EE7374 – Digital Image Processing

Homework-1

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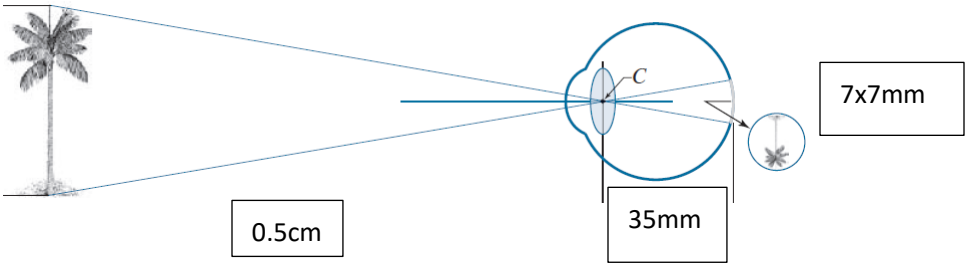
1. Modeling the imaging process (5 points)

Problem 2.8 from Gonzalez and Woods 4e. The problem reads: "A CCD camera chip of dimensions 7 x 7mm…."

Modeling the imaging processing as in figure 2.3



Now we can get the size of flat area = 7/35*500 = 100x100mm

So the pixel per mm = 1024/100 = 10

And because width of line pairs is 2W, so pairs per mm = 10/2 = 5.

2. Image denoising (20 points)

For this portion of the assignment you will be simulating image denoising by averaging. Please use the Sombrero Galaxy image (sombrero-galaxy-original.tif) supplied with the assignment to complete the assignment. Note that the supplied image is free of noise. You are required to simulate corruption of the image by adding white Gaussian noise. The noise should have zero mean and a standard deviation of 16 gray levels. The task may be accomplished using the `randn` function, following the approach suggested in Slide-48 of Lecture-3.

Please refer to the MATLAB help (`help randn`) for details on simulating zero mean white-Gaussian noise with a prescribed standard deviation.

Deliverables & Questions

1. MATLAB code for this portion of the assignment made available as a function or script with the name `HWK1_Denoising_by_Averaging.m`. (10 points)
2. What are the largest and smallest intensities in the original image? (1 point)

   Largest = 255
   Smallest = 0
3. What makes the noise Gaussian and white? (3 points)

White refers to the idea that it has uniform power across the frequency band for the information system. It is an analogy to the color white which has uniform emissions at all frequencies in the visible spectrum.

Gaussian because it has a normal distribution in the time domain with an average time domain value of zero.

4. Does the result of denoising improve with averaging more realizations/images? How does your answer compare with the MSE for each case? (3 points)

   Yes, it improves.

