Principles and Applications of Image Processing

【Fall, 2015】

Mid-Term Exam

Problem 1: Gray Level Interpolation (20%)

Four pixels in an image have the grey levels as shown in Figure 1a. Fill in the grey levels of pixels $n_1 \sim n_5$ in Figure 1b when the original image is enlarged twice of the original size using the bilinear interpolation method.

	10	20	
	40	80	

Figure 1a

	10	n_1	20	
	n_2	n_3	n_4	
	40	n_5	80	

Figure 1b

Problem 2: Histogram Equalization (20%)

An image has been quantized with eight levels (n = 0, 1, 2, … , 7). The probability of each level is $p(n) = k\sqrt{n+0.5}$. Find k and equalize the histogram. What are the probabilities of the eight levels of the equalized image?

Problem 3: Convolution (15%)

Find the linear convolution of the following two sequences:

$$f(n) = [0,4,0,-1], \quad h(n) = [\,1,2,4,2,1]$$

Show the details of how you obtain the result.

Problem 4: Mask and Filter (15%)

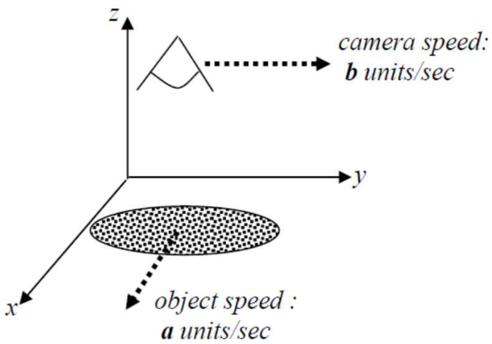
Find the equivalent filter, $H(u,v)$, that implements in the frequency domain the spatial operation performed by the Laplacian mask in Fig. 3.37(b).

Problem 5: Image Degradation Model (15%)

Consider an image acquisition system shown below. The camera is placed above the object that resides on the x-y plane. The camera moves horizontally in the y-axis direction at a speed of ***b*** units per seconds while the object moves horizontally in the x-axis direction at a speed of ***a*** units per second. Assume the image acquisition process continues for a period of **T** seconds and the lens opening and closing are both instantaneous. Other parameters of the camera (like the focus length, the viewing angle, and the distance from the x-y plane) are all fixed.

(a) Derive the linear filter, $H(u,v)$, corresponding to the motion blur caused by the imaging acquisition process.

(b) Derive the Weiner filter that can be used to restore the blurred image, assuming white noise exists during image acquisition.



Problem 6: Chromaticity Diagram (15%)

Give the percentage of red (X), green (Y), and blue (Z) light required to generate the points labeled "BLUE" and "COOL WHITE" in Figure 6.5.

Compute the RGB, CMY and HSI components of the "BLUE" and "COOL WHITE" points assuming the conversion of XYZ to RGB can be obtained using the following matrix equation:

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 2.042 & -0.565 & -0.344 \\ -0.969 & 1.876 & 0.0415 \\ 0.0134 & -0.118 & 1.015 \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}$$