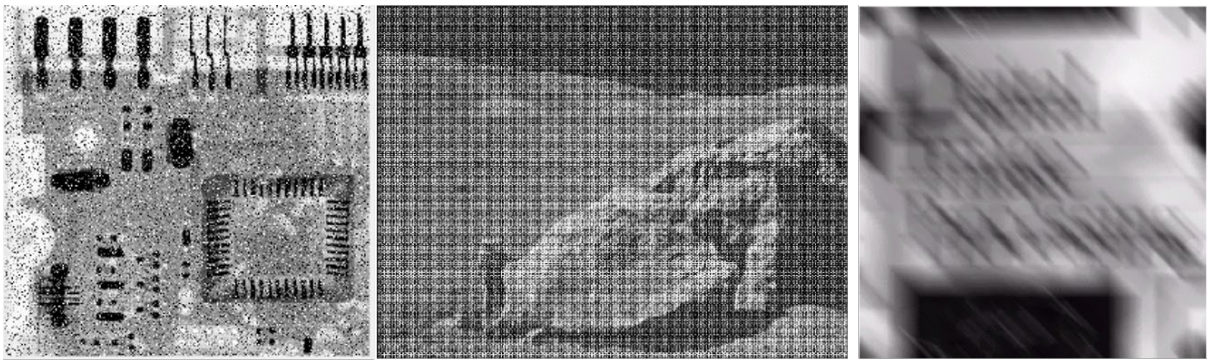
(12) The corresponding relation between an image and its gray histogram is one to many (×)

(13) Intensity-Level Slicing transform highlights a specific range of intensities in an image. (√)

(14) Median Filters can work better to remove noise compared with average filters. (√)

(15) Local histogram equalization always shows better performance compared with global histogram equalization. (×)

21 Point out by what kinds of noises the images shown in the following image are corrupted. Which methods can be used to remove noises? (6%)



(a) (b) (c)

Solutions:
(a) salt and pepper noise, (can be removed by median filter)
(b) periodic noise (notch filter in the frequency domain)
(c) moving noise (inverse filter)

22 Whether the adaptive filter could enhance edges? Please illustrate the reasons. (4 points)

Solutions: please check notes of Lecture 5, pp 60-63.

23 There is an image shown as follows because of the noise interruption. How do you process the noisy image? Show the result. (6%)

1	1	1	8	7	4
2	255	2	3	3	3
3	3	255	4	3	3
3	3	3	255	4	6
3	3	4	5	255	8
2	3	4	6	7	8

Solutions:
This image is interrupted by salt noise. Min filter can be used to remove this noise. The filtered image is showing as following with zero padding methods. (P.S., Median filter and harmonic filter are also OK.)

0	0	0	0	0	0	0	0
0	1	1	1	8	7	4	0
0	2	255	2	3	3	3	0
0	3	3	255	4	3	3	0
0	3	3	3	255	4	6	0
0	3	3	4	5	255	8	0
0	2	3	4	6	7	8	0
0	0	0	0	0	0	0	0

0	0	0	0	0	0
0	1	1	2	3	0
0	2	3	2	3	0
0	3	3	3	3	0
0	3	3	3	4	0
0	0	0	0	0	0

24 (randomly choose one of two questions)

