# Image Processing Exam#1 answer

1.

a.

when an image is quantized with few quantization levels, the difference between two adjacent quantization level increase, making continue changing region become step-changing and makes human eye to see the false contour.

b.

The purpose of unsharp masking is to enhance the edge contrast of an image.

First obtain the unsharp mask: $g_{mask} = f(x,y) - \bar{f}(x,y)$

Then apply the mask to original image: $g(x,y) = f(x,y) + k * g_{mask}$

c.

Inks alter the content of light by changing how a surface reflects light, so we use CMY, the complement of RGB, instead of RGB for printing device.

d.

take (1, 0.25, 0) gamma=0.5 as an example:

(1, 0.25, 0), hue: $15°$

After gamma correction:

(1, 0.5, 0), hue: $30°$

Hue changed.

e

| | | | | |
|---|---|---|---|---|
| 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 0 | 0 |

After applying median filter, zero padding:

| | | | | |
|---|---|---|---|---|
| 1 | 1 | 0 | 0 | 0 |
| 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 0 | 0 | 0 |

Apply box filter, zero padding:

Box filter:

| | | |
|---|---|---|
| $\frac{1}{9}$ | $\frac{1}{9}$ | $\frac{1}{9}$ |
| $\frac{1}{9}$ | $\frac{1}{9}$ | $\frac{1}{9}$ |
| $\frac{1}{9}$ | $\frac{1}{9}$ | $\frac{1}{9}$ |

After applying filter:

| | | | | |
|---|---|---|---|---|
| $\frac{4}{9}$ | $\frac{6}{9}$ | $\frac{4}{9}$ | $\frac{2}{9}$ | 0 |
| $\frac{6}{9}$ | 1 | $\frac{6}{9}$ | $\frac{3}{9}$ | 0 |
| $\frac{6}{9}$ | 1 | $\frac{6}{9}$ | $\frac{3}{9}$ | 0 |
| $\frac{6}{9}$ | 1 | $\frac{6}{9}$ | $\frac{3}{9}$ | 0 |
| $\frac{4}{9}$ | $\frac{6}{9}$ | $\frac{4}{9}$ | $\frac{2}{9}$ | 0 |

Median filter cause less blurring than box filter at an image edge.

2.

Probability

| Gray-level | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| percent | 0 | 0.05 | 0.2 | 0.5 | 0.25 | 0 | 0 | 0 |

Accumulate Probability

| Gray-level | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| percent | 0 | 0.05 | 0.25 | 0.75 | 1 | 1 | 1 | 1 |

Transformation : (P*7)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Gray-level | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| value | 0 | 0.35 | 1.75 | 5.25 | 7 | 7 | 7 | 7 |

transformation: round(P*7)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Gray-level | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| New Gray-level | 0 | 0 | 2 | 5 | 7 | 7 | 7 | 7 |

3.

(a)

Use 5x5 filter below

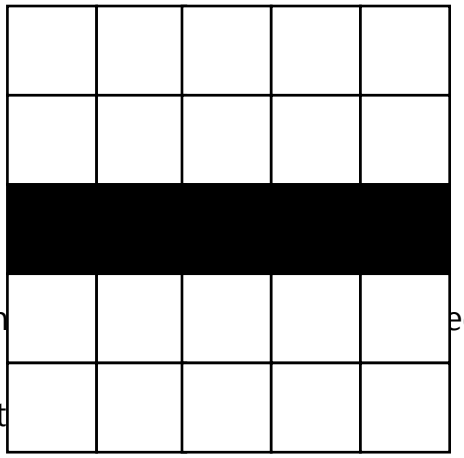
1/5 X

| | | | | |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 1 | 1 | 1 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |

Set the threshold to 153(white 255 * 3 / 5), if the value <=153 · set the

value to 0, else set to 255.

(b)

Use structuring element  and do dilation on the origin ect the broken black line. (The answer is not

