

《SE-343 数字图像处理》期末试题 (A 卷)

(考试形式：闭 (45 分钟) / 开 (75 分钟) 考试时间：共 2 小时)



《中山大学授予学士学位工作细则》第六条

考试作弊不授予学士学位

方向：_____ 姓名：_____ 学号：_____

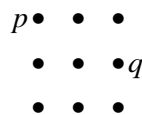
注意：答案一定要写在答卷中，写在本试题卷中不给分。本试卷要和答卷一起交回。

Part I (Close book exam 40 pts) 45min

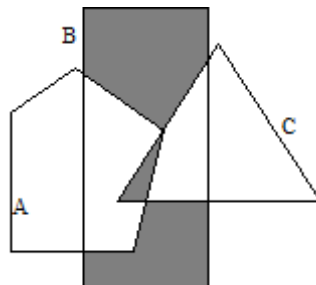
1. (4 pts) Given an image with size 3×3 as following. Reduce its gray level resolution in half, generate a result image and describe your methods.

$$\begin{pmatrix} 1 & 2 & 3 \\ 4 & 0 & 2 \\ 5 & 4 & 7 \end{pmatrix}$$

2. (6 pts) Consider two pixels p and q in the following figure. Calculate the (a) Euclid distance, (b) city-block distance and (c) chessboard distance between p and q .



3. (6 pts) Give the expression for the set shown shaded in the following figure in terms of sets A , B , and C .



4. (5 pts) Can a typical image display device show any natural color? Why?
5. (6 pts) Consider an image pixel with color $[10, 20, 30]$ in RGB color space. (Assume that the intensity level range of each color channel is $[0, 255]$.) Please

answer the following questions:

- What is the intensity of this pixel?
- What is the saturation of this pixel?
- What is the complement of this pixel?

6. (4 pts) As shown in the following figure. The upper row is the input images, and the bottom row is the output images after a spatial filtering. Choose the corresponding filter for each image pair.



(a)

____(b)

(c)

— (d)

A. $\begin{pmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{pmatrix}$

B. $\frac{1}{9} \begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix}$

C. median filter

D. $\begin{pmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{pmatrix}$

7. (4 pts) Consider the continuous function $f(t) = e^{j2\pi nt}$. Please answer the following questions briefly:

- What is the period of $f(t)$?
- What is the frequency of $f(t)$?

8. (5 pts) Give both the 1D Fourier transformation and inverse Fourier transformation pair.

Part II (Open book exam 60 pts) 75min

1. (6 pts) Two images, $f(x, y)$ and $g(x, y)$, have histograms as following. Please determine the histograms of image $f(x, y) + g(x, y)$.

r_k	0	1	2	3	4	5	6	7
$p_f(r_k)$	0.3	0.2	0.2	0.1	0.05	0.15	0	0
$p_g(r_k)$	0	0	1.0	0	0	0	0	0

2. (8 pts) Give the expression of contraharmonic mean filter:

$$\hat{f}(x, y) = \frac{\sum_{(s,t) \in S_{xy}} g(s, t)^{Q+1}}{\sum_{(s,t) \in S_{xy}} g(s, t)^Q}$$

Please explain that if the parameter $Q > 0$, it can eliminate pepper noise, but is invalid for salt noise.

3. (9 pts) Let $V = \{0, 1, 2\}$ and compute the lengths of the shortest 4-, 8-, and m -path between p and q . If a particular path does not exist between these points, explain why.

	3	4	1	2	0
	0	1	0	4	$2(q)$
	2	2	3	1	4
(p)	2	0	4	2	1
	1	2	0	3	4

4. (9 pts) Based on the relationship between the original image and its filtered image, determine the linear filter coefficients. (Ignore the border effects.)

$$\begin{pmatrix} 2 & 0 & 2 & 0 \\ 0 & 2 & 0 & 2 \\ 2 & 0 & 2 & 0 \\ 0 & 2 & 0 & 2 \end{pmatrix} \rightarrow \begin{pmatrix} \square & \square & \square \\ \square & \square & \square \\ \square & \square & \square \\ \square & \square & \square \end{pmatrix} \rightarrow \begin{pmatrix} 2 & 0 & 2 & 0 \\ 0 & 2 & 2 & 2 \\ 2 & 2 & 2 & 0 \\ 0 & 2 & 0 & 2 \end{pmatrix}$$

5. (8 pts) Design a morphological operation to extract the edge of the image below following.

```

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

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6. (10 pts) In general, spatial filtering of an image of size $M \times N$ with a filter of size $m \times n$ is given by the expression:

$$g(x, y) = \sum_{s=-a}^a \sum_{t=-b}^b w(s, t) f(x+s, y+t) .$$

Show that this is a linear operator.

7. (10 pts) Consider any three valid colors c_1 , c_2 , and c_3 with coordinates (0, 0), (10, 0) and (6, 8) in the chromaticity diagram. A color c is lie within the triangle with coordinate (5, 4). Computing the relative percentages of c_1 , c_2 , and c_3 composing the given color c .