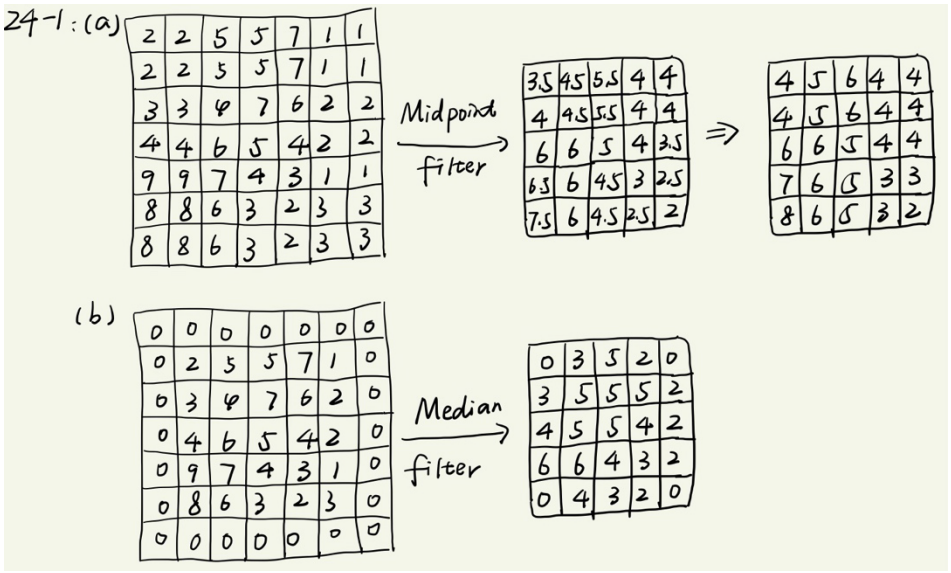
24-1A 5*5 grayscale image is given by

2	5	5	7	1
3	4	7	6	2
4	6	5	4	2
9	7	4	3	1

8	6	3	2	3

Please calculate the results with the
(a) Midpoint filter after replicate padding (filter size 3*3).
(b) Median filter after zero padding (filter size 3*3).

Solutions:

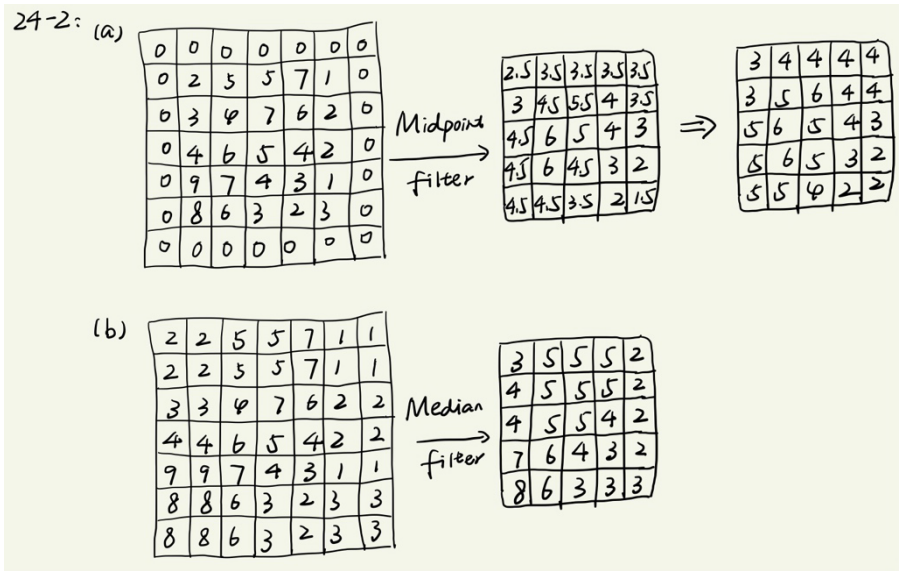


24-2 A 5*5 grayscale image is given by

2	5	5	7	1
3	4	7	6	2
4	6	5	4	2
9	7	4	3	1
8	6	3	2	3

Please calculate the results with the
(a) Midpoint filter after zero padding (filter size 3*3).
(b) Median filter after replicate padding (filter size 3*3).

