# 網媒所博士班基本學科考試：數位影像處理

2013 年 3 月 8 日

**1. (20%)** If a filter transfer function H(u,v) is real and symmetric, then

$$H(u,v) = H^*(u,v) = H^*(-u,-v) = H(-u,-v)$$

Please show that the corresponding spatial domain filter $h(x,y)$ also is real and symmetric.

[Hint]: $h(x,y) = \Im^{-1}\left[H(u,v)\right] = \sum_{x=0}^{M-1}\sum_{y=0}^{N-1} H(u,v)e^{j2\pi(ux/M+vy/N)}$

**2. (20%)**

**(a)(10%)** Consider the problem of image blurring caused by uniform acceleration in the x-direction. If the image is at rest at time t = 0 and accelerates with a uniform acceleration $x_0(t) = a\,t^2/2$ for a time interval T, find the blurring function H(u,v). You may assume that shutter opening and closing times are negligible.

(Hint: Fresnel cosine and sine integrals are C(x) and S(x) shown below. You can express your answer using Fresnel cosine and sine integrals.)

$$C(x) = \int_0^x \cos t^2 dt$$

$$S(x) = \int_0^x \sin t^2 dt$$

**(b)(10%)** Let g(x,y) be the blurred image due to the motion described in **(a)**. Given the blurring function H(u,v), how can one obtain the deblurred image $\hat{f}(x,y)$ using the inverse filtering ?

**3. (20%)** Image enhancement can be achieved by subtracting from an image its Laplacian. Show that this operation is proportional to unsharp masking. Here, the Laplacian is defined as:

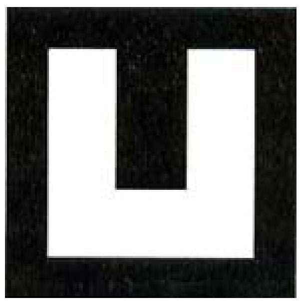
$$\nabla^2 f = [f(x+1,y) + f(x-1,y) + f(x,y+1) + f(x,y-1)] - 4f(x,y)$$

and the unsharp masking can be expressed as

$$f_s(x,y) = f(x,y) - \alpha\,\bar{f}(x,y)$$

where $\alpha$ is a constant.

**4. (20%)** With reference to the "Original Image" shown below, give the structuring elements and morphological operation(s) that produced each of the results shown in Fig. 4(a) and Fig. 4(b). The dashed lines show the boundary of the original set and are displayed only for reference.



Original Image

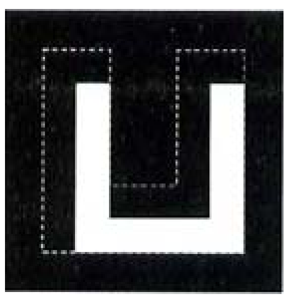


Fig. 4(a)

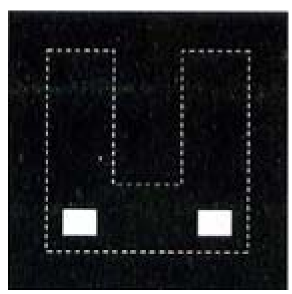


Fig. 4(b)

**5. (20%)** Suppose that you are given two images. The image shown in Fig. 5(b) is obtained from Fig. 5(a) by the procedure listed below:

(i) multiplying the image on the left by $(-1)^{x+y}$ ;
(ii) computing the DFT
(iii) taking the complex conjugate of the transform
(iv) computing the inverse DFT
(v) multiplying the result by $(-1)^{x+y}$

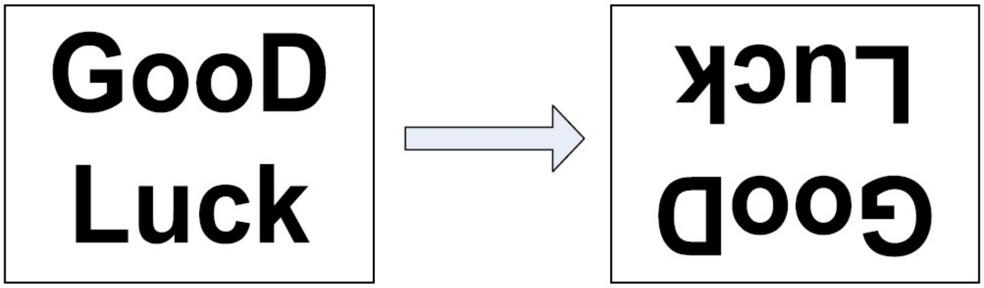



Fig. 5(a) Original image f(x,y) Fig. 5(b) Modified image

Please write down the mathematical expression of each step and explain why the modified image looks like the one in Fig. 5(b)