Department of Electrical and Computer Engineering
University of Delaware

ELEG404/604 - Digital Imaging and Photography

Homework 2, Spring 2022

Due date: March 2, 2022

1 Problem.

Modify the images “imgnoise1” and “imgnoise2” to smooth the noise on them using:

(a) a 5×5 average filter.

(b) a center weighted median filter. You should design the window size and the center weight so that you get a satisfactory result.

Show your results and explain which filter is better and why.

NOTE: DO NOT use built-in functions to perform the filtering of the images. You should implement your own convolution routines. You can use either Matlab or Python for this assignment.

2 Problem.

Given the 6×6 image I shown below

$$I = \begin{bmatrix} 1 & 3 & 4 & 2 & 2 & 5 \\ 1 & 1 & 7 & 5 & 1 & 2 \\ 6 & 5 & 0 & 5 & 2 & 4 \\ 3 & 5 & 1 & 0 & 4 & 3 \\ 1 & 3 & 2 & 3 & 2 & 3 \\ 0 & 6 & 7 & 7 & 4 & 5 \end{bmatrix}$$

Do the following calculations by hand:

(a) Determine the histogram of the image.

(b) Determine the cumulative distribution.

(c) Determine the point transform $T[I]$ which best performs histogram equalization.

(d) Show the transformed image.

(e) Determine the histogram of the transformed image.

3 Problem.

Solve the problem that corresponds to the level of your course. Zoom in relevant areas of the image to emphasize the performance of your routine:

1. ELEG404: Implement a Sobel edge detector and apply it to the image “building.jpg”.
2. ELEG604: Implement a bilateral filter and apply it to the image “buildingNoisy.png”. Find the implementation of the filters BM3D and FFDNet and apply them to the same image. Explain the differences observed in the filtered images. What advantages and disadvantages do you observe in each of these filters?

4 Problem.

Solve the problem that corresponds to the level of your course:

1. ELEG404: Prove the scaling property of the Fourier transform, i.e., show mathematically that for a function $g(t)$ with Fourier transform $G(u)$, and a constant T, we have:

$$g\left(\frac{t}{T}\right) \xrightarrow{\mathscr{F}} TG(uT) \tag{1}$$

2. ELEG604: Prove the convolution property of the Fourier transform, i.e., show mathematically that for two functions $g(t)$ and $h(t)$ with Fourier transforms $G(u)$ and $H(u)$, respectively, we have:

$$g(t) * h(t) \xrightarrow{\mathscr{F}} G(u)H(u) \tag{2}$$

5 Problem.

Solve the problem that corresponds to the level of your course and show the mathematical process followed to reach your answer:

1. ELEG404: Find by hand the Fourier transform of the triangle function defined as:

$$\Lambda(t) = \begin{cases} 1 - |t|, & \text{if } |t| \leq 1 \\ 0 & \text{otherwise} \end{cases} \tag{3}$$

2. ELEG604: Find by hand the Fourier transform of the Dirac comb defined as:

$$\Delta_T(t) = \sum_{m=-\infty}^{\infty} \delta(t - mT) \tag{4}$$

Important

1. Turn in your homework on **ONE SINGLE** pdf file on Canvas. You are allowed to take pictures of the problems you develop by hand. However, make sure these pictures are legible.
2. You have to include the code that you write.