Solutions:



25 (randomly choose one of two questions)

25-1A 6 x 6 image with eight gray levels is given below:

1	2	1	3	6	6
1	2	2	4	5	7
1	0	2	5	6	7
0	2	3	6	6	7
3	0	4	4	5	7
1	4	3	5	5	7

(a) Obtain the histogram of the image. Noted that histogram is not the pdf. (4 Points)
(b) Apply histogram equalization on the above image and determine the new intensity values of the histogram equalized image. (10 points)

Solution:

Gray level	hk	sk
0	3	7*3/36 ->1
1	5	7*8/36->2
2	5	7*13/36->3
3	4	7*17/36->3
4	4	7*21/36->4
5	5	7*26/36->5
6	5	7*31/36->6
7	5	7*36/36->7

25-2 A 6 x 6 image with eight gray levels is given below:

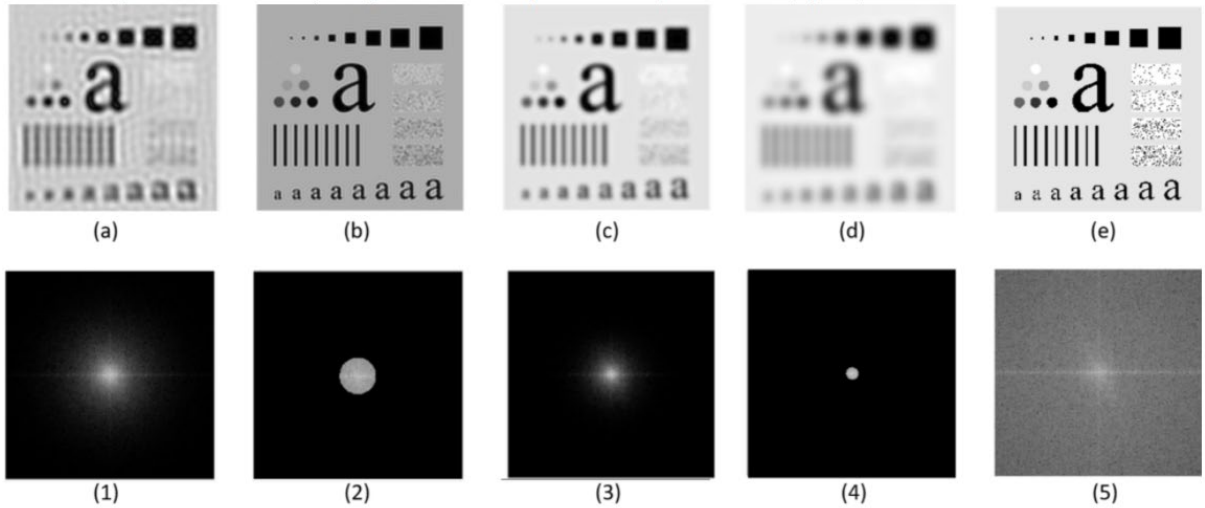
1	2	1	3	6	6
1	2	2	4	5	7
1	0	2	7	6	5
0	2	3	7	6	6
3	0	4	7	5	4
1	4	3	7	5	5

(a) Obtain the histogram of the image. Noted that histogram is not the pdf. (4 Points)
(b) Apply histogram equalization on the above image and determine the new intensity values of the histogram equalized image. (10 points)

Solution:

Gray level	hk	sk
0	3	7*3/36 ->1
1	5	7*8/36->2
2	5	7*13/36->3
3	4	7*17/36->3
4	4	7*21/36->4
5	5	7*26/36->5
6	5	7*31/36->6
7	5	7*36/36->7

26 Match the images below to their corresponding Fourier transform spectrum and explain the reason. (8 points)



Solutions:
(a)->(4) In the a and b, they have ring effects on the images, which means that they have clear cut-off on the frequency domain, therefore, a and b should correspond to (2) and (4). Compared with (2) and (4), (2) have more low frequency information, which means that the original image corresponding to (2) should more clear and preserve more information with the original images. Therefore, (a)->(4)