   MSE of averaging 25 noisy images:

```
mse =

    1.5633e-04
```

   MSE of averaging 50 noisy images:

```
mse =

    7.8100e-05
```

   MSE of:

```
mse =

    3.9120e-05
```

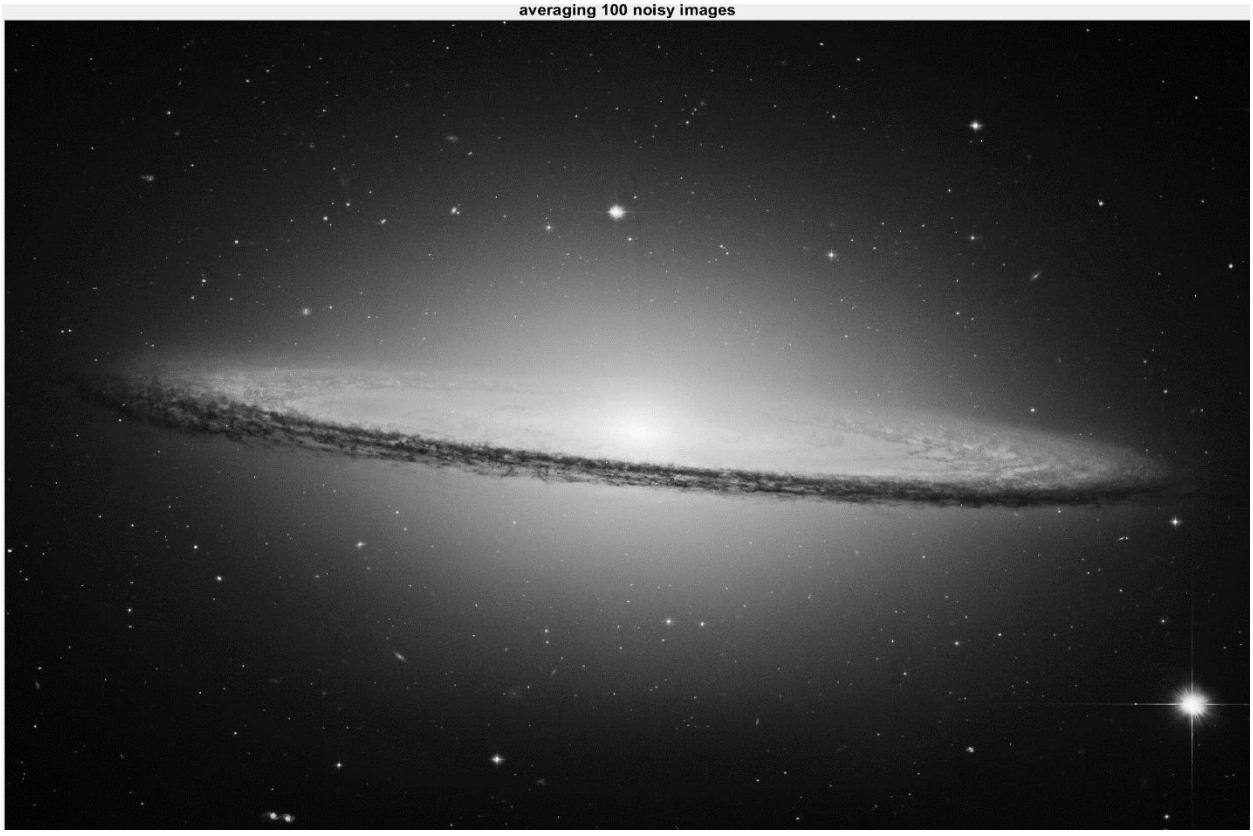
5. Screenshots of the original image and the 3 denoised images. Label each screenshot clearly. Failure to do so will result in deduction of points. (3 points)

