資訊網路與多媒體研究所

博士班基本學科考試：數位影像處理

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1. (20%) Assume that we have an image of 8x8 pixels, ranging from 0 to 7, as shown below:

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

   (a) Suppose it is displayed on a device with 15 grey-levels (i.e. the pixel values ranging from 0 to 14.) Please design a linear transformation of the histogram in order to make the image more appealing on this device. Write down and plot the transfer function.
   (b) Please plot the histogram of the output image obtained in part (a).
   (c) Now we would like to further enhance the result in part (b) by discrete histogram equalization. In other words, the desired histogram is supposed to be as flat as possible. Please explain how to perform equalization to this image and plot the resultant histogram (note that you have to label the grid for both x-axis and y-axis).
   (d) Please compare the results of part (b) and part (c).

2. (30%)
   Suppose that an image of size 128×128 is expending with the rate of 2 pixels per second in each dimension separately (note that the center of the pixel is fixed). Let F(i,j) denote the original image and G(i,j) represent the expanded image after 10 seconds. Please calculate the pixel values at G(0,0), G(120,60) and G(16, 32) in terms of F(i,j), respectively.

3. (20%) Suppose an image is corrupted by different kind of noise including uniform, impulse and sinusoid noises. Try to develop an algorithm to obtain a clear edge map of this image. Please describe your method step by step.

4. (30%)
   (a) What is the difference between image restoration and image enhancement?
   (b) Write down the definitions of arithmetic mean filter and geometric mean filter, respectively. What's the difference between them?
   (c) What is ideal low-pass filter in frequency domain? Please discuss its pros and cons.
   (d) Please write down the definitions of open and close operators.
   (e) Please briefly describe what digital halftoning is and provide one example where it is applicable.
   (f) Suppose we have the following two dithering threshold matrices, T1 and T2. Which one serves as a good dither matrix? Why or why not?

| | | | |
|---|---|---|---|
| 128 | 0 | 64 | 240 |
| 224 | 16 | 96 | 144 |
| 160 | 32 | 80 | 208 |
| 192 | 48 | 112 | 176 |

T1

| | | | |
|---|---|---|---|
| 0 | 128 | 240 | 112 |
| 224 | 16 | 96 | 144 |
| 160 | 80 | 32 | 208 |
| 64 | 192 | 176 | 48 |

T2