EECS 203A HW2 John Liu 25961868

1. Suppose that we have an input image with the histogram

$$h(r_k) = 3r_k \qquad r_k = 0, 1, 2, \ldots, 10$$

We desire a gray level transformation $M(r_k)$ such that the histogram of the transformed image is as close as possible to

$$d(r_k) = 3(10 - r_k) \qquad r_k = 0, 1, 2, \ldots, 10$$

a) Using the method described in class, determine $M(r_k)$ for $r_k = 0, 1, \ldots, 10$.
b) What is the histogram $o(r_k)$ for $r_k = 0, 1, 2, \ldots, 10$ of the transformed image?

Input

r_k	P_r	$T(r_k)$
0	0	0
1	3	3
2	6	9
3	9	18
4	12	30
5	15	45
6	18	63
7	21	84
8	24	108
9	27	135
10	30	165

Desired

z_k	P_z	$T(z_k)$
0	30	30
1	27	57
2	24	81
3	21	102
4	18	120
5	15	135
6	12	147
7	9	156
8	6	162
9	3	165
10	0	165

a)

r_k	$M(r_k)$
0	0
1	0
2	0
3	0
4	0
5	1
6	1
7	2
8	3
9	5
10	10

b)

r_k	$O(r_k)$
0	30
1	33
2	21
3	24
4	0
5	27
6	0
7	0
8	0
9	0
10	30

2. Suppose that we capture a sequence of images

$$g(x, y, t_i) = f(x, y) + n(x, y, t_i)$$

where $f(x, y)$ is a noise-free image and $n(x, y, t_i)$ is a zero-mean additive noise source with variance $\sigma_n^2(x, y)$. Assume that the noise at any time is independent of the noise at any other time.

a) Suppose that we form the image

$$h(x, y) = \frac{1}{N} \sum_{i=1}^{N} (-1)^i g(x, y, t_i)$$

where N is an even integer. What is the expected value of $h(x, y)$?

b) What is the variance of $h(x, y)$?

a) $h(x,y) = 1/N(-f(x,y) - n(x,y,t_1) + f(x,y) + n(x,y,t_2) + \cdots - f(x,y) - n(x,y,t_{N-1}) + f(x,y) + n(x,y,t_N))$

$\because$ $n(x,y,t_i)$ is zero-mean

$\therefore E[h(x,y)] = 0$

b) $VAR[h(x,y)] = VAR[1/N(-n(x,y,t_1) + n(x,y,t_2) + \cdots - n(x,y,t_{N-1}) + n(x,y,t_N))]$

$= 1/N^2\ VAR[-n(x,y,t_1) + n(x,y,t_2) + \cdots - n(x,y,t_{N-1}) + n(x,y,t_N)]$

$\because$ noise is independent

$\therefore VAR[h(x,y)] = 1/N^2 \cdot N \cdot \sigma_n^2(x,y) = 1/N \cdot \sigma_n^2(x,y)$

Computer Problems:

a) Assume $L = 256$ and generate a lookup table that maps input gray-levels to output gray-levels for a power law transform with $\gamma = 0.4$ and $\gamma = 2.5$. For the two cases, plot output gray-level s versus input gray-level r. These should look like Figure 3.6 in the textbook. Submit a plot of your two curves. Apply these two GLTs to the cat image and submit the images. Describe the appearance of the two transformed images compared to the original image.

b) Apply histogram equalization to the cat image. Submit your code and a plot of the output gray-level versus input gray-level for the transform. Submit the histogram equalized image. Describe the appearance of the transformed image compared to the original image.

'EECS203A_HW2_a.m' generates table (.csv), plot (.jpg)

'EECS203A_HW2_a.c' applies GLTs to generate transformed images (.raw)

'EECS203A_HW2_b.m' generates plot (.jpg) and the histogram equalized image (.raw)

a) Compared to the original image. image of output gray level for a power law transform with $\gamma = 0.4$ turns to be brighter. and the one with $\gamma = 2.5$ turns to be darker.

b) Compared to the original image, the histogram equalized image has stronger contrast, bright part becomes brighter and dark part becomes darker