DIP HW1 Report

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Warm-up: Simple Manipulations

(a) Perform horizontal flipping on image I_1.

To flip the image horizontally, I created a new image array and fill in each row of pixels in reverse order.

Figure 1: I_1, sample1.raw

Figure 2: image B

(b) Perform a power-law transform to enhance image B.

The following are the transformed images with their corresponding histograms using different transform functions. As the power goes larger, the image becomes darker and the contrast increases. But the sky becomes more noisy in the image with power $= 3$.

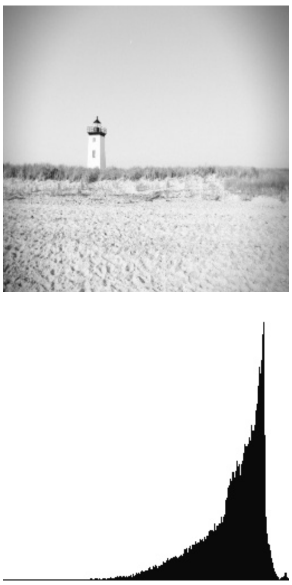
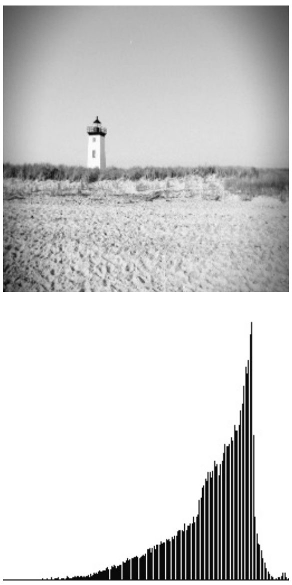
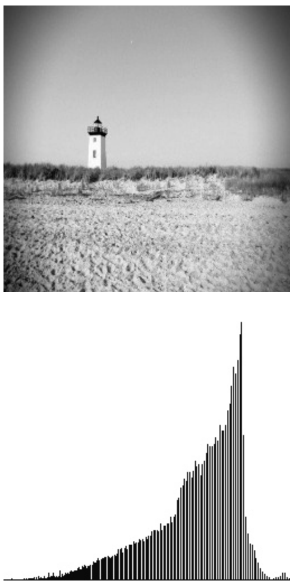


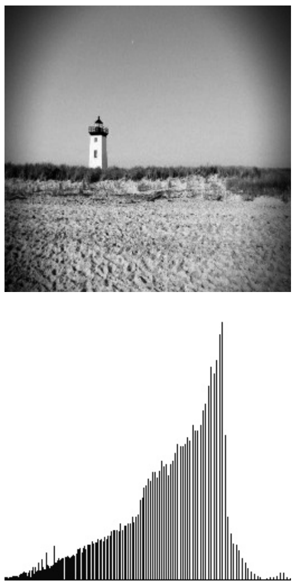
image B



Power $= 1.5$



Power $= 2.0$



Power $= 3.0$

Problem 1: Image Enhancement

(a) Decrease the brightness of I_2 by dividing the intensity values by 2 as image D.

(b) Decrease the brightness of I_2 by dividing the intensity values by 3 as image E.

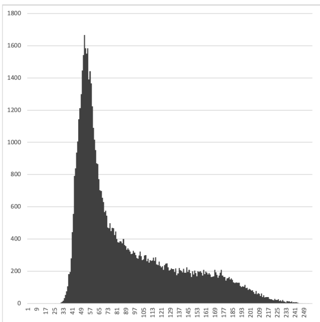
Figure 3: I_2, sample2.raw

Figure 4: image D

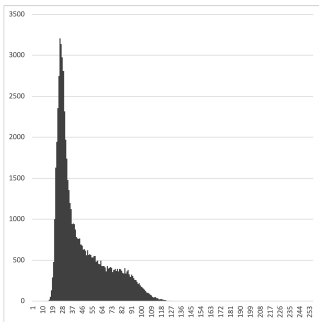
Figure 5: image E

(c) Plot the histograms of I_2, D and E.

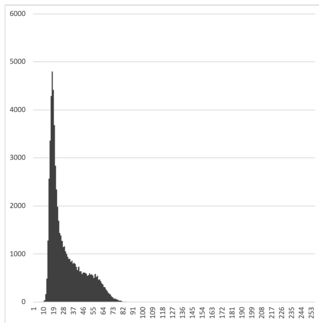
With the intensity divided, the images become much darker and the contrast is very low. From the histogram we can see that for image E, the intensity is limited to the lower 1/3.