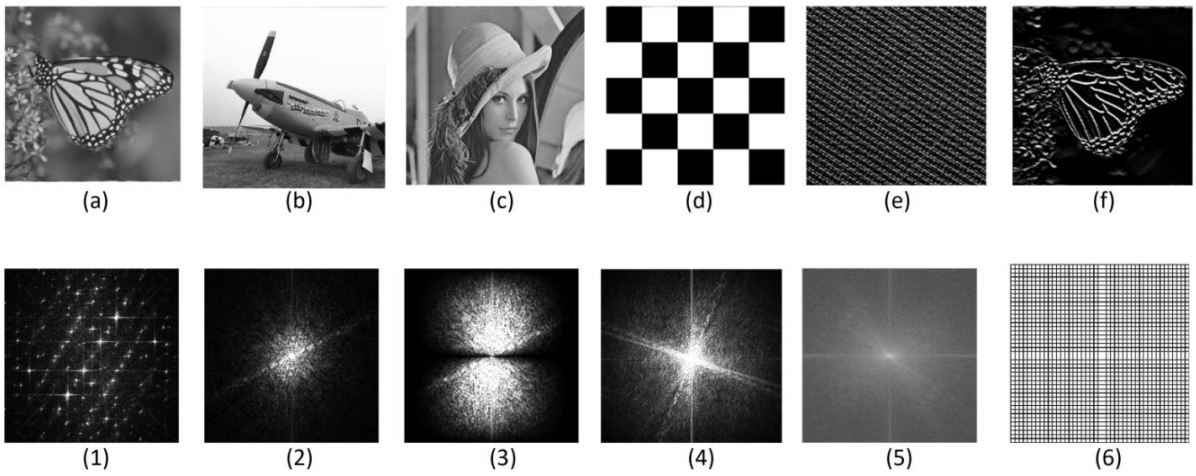
(b)->(2) See the above reasons

(c)->(1) Compared with (c) and (d), (c) have more low frequency information, which means that the original frequency corresponding to (c) should more clear and preserve more information with the original images. Therefore, (c)->(1)

(d)->(3) See the above reasons

(e)->(5) This image includes both high frequency information and low frequency information, therefore corresponding to (5)

27 Match the images below to their corresponding Fourier transform spectrum and explain the reason. (8 points)



Solutions:

(a)->(2) a slowly varying image has essentially low frequency contents.

(b)->(4) strong directional features result in orthogonal lines in Fourier

(c)->(5) compared with (a), image (c) has wide information in the spatial domain, and the frequency domain has more much large range.

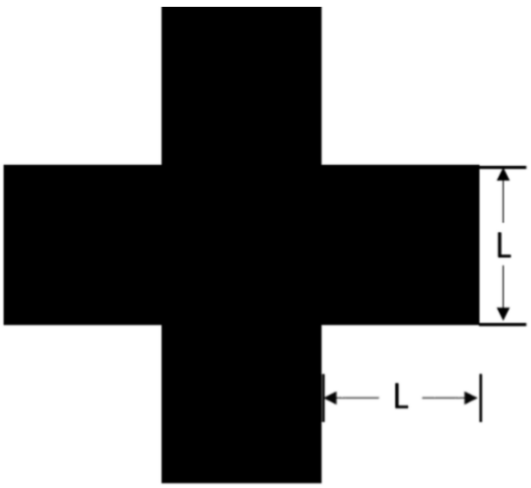
(d) ->(6) A shape edge will result in high energy perpendicular to the edge

(e) ->(1) periodic information in the spatial domain corresponds to the isolated points in the frequency domain.

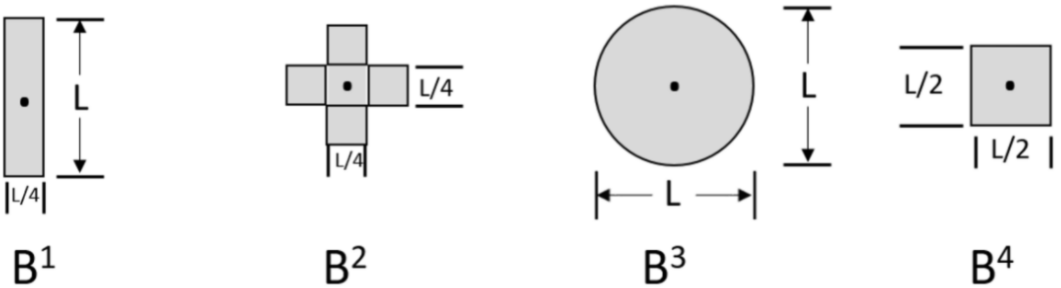
(f)->(3) fastly varying image has higher frequency contents, with limited low-frequency contents.

