Principles and Applications of Digital Image Processing

Fall, 2021

作業一

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Part 1:

2.5

(a)

$$\frac{lp}{mm} = \frac{2048}{2} * \frac{1}{50} = 20.48 \approx 21\ lp/mm$$

(b)

$$dpi = \frac{dot}{inches} = \frac{2048}{2} = 1024\ dpi$$

2.12

$$f(x,y) = i(x,y) \times 1.0$$
$$= 255e^{-[(x-x_0)^2+(y-y_0)^2]}$$

The image has distribution range [0 255], the change of intensity level must be bigger than 8 to avoid false contouring, so it can be calculated as following

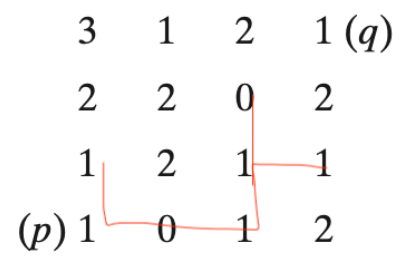
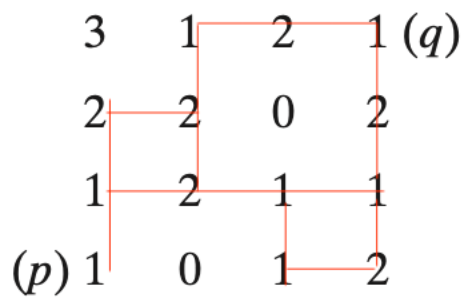
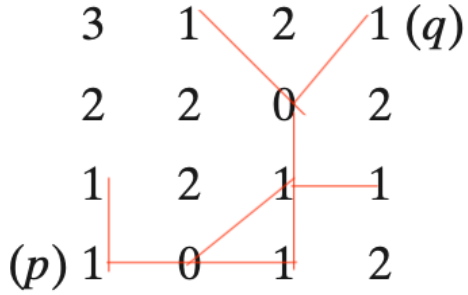
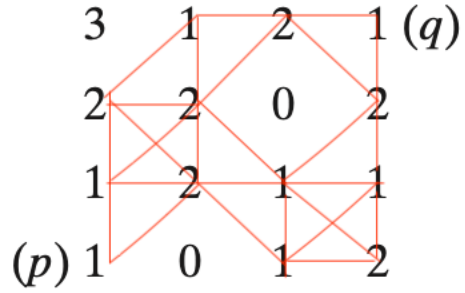
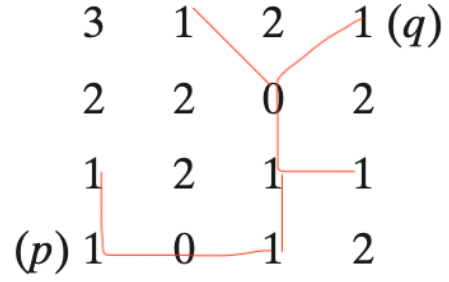
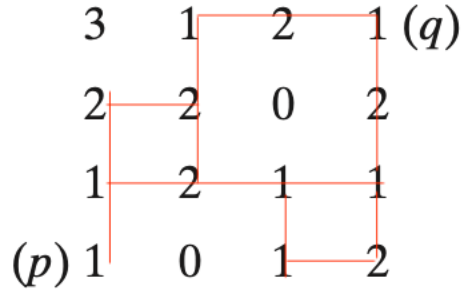
$$\frac{255+1}{2^k} \geq 8$$

$$k \leq 5$$

The largest k will be 5.

2.18

consider value = V and draw adjacent like following

path	(a) V = {0,1}	(b) V = {1,2},
4	 Length = 0, cause p can't reach q	 Length = 6
8	 Length = 4	 Length = 4
m	 Length = 5	 Length = 6

2.36

To create single, composite transformation functions just multiply to matrices

(a)

$$\begin{bmatrix} 1 & 0 & t_x \\ 0 & 1 & t_y \\ 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} C_x & 0 & 0 \\ 0 & C_y & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} C_x & 0 & t_x \\ 0 & C_y & t_y \\ 0 & 0 & 1 \end{bmatrix}$$

(b)

$$\begin{bmatrix}\cos\theta & -sin\theta & 0\\ sin\theta & cos\theta & 0\\ 0 & 0 & 1\end{bmatrix}\begin{bmatrix}1 & 0 & t_x\\ 0 & 1 & t_y\\ 0 & 0 & 1\end{bmatrix}\begin{bmatrix}C_x & 0 & 0\\ 0 & C_y & 0\\ 0 & 0 & 1\end{bmatrix}=\begin{bmatrix}C_X cos\theta & -C_y sin\theta & t_x cos\theta - t_y sin\theta\\ C_x sin\theta & C_y cos\theta & t_y cos\theta + t_x sin\theta\\ 0 & 0 & 1\end{bmatrix}$$

(c)

$$\begin{bmatrix}\cos\theta & -sin\theta & 0\\ sin\theta & cos\theta & 0\\ 0 & 0 & 1\end{bmatrix}\begin{bmatrix}1 & 0 & t_x\\ 0 & 1 & t_y\\ 0 & 0 & 1\end{bmatrix}\begin{bmatrix}C_x & 0 & 0\\ 0 & C_y & 0\\ 0 & 0 & 1\end{bmatrix}\begin{bmatrix}1 & S_v & 0\\ 0 & 1 & 0\\ 0 & 0 & 1\end{bmatrix}$$
$$=\begin{bmatrix}C_X cos\theta & C_x S_v cos\theta - C_y sin\theta & t_x cos\theta - t_y sin\theta\\ C_x sin\theta & C_x S_v sin\theta + C_y cos\theta & t_y cos\theta + t_x sin\theta\\ 0 & 0 & 1\end{bmatrix}$$

(d)

Try perform different order of (a)

$$\begin{bmatrix}C_x & 0 & 0\\ 0 & C_y & 0\\ 0 & 0 & 1\end{bmatrix}*\begin{bmatrix}1 & 0 & t_x\\ 0 & 1 & t_y\\ 0 & 0 & 1\end{bmatrix}=\begin{bmatrix}C_X & 0 & C_x t_x\\ 0 & C_y & C_y t_y\\ 0 & 0 & 1\end{bmatrix}$$

Yes, It does has difference. The order of multiplication means the order to do the transformation and the result image will have a bit difference.

3.12

First write functions of Pr and Pz.

$P_r(r) = -2r + 2$

$P_z(z) = 2z$

Then, transformation function can be deduced easily

$z = T(r) = -r + 2$

3.21

Using zero padding

(a)

Ans = $$\begin{bmatrix}0 & 0 & 0 & 0 & 0 & 0 & 0\\ 0 & 0 & 1 & 2 & 1 & 0 & 0\\ 0 & 0 & 3 & 6 & 3 & 0 & 0\\ 0 & 0 & 4 & 8 & 4 & 0 & 0\\ 0 & 0 & 3 & 6 & 3 & 0 & 0\\ 0 & 0 & 1 & 2 & 1 & 0 & 0\\ 0 & 0 & 0 & 0 & 0 & 0 & 0\end{bmatrix}$$

(b)

Yes, the sum of the pixels in the original and filtered images is not the same, because the kernel isn't normalized.

Part 2:

按鈕一一對應各題的要求

4 到 7 題將只針對第 2 題的A的結果進行調整