original images

averaging 25 noisy images

averaging 50 noisy images

averaging 100 noisy images



3. Detecting image tampering by image differencing(10 points)

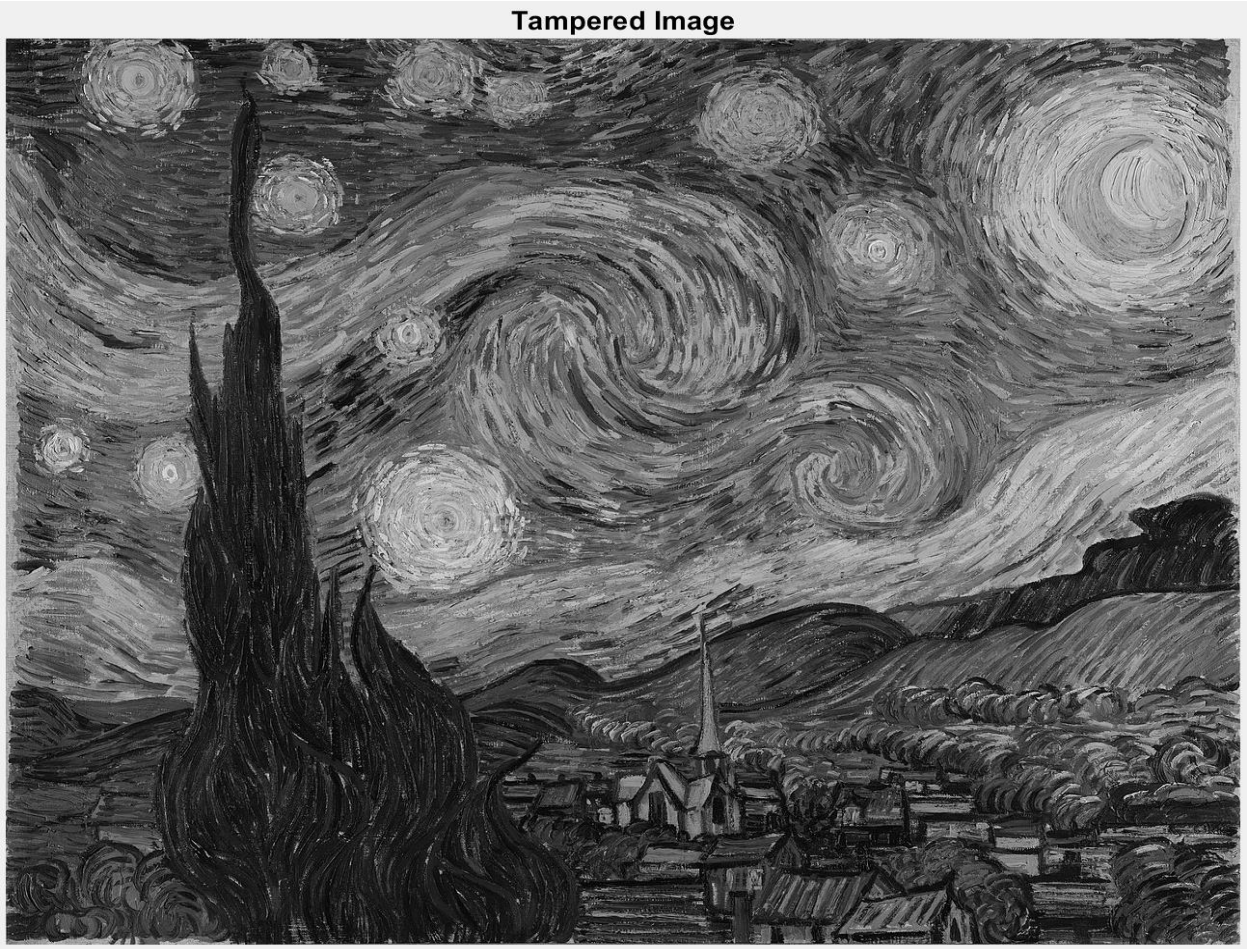
For this portion of the assignment you will be using the starter MATLAB code `HWK1_ImageTampering.m` supplied with the assignment. The purpose is to detect tampering of an image by subtracting the image suspected of tampering from the original image. In this case, the original image is a picture of Van Gogh's Starry Night. The image has been borrowed from https://en.wikipedia.org/wiki/The_Starry_Night.

Deliverables & Questions

1. Completed MATLAB code for `HWK1_Image_Tampering.m`. (5 points)
2. What message is hidden in your painting? (2 points)
   11-Feb-2019 21:06:32
3. Provide screenshots of the original image, the tampered image, the difference image with and without typecasting into `double` format. Label each screenshot clearly. Failure to do so will result in deduction of points. (3 points)

   Original Image:

Tampered Image:



difference image with typecasting:

difference image without typecasting:

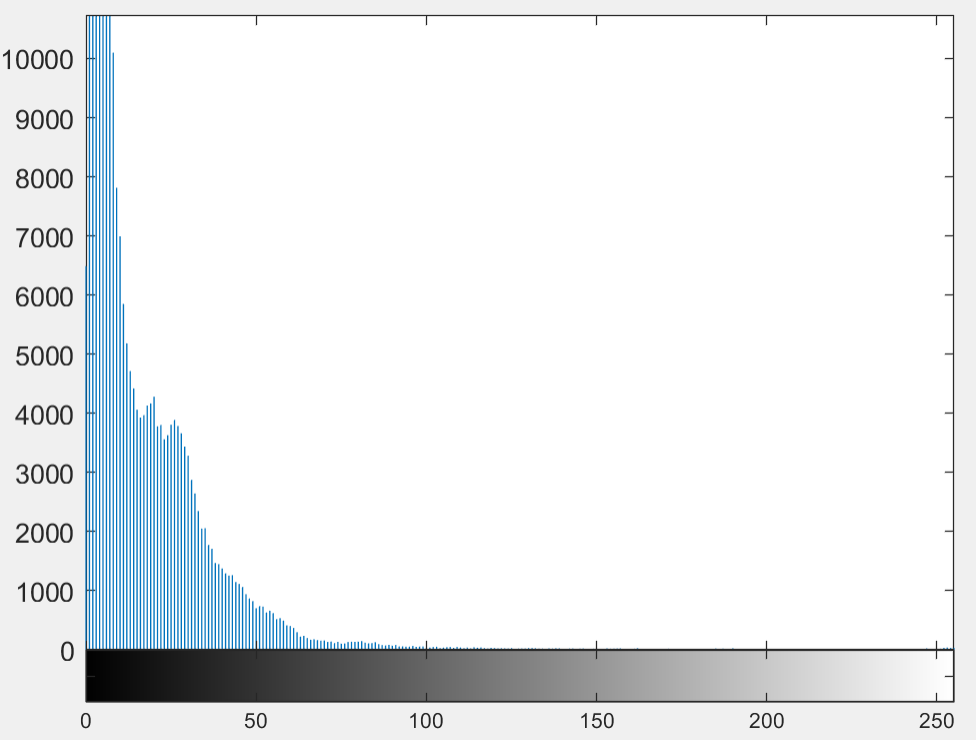
4. Histogram Equalization (15 points)

Part-I (5 points)

It is common knowledge that the visibility of lane markings, road signs, and obstacles on roads is significantly reduced at nighttime. Your task is to develop a contrast enhancement algorithm based on the principles of histogram equalization. For this portion of the assignment you will be using the image Dark_Road.jpg.

Please perform the following operations on the image and document the results in your writeup:

a) Plot and submit histogram of the original image (lookup MATLAB tips below). (1 point)

