COMP 478/6771 – Image Processing

Midterm Exam
Oct 22, 2024

First Name	Last Name	Student ID

DURATION: 1 hour
INSTRUCTIONS

- The question sheet (double-sided) has 16 multiple choice questions worth a total of 16 points. Wrong or multiple answers to a question will get 0. For this part, use a **PENCIL** ONLY to mark your answers on the **scan sheet** provided with the exam booklet. You can use any space on your exam booklet for the rough work: it will be ignored. Make sure to fill in **your name and student ID** on the scan sheet.
- There are **6 pages** including this cover page. Check that you have all the pages.
- Approved calculator with a GCS sticker is allowed.
- Books, notes, smart watches or other electronic devices (except calculators as explained in the previous point) and cameras are NOT allowed.
- DO NOT BEND the scan sheet. Do not detach any pages.

1. **True or False**: The phase map obtained from Fourier Transform of an image carries the crucial structural information to reconstruct the image with inverse Fourier Transform.

    A. True

    B. False

2. **True or False**: Is the following spatial filter a valid averaging filter?

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

    A. True

    B. False

3. **True or False**: The result of highboost filtering cannot have negative intensity values.

    A. True

    B. False

4. **True or False**: A median filter of size 5x5 pixels is a nonlinear filter.

    A. True

    B. False

5. **True or False**: The contrast of an image can be further improved by applying histogram equalization twice in a row, in comparison to just once.

    A. True

    B. False

6. Which of the following filtering operations in spatial domain is equivalent to a high-pass filtering in frequency domain?

   A. Laplacian filtering
   B. Median filtering
   C. Max filtering
   D. Homomorphic filtering
   E. None of the other stated operations

7. If we remove the most significant bit of an image's bit-plane representation, which of the stated effects below will NOT happen?

   A. The overall brightness of the image will be reduced
   B. The bins that represent odd pixel values in the image's histogram will have zero counts
   C. The overall image contrast will become worse
   D. The heights of the non-zero-count bins in the image's histogram can increase
   E. The image's histogram will be distributed towards the left of the intensity value range

8. Which of the following is a valid derivative filter?

$$A = \begin{bmatrix} 1 & 0 & -1 \\ -2 & 0 & 2 \\ 1 & 0 & -1 \end{bmatrix},\ B = \begin{bmatrix} 1 & 1 & 1 \\ 1 & -6 & 1 \\ 1 & 1 & 1 \end{bmatrix},\ C = \begin{bmatrix} 1 & 0 & 1 \\ 0 & -4 & 0 \\ 1 & 0 & 1 \end{bmatrix},\ D = \begin{bmatrix} -1 & -1 & 0 \\ -1 & 0 & -1 \\ 0 & -1 & -1 \end{bmatrix}$$

   A. Filter A B. Filter B C. Filter C D. Filter D E. None of the other filters

9. Which of the image filters stated below can produce ringing artifacts?

   A. Gaussian low-pass filter
   B. Butterworth band-pass filter
   C. Ideal low-pass filter
   D. Difference of Gaussian (DoG) filter
   E. None of the other stated filters

10. We have the following binary image with a bright rectangular bar at the center.

If we want to perform spatial transformation of the rectangular shape while keeping it still within the field of view of the image, which of the following operations won't change the image's magnitude image (spectrum) from Fourier Transform?

A. Shift the rectangular shape vertically to the bottom
B. Rotate the rectangular shape clock-wise by 45 degrees
C. Scale the rectangular shape to half of its current size
D. Move the rectangular shape horizontally to the right and rotate it by 90 degrees
E. None of the other stated spatial transformations

11. Convolution with a Gaussian kernel in the Fourier frequency domain is equivalent to

A. Convolution with a Gaussian function in the spatial domain
B. Convolution with a box function in the spatial domain
C. Multiplication with a sinc function in the frequency domain
D. Multiplication with a Gaussian function in the spatial domain
E. None of the other stated operations

12. For a 3-bit image of 200 pixels, the histogram is expressed in the following table:

Grey levels	0	1	2	3	4	5	6	7
# of pixels	0	20	10	50	40	20	60	0

If we need to perform histogram equalization on this image, what is the transformed grey level value for grey level = 2 in the original image? **Express your result as a discrete value.**

A. 2 B. 0 C. 3 D. 1 E. None of the other results

13. Please select the image filter that can effectively reduce the type of noise contained in the image below:

A. Box filter

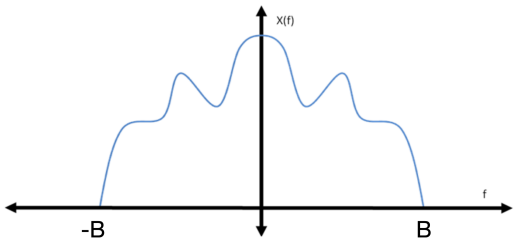
B. Gaussian low-pass filter

C. Median filter

D. Laplacian filter

E. Max filter

14. For the following band-limited signal in the frequency domain, what is the minimum sampling frequency that you should use?



Note that here B = 4Hz

A. 8Hz

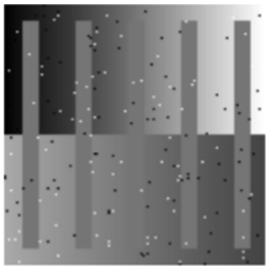
B. 4Hz

C. 2Hz

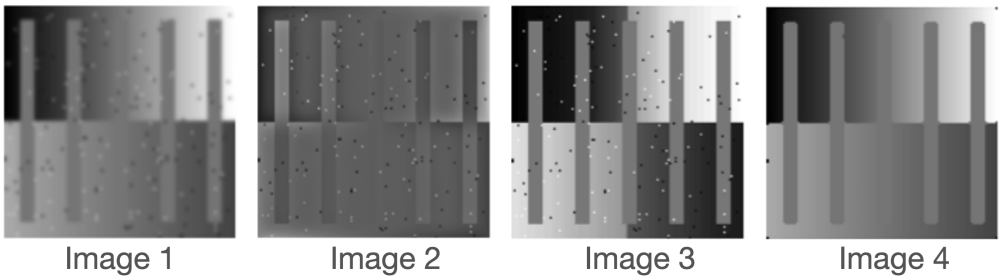
D. 10Hz

E. None of the other frequencies

15. Given an image below:



Four image processing techniques were used to obtain four new images. Which image is likely generated by histogram equalization?



A. Image 1 B. Image 2 C. Image 3 D. Image 4 E. None of the images

16. Please compute the following integral:

$$\int_{-\infty}^{\infty} (2t^2 + 1)\delta(t-1)dt, where\ \delta(\cdot) is\ an\ impulse\ function$$

A. 2
B. 3
C. 0
D. 1
E. None of the other answers

END OF EXAM