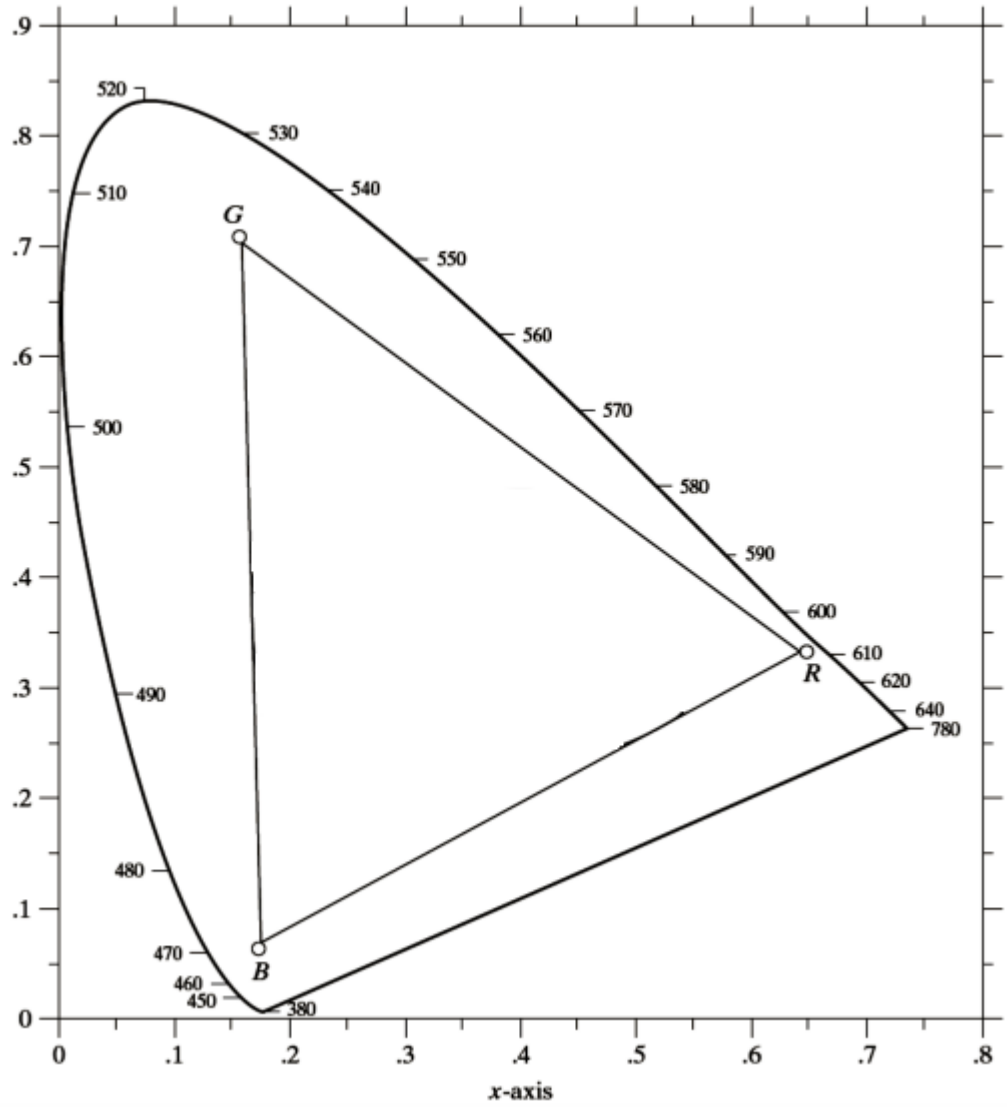
4.

(a) Range of reproducible colors by a device.

[3 point]

(b)The shape is triangle because the color is represented by linear combination of R, G, B channels.

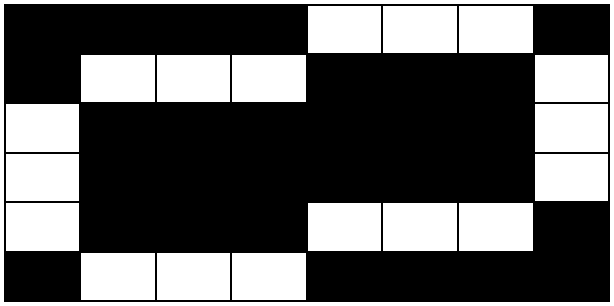
[description 3 point, RGB 1 point for each, triangle 1 point]


.9
.8
.7
.6
.5
.4
.3
.2
.1
0
520
530
540
510
550
560
570
500
580
590
600
610
620
640
780
490
480
470
460
450
380
G
R
B
0
.1
.2
.3
.4
.5
.6
.7
.8
x-axis

5.

Following solution use white slot to represent foreground pixels.

