

(1) Assignment statement

Homework 2 (Due:3/14)(A) Given a grayscale image I ,Step 1: Use the dithering matrix D_2 to generate an array D of image size by repeating D_2

$$D_2 = \begin{bmatrix} 0 & 128 & 32 & 160 \\ 192 & 64 & 224 & 96 \\ 48 & 176 & 16 & 144 \\ 240 & 112 & 208 & 80 \end{bmatrix}$$

$$D = \begin{bmatrix} D_2 & D_2 & D_2 & D_2 \\ D_2 & D_2 & D_2 & D_2 \\ D_2 & D_2 & D_2 & D_2 \\ D_2 & D_2 & D_2 & D_2 \end{bmatrix}$$

Step 2: Threshold image I by

$$I'(i, j) = \begin{cases} 255 & \text{if } I(i, j) > D(i, j) \\ 0 & \text{if } I(i, j) \leq D(i, j) \end{cases}$$

Step 3: Show images I and I'

3-0

(B) Extend to $n = 4$ gray values

1. $255 / 3 = 85$

2. $Q(i, j) = [I(i, j) / 85]$

3. $D_1 = \begin{bmatrix} 0 & 56 \\ 84 & 28 \end{bmatrix} \Rightarrow D_{\text{extend}}$

4. $I'(i, j) = Q(i, j) + \begin{cases} 1 & \text{if } I(i, j) - 85Q(i, j) > D(i, j) \\ 0 & \text{if } I(i, j) - 85Q(i, j) \leq D(i, j) \end{cases}$

5. Scale values of I' so that its values are in $[0, 255]$ for displaying

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(2)

(A) the first question

(A-a) Input/output images

Input:



Output:



(A-b) Source code

```
hw2-2.py  hw2.py  x  hw.py
hw2.py > ...
1 import sys
2 import numpy as np
3 import matplotlib.pyplot as plt
4 import matplotlib.image as mpimg
5
6 x=mpimg.imread(sys.argv[1])
7 x=x[...,0]
8
9 D2 = np.array([[0, 128, 32, 160], [192, 64, 224, 96], [48, 176, 16, 144], [240, 112, 208, 80]])
10 r2 = x.copy()
11 r2[:,x.shape[0]//D2.shape[0] *4, :x.shape[1]//D2.shape[1] *4] = np.tile(D2, (x.shape[0]//D2.shape[0], x.shape[1]//D2.shape[1]))
12
13 x4 = (x>r2).astype(np.uint8)
14
15 plt.imsave("input_"+sys.argv[1],x,cmap='gray')
16 plt.imsave("out_a_"+sys.argv[1],x4,cmap='gray')
17
18 figure,ax=plt.subplots(1,2)
19 ax[0].imshow(x,cmap='gray')
20 ax[1].imshow(x4,cmap='gray')
21 plt.show()
```

(B) the second question

(B-a) Input/output images

Input:



Output:



(B-b) Source code

```
hw2-2.py x hw2.py out_btest.jpg hw.py
hw2-2.py > ...
1 import sys
2 import numpy as np
3 import matplotlib.pyplot as plt
4 import matplotlib.image as mpimg
5 import math
6
7 x=mpimg.imread(sys.argv[1])
8 x=x[...,0]
9
10 D2 = np.array([[0, 56], [84, 28]])
11 r2 = x.copy()
12 r2[:x.shape[0]//D2.shape[0] *2, :x.shape[1]//D2.shape[1] *2] = np.tile(D2, (x.shape[0]//D2.shape[0], x.shape[1]//D2.shape[1]))
13 x4 = x.copy()
14 x = x.astype(np.float64)
15
16 for i in range( x.shape[0] ):
17     for j in range( x.shape[1] ):
18         q = math.floor(x[i][j]/85)
19         x4[i][j] = q+(x[i][j]-85*q>r2[i][j])
20
21 plt.imsave("input_"+sys.argv[1],x,cmap='gray')
22 plt.imsave("out_b"+sys.argv[1],x4,cmap='gray')
23
24 figure,ax=plt.subplots(1,2)
25 ax[0].imshow(x,cmap='gray')
26 ax[1].imshow(x4,cmap='gray')
27 plt.show()
```

(c) Comments

產生輸出圖以後，我發現 output 圖片在預覽程式裡看起來比用 imshow() 顯示的還要更淺。後來發現顏色不同應該是我用的預覽程式的問題，因為我將 output 圖片放到 word 中就發現它看起來與用 imshow() 顯示的圖片顏色相同，代表 output 圖片本身應該是跟 imshow() 顯示的相同，只是我用的預覽程式顯示圖片時會將圖片的顏色變淡。