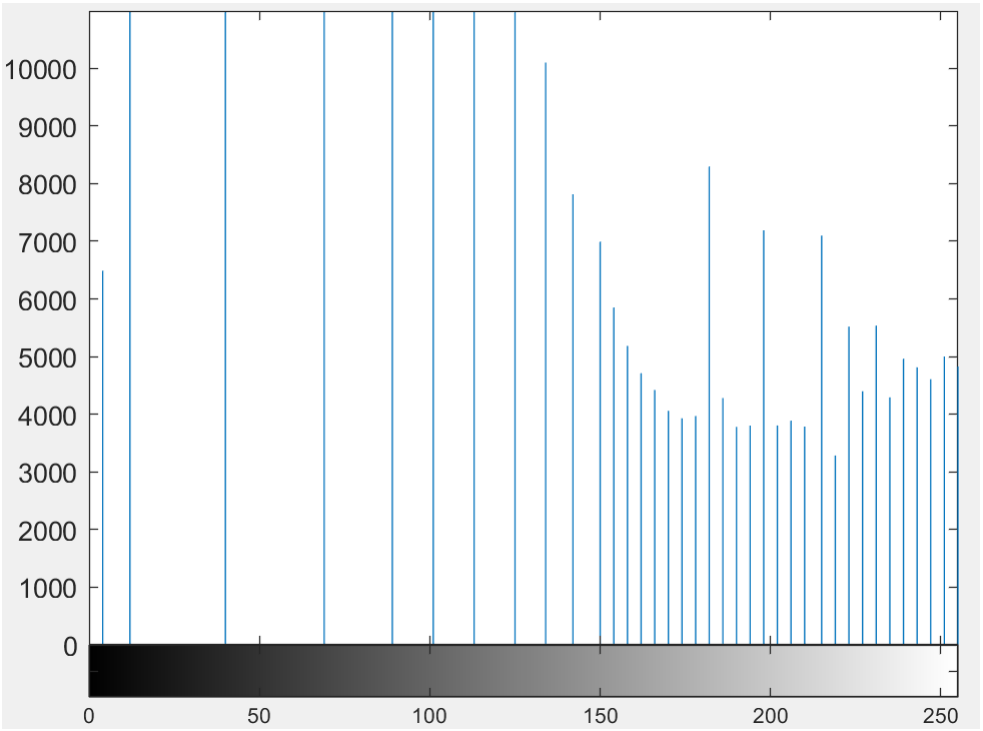


b) Briefly comment on the shape of the histogram. Does the histogram explain why the image appears dark? (1 point)

The histogram shows that the components are localized in low intensity value. And because low intensity value is darker, so the image appears dark.

c) Apply histogram equalization to the original image (use MATLAB function: `histeq`). Display and submit the result of enhancement. (1 point)

d) Plot and submit the histogram of the enhanced image. (1 point)



e) Comment on desirable/undesirable enhancements in the image (1 point)

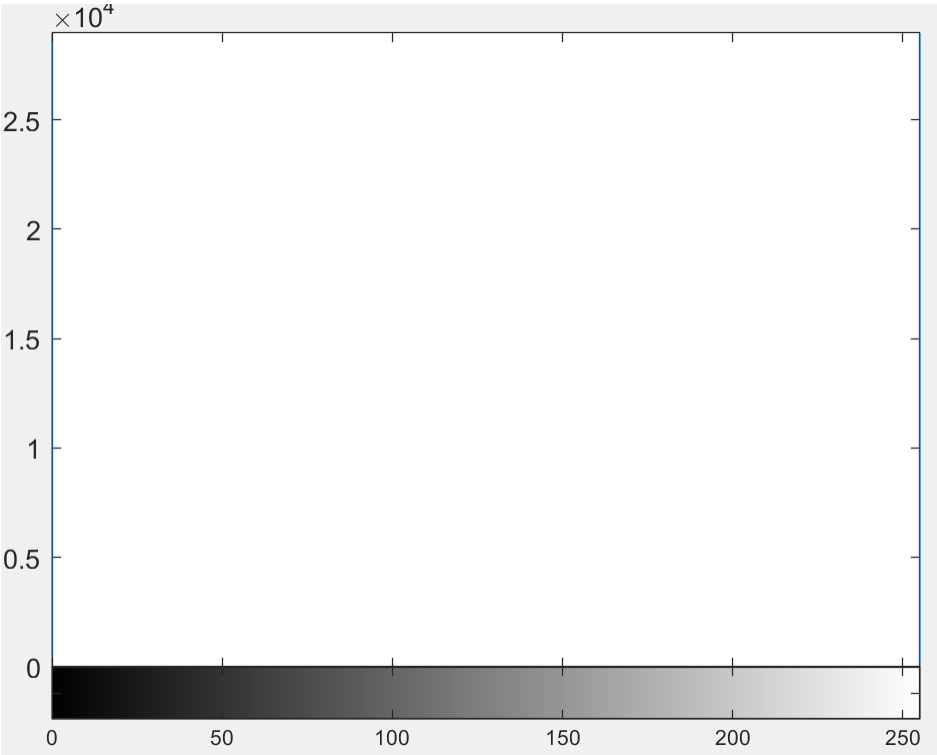
The enhanced image is much lighter and shows more details. But there is many noise.

Part-II (10 points)

The second part of the assignment tests your understanding of the principles governing histogram equalization. For this portion of the assignment you will be using the binary image Checkerboard.png. Notice that the squares in the image are either black or white. This fact may be confirmed by examining the gray levels and plotting the histogram of the image.