(a)

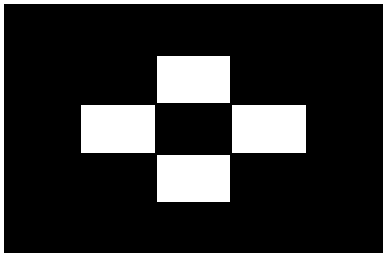


[5 point, 1 point per missing slot]

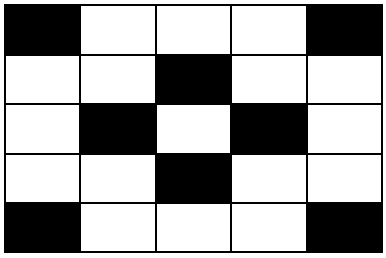
(b)

<solution 1>

First structure element

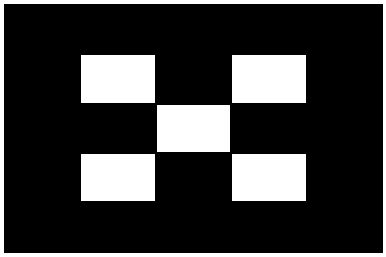


Second structure element

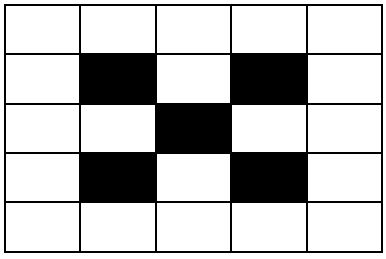


<solution 2>

First structure element



Second structure element



[5 point, 1 point per missing slot]

(c)

(1) Apply erosion to target image with first structure element to get B1. B1 is match point of specific shape.

(2) Apply erosion to complement of target image with second structure element to get B2. B2 is match point of background of specific shape.

(3) Intersect B1 and B2 to get the center point of specific shape. Such center point has exact the specific shape and surrounding background.

[5 point]

6.

f1 : $2\cos\theta + 2\sin\theta = \rho$

f2 : $\rho = 0$

f3 : $-\cos\theta - 2\sin\theta = \rho$

f4 : $2\cos\theta - 2\sin\theta = \rho$

**if $\boldsymbol{\theta = 0°}$ :**

f1: $\rho$ = 2*1 + 2*0 = 2

f2: $\rho$ = 0

f3: $\rho$ = -1 - 0 = -1

f4: $\rho$ = 2

**if $\boldsymbol{\theta = 45°}$ :**

f1: $\rho$ = 2*0.7 + 2*0.7 = 2.8

f2: $\rho$ = 0

f3: $\rho$ = -1.4

f4: $\rho$ = 0

**if $\boldsymbol{\theta = 90°}$ :**

f1: $\rho$ = 2

f2: $\rho$ = 0

f3: $\rho$ = -1

f4: $\rho$ = -2

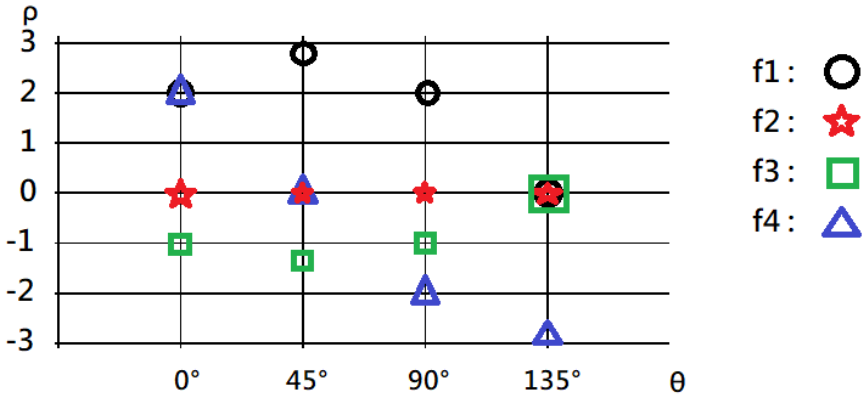
**if $\boldsymbol{\theta = 135°}$ :**

f1: $\rho$ = 0

f2: $\rho$ = 0

f3: $\rho$ = 0

f4: $\rho$ = -2.8




3 lines(f1,f2,f3) are concurrent at $\rho$ =0 , θ=135°

The most significant line:

→ $\mathrm{x}\cos 135° + y \sin 135° = 0$

→ $-0.7\mathrm{x} + 0.7\mathrm{y} = 0$

7.

(a) Orange

(b)

$$\mathrm{H} = 60° * \frac{0.5-0}{1-0} = 30°$$

$$\mathrm{L} = \frac{1+0}{2} = 0.5$$

$$\mathrm{S} = \frac{1-0}{2*0.5} = 1$$

(c)

$\mathrm{HSL}(30^{\circ}, 0.5, 0.5)$

→ $\frac{\max+\min}{2} = 0.5$ , $\frac{\mathrm{G}-\mathrm{B}}{\max-\min} = 0.5$ , $\frac{\max-\min}{\max+\min} = 0.5$

→ $\max = 0.75$ , $\min = 0.25$ , $\mathrm{G} - \mathrm{B} = 0.25$ ,

→ $\mathrm{RGB}(0.75, 0.5, 0.25)$