COMP 435 Biometrics & Security Homework-1