Please perform the following operations on the image and document the results in your writeup:

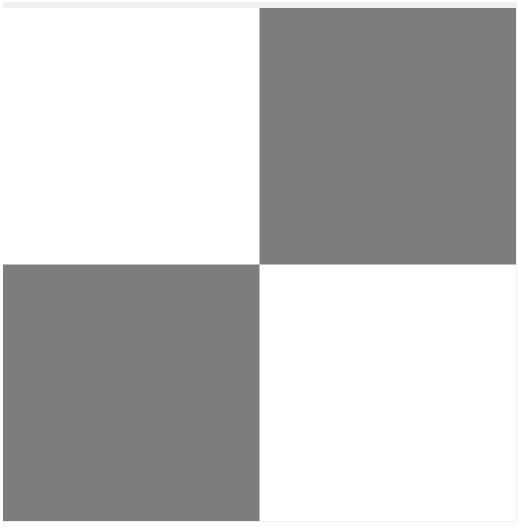
a) Plot and submit histogram of the original image. (1 point)



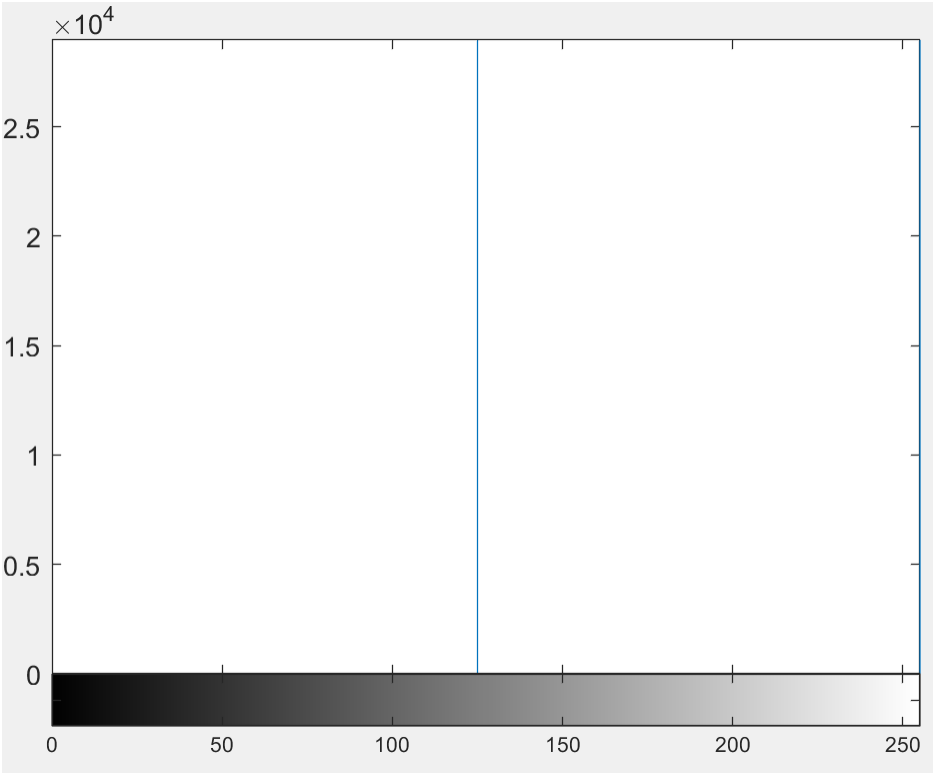
b) Comment on the structure of the histogram? (1 point)

The histogram shows that all the components are either 0 or 255 because the square in the image are either black or white.

c) Apply histogram equalization to the original image (use MATLAB function: `histeq`).
Display and submit the result of enhancement. (1 point)



d) Plot and submit the histogram of the enhanced image. (1 point)



e) What happened to the intensity of the black and white squares? (1 point)

Black squares become grey while white squares are still white.

f) Provide a mathematical justification for why the result makes sense. (HINT: Lookup slide-23 from Lecture-3). (5 points)

Because the value of image is half 0 and half 255, so the cdf of 0 is 0.5*M*N and the cdf of 255 is M*N.

$H(0) = \text{round}(\frac{0.5*M*N}{M*N} * 255) = 128$

$H(255) = \text{round}(\frac{M*N}{M*N} * 255) = 255$