

《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： 08 数字媒体 姓名： 学号：

Part I (Close book exam) 45min

1. (16 pts) Answer the following questions.
 - a) Please explain the meaning of each component H, S, and I in a HSI color model?
 - b) What is the different between image enhancement and image restoration?
 - c) One of HDTV formats is 1080p24. A video stream with this format will have full frames of 1920×1080 pixels at frame rate 24 fps. If each pixel has 24 bits color depth (8 bits each for red, green and blue channels), how many gigabytes it will be for a 2 hours of HDTV video without compression?
 - d) Give the steps of image filtering in the frequency domain briefly.
2. (5 pts) Let $V = \{0,1\}$ 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	2	2	1	(q)
	2	2	0	2	
	1	2	1	1	
(p)	1	0	1	2	

3. (6 pts) Filtering the following 4×4 gray level image

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

with

- a) 3×3 weighted mean filter using zero padding with mask

$$w = \frac{1}{16} \begin{pmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{pmatrix}$$

b) 3×3 median filter processing only such pixels that have all needed neighbors

4. (8 pts) Suppose a camera is equipped with a single CCD sensor. At each pixel location, only a single color sample (out of three) is captured. The missing color samples are then inferred from neighboring values. Assuming the following layout for color sensitive pixel elements, derive a simple linear filtering based interpolation method for constructing a full RGB image from the input image from sensor.

$$\begin{matrix} G & B & G & B & G & \dots \\ R & G & R & G & R & \dots \\ G & B & G & B & G & \dots \\ R & G & R & G & R & \dots \\ \vdots & \vdots & \vdots & \vdots & \vdots & \ddots \end{matrix}$$

5. (5 pts) Morphological operation.
- Perform morphological dilation of the image A by the given structure element B.
 - Perform morphological erosion of the image A by the given structure element B.

(The origin of B is underlined.)

$$\begin{matrix} & & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ & & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 \\ & & 0 & 1 & 1 & 1 & 1 & 1 & 1 & 0 \\ A & & 0 & 0 & 1 & 1 & 1 & 0 & 1 & 0 \\ & & 0 & 1 & 1 & 1 & 1 & 1 & 1 & 0 \\ & & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{matrix} \qquad \begin{matrix} & & 0 & 1 & 0 \\ B & & 1 & \underline{1} & 1 \\ & & 0 & 1 & 0 \end{matrix}$$

Part II (Open book exam) 75min

1. (10 pts) Compute the 2-D discrete Fourier transform of the following image

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

2. (10 pts) Filter the same image of previous question with the following frequency domain filter H

$$H = \frac{1}{4} \begin{bmatrix} 2 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

3. (10 pts) Histogram Equalization

- a) Perform histogram equalization given the following histogram. (r =Gray level, n =number of occurrences)

r	0	1	2	3	4	5	6	7
n	400	700	800	900	500	400	196	200

- b) Perform histogram specification of the previous histogram using the specified histogram shown in the following table. (r =Gray level, p =probability of occurrences)

r	0	1	2	3	4	5	6	7
p	0.05	0.05	0.1	0.1	0.15	0.2	0.25	0.1

4. (10 pts) Give the expression of contraharmonic mean filter,

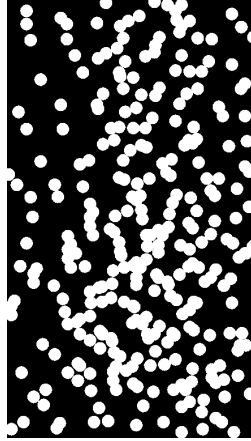
$$\hat{f}(x, y) = \frac{\sum_{(s,t) \in S_{xy}} g(s, t)^{Q+1}}{\sum_{(s,t) \in S_{xy}} g(s, t)^Q}$$

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

5. (10 pts) A preprocessing step in an application of microscopy is concerned with the issue of isolating individual round particles from similar particles that overlap in groups of two or more particles (see following image). Assuming that all

particles are of the same size, propose a morphological algorithm that produces three images consisting respectively of

- a) Only of particles that have merged with the boundary of the image.
- b) Only overlapping particles.
- c) Only nonoverlapping particles.



6. (10 pts) Given a image, its probability density function is $p_r(r) = Ae^{-r}$, where $r \in [0, b]$ is the gray level range and A is the normalization factor. After gray level transformation by function $s = T(r)$, its probability density function is $p_s(s) = Bse^{-s^2}$, where $s \in [0, b]$ is the gray level range and B is the normalization factor. Please calculate the transformation function $s = T(r)$.