博士班基本學科考試：數位影像處理

2014 年 3 月 13 日

1. (20%).
   (a) (10%) What is the difference between local and global histogram equalizations?
   (b) (10%) Describe the sampling theorem and explain why aliasing would occur if the chosen sampling rate is inappropriate.

2. (36%) Suppose a gray-level image contains various noise including uniform, impulse and sinusoid noises.
   (a) (15%) Please design an algorithm to remove those noises and describe it in detail.
   (b) (15%) If the proposed method in part(a) is performed in pixel domain, explain the advantage over performing noise removal in frequency domain. If the algorithm proposed in part(a) is implemented in frequency domain, explain why it is chosen rather than algorithms in pixel domain.
   (c) (6%) What extra issues we should concern if the noisy image is a color image instead of a gray-level one?

3. (26%) The Discrete Cosine Transform (DCT) is a widely used transform. The definition of M×N DCT is

$$F(u,v) = \frac{2C(u)C(v)}{\sqrt{MN}} \sum_{i=0}^{M-1} \sum_{j=0}^{N-1} \cos\frac{(2i+1)u\pi}{2M} \cos\frac{(2j+1)v\pi}{2N} f(i,j),$$

   where $f(i,j)$ represents the image pixel value at position (i,j), u = 0, 1, …, M-1 and j, v = 0, 1, …, N-1, and the constants C(u) and C(v) are determined by

$$C(\xi) = \begin{cases} \frac{\sqrt{2}}{2}, & \xi = 0 \\ 1, & otherwise \end{cases}.$$

   (a) (6%) F(0,0) is also known as a DC coefficient. From the equation given above, please explain what the meaning of DC coefficient is and why it is called a "DC value".
   (b) (10%) Fig. 1 shows 8×8 2-D DCT basis functions. By definition of DCT transform, please show in a mathematical way that F(0,2) is actually related to the pattern in the position (0,2) below.

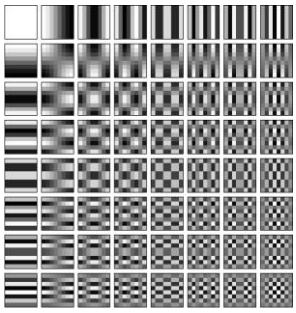

Fig. 1: 2-D DCT basis functions

(c) (10%) Please explain why DCT is commonly adopted in image compression.

4. (18%) Morphological Processing
   (a) (3%) Please sketch and specify the size of the result of dilating a circle of radius r by a circular structuring element of radius d, where $d < r$.
   (b) (3%) Use the same structuring element to dilate a square of size $r \times r$. Please sketch and specify the size of the result.
   (c) (3%) Use the same structuring element to dilate an equilateral triangle with sides of length d. Please sketch and specify the size of the result.
   (d) (9%) Repeat (a) to (c) for erosion.