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| Principles and Applications of Image Processing |

【Fall, 2018】

Mid-Term Exam

**Problem 1: Image Equalization (20%)**

A 3-bit image has the probability distirubtion function of its histogram described by the following equation:

is p (rk) = a. Find a and equalize the histogram. What are the probabilities of the eight levels of the equalized image? Show the steps of your computation.

<sol>

() a = 1

k = 0.0467

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | 0.05 |  | 0.05 | |  | 0.33 | 0 |
|  | 0.08 |  | 0.13 | |  | 0.89 | 1 |
|  | 0.10 |  | 0.23 | |  | 1.62 | 2 |
|  | 0.12 |  | 0.36 | |  | 2.49 | 2 |
|  | 0.14 |  | 0.50 | |  | 3.47 | 3 |
|  | 0.15 |  | 0.65 | |  | 4.55 | 5 |
|  | 0.17 |  | 0.82 | |  | 5.73 | 6 |
|  | 0.18 |  | 1.00 | |  | 7.00 | 7 |
|  | | | | 0.0467 | | | |
|  | | | | 0.0809 | | | |
|  | | | | 0.228 | | | |
|  | | | | 0.1401 | | | |
|  | | | | 0 | | | |
|  | | | | 0.1549 | | | |
|  | | | | 0.1684 | | | |
|  | | | | 0.1810 | | | |

**Problem 2: Fourier Transform (15%)**

Please find the discrete Fourier transform of the following 4-point complex sequence:

f[n] = [0+0j, 1+1j, 0+0j, -1-1j]

<sol>

一維離散傅利葉公式：





F(0) = 0;

F(1) = -2j+2;

F(2) = 0;

F(3) = 2j-2;

所以傅利葉轉換後之新矩陣為{0,-2j+2, 0, 2j-2}

**Problem 3: Mask Operation (15%)**

The following two imags both have a resolution of 512x512 and 256 gray scale.

1. Draw the histogram of the two images in detail.
2. Draw the histogram of the two images after they are blurred by a 3x3 average filter. Explain your results.

<sol>

(a)

(b)

3(a)

3(b)

**Problem 4: Gray level Interpolation (20%)**

Four pixels in an image have the grey levels as shown in Figure 4a. Fill in the grey levels of pixels n1 ~ n5 in Figure 4b when the original image is enlarged twice of the original size using the bilinear interpolation method.

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  | 10 | 20 |  |
|  | 40 | 80 |  |
|  |  |  |  |

<sol>

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  |  |
|  | 10 | 15 | 20 |  |
|  | 25 | 37.5 | 50 |  |
|  | 40 | 60 | 80 |  |
|  |  |  |  |  |

**Problem 5: Convolution (15%)**

Find the convolution of the following two sequences:

*f*(x)= [5,5,4,3,2,1,1,1], h(x) = [1,0,-1,2]

Show the details of how you obtain the result.

<sol>

**Problem 6: Image Degradation Model (15%)**

An imaging system has a spatially invariant impulse response function

h(x,y) = Ke-(x2+y2)

Suppose that the input image f(x,y) to the system is a vertival line located at x=a.

1. Construct an analytical model to compute the output g(x,y) given the input f(x,y)
2. Compute and sketch the input and output images

Note the calculation will have an unknown multiplicative scale factor.

<sol>

(a) According to Eq. 5.6-8 ~ 5.6-10 in the Textbook, the linear filter *H(u,v)* is

,

, , then the *H(u,v)* is able to be derived as



To be continue ….