Histogram of I_2



Histogram of image D



Histogram of image E

(d) Perform global histogram equalization on D and E and output the results as H_D and H_E respectively.

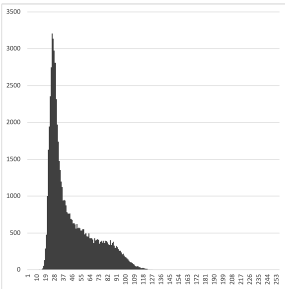
I cannot see clear difference directly between image H_D and H_E, but although the histograms of H_D and H_E have roughly the same shape (due to histogram equalization), the distribution of H_E is sparser. Because the intensity of image E is compressed to a smaller range, their are more lost information, so some pixels cannot be distinguished when doing histogram equalization.

image D

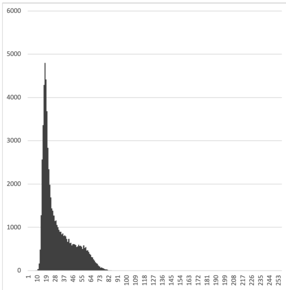
image E

image H_D

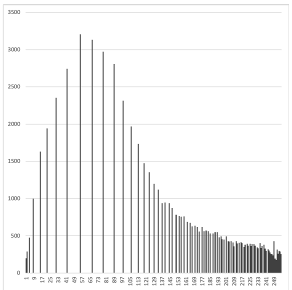
image H_E



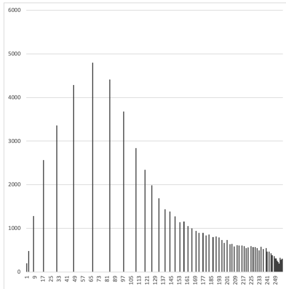
Histogram of D



Histogram of E



Histogram of H_D



Histogram of H_E

(e) Perform local histogram equalization on D and E and output the results as L_D and L_E respectively.

Local histogram equalization is done on each pixel with a transformation function derived from a neighboring 32×32 block and apply histogram equalization. At the image boundaries, the block is sampled by mirroring pixels with respect to the boundary.

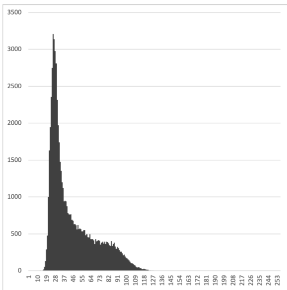
Because the transformation function of each pixel is derived individually, there are no gaps in the histograms as those of global histogram equalization.

image D

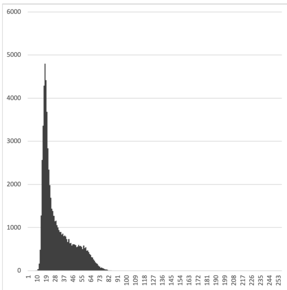
image E

image L_D

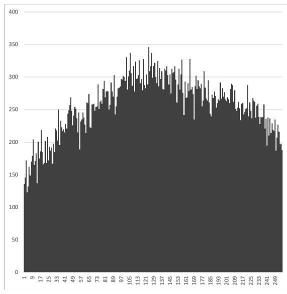
image L_E



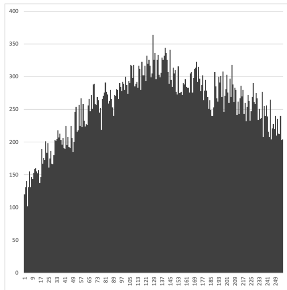
Histogram of D



Histogram of E



Histogram of L_D



Histogram of L_E

(f) Comparing local histogram equalization to global histogram equalization, the contrast of each region is more enhanced and also more uniform throughout the image. The histograms are also more uniformly distributed.

Problem 2: Noise Removal

(a) Remove noise from Fig.3(b) and Fig.3(c).

The noise in Fig.3(b) is more like a uniform noise, so I choose to use low pass filtering to cancel the noise. The filter I used is

$$H = \frac{1}{16}\begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$$

The noise in Fig.3(c) is more like a impulse noise, so I choose to use median filtering to cancel the noise. Each pixel is set to the median value of the neighboring 3×3 block.

Fig.3(b)

image N_1

Fig.3(c)

image N_2

(b) Compute the PSNR values of N_1 and N_2. The following is the PSNR of each image.

Fig.3(b) (sample4)	23.49
image N_1	28.66
Fig.3(c) (sample5)	14.71
image N_2	18.57

After the filtering, the PSNR value increased for both Fig.3(b) and Fig.3(C), so the filtering did successfully cancelled out some noise.