28 Let A denote the set shown shaded in the following figure. Refer to the structuring elements shown (the black dots denote the origin). Sketch the result of the following morphological operations. Please illustrate the steps clearly.

- $Y1= (A \ominus B^3) \oplus B^2$ where $\ominus$ denotes the morphological erosion operator and $\oplus$ denotes the morphological dilation operator; (4 marks)
- $Y2= (A \ominus B^1) \oplus B^4$. (4 marks)
- $Y3= (A \ominus B^3) \oplus B^4$. (6 marks)

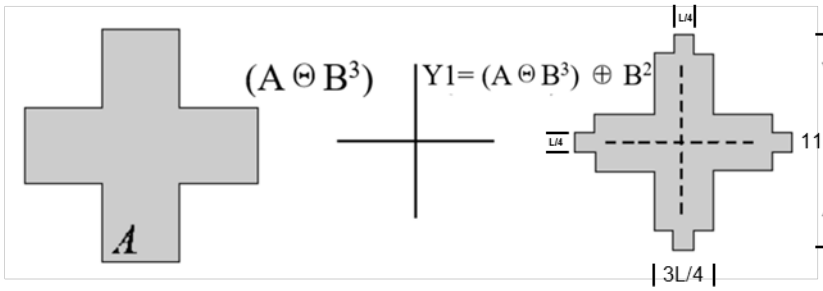


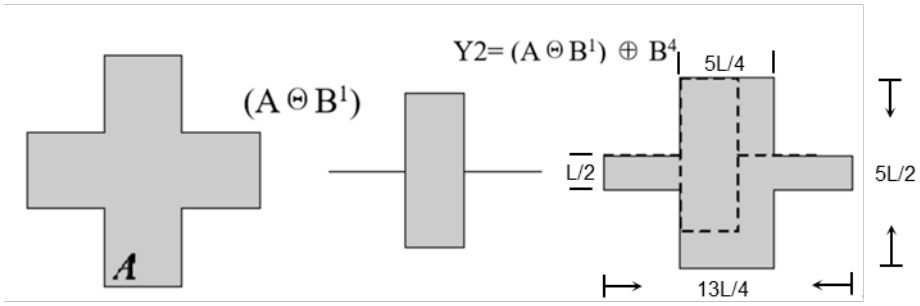
A

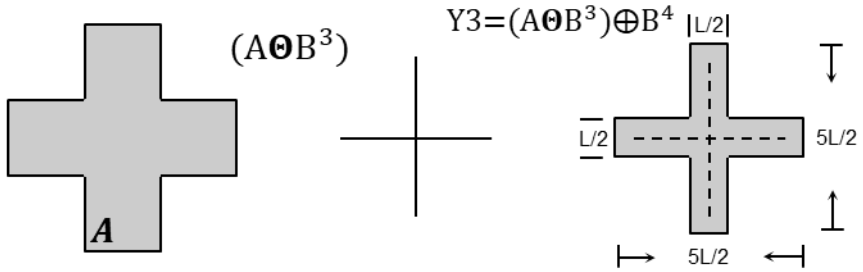


B^1 B^2 B^3 B^4

Solutions:


$(A \ominus B^3)$
$Y1 = (A \ominus B^3) \oplus B^2$
A
L/4
L/4
11L/4
3L/4


$Y2 = (A \ominus B^1) \oplus B^4$
$(A \ominus B^1)$
A
5L/4
L/2
5L/2
13L/4


$(A \Theta B^3)$
$Y3 = (A \Theta B^3) \oplus B^4$
A
L/2
L/2
5L/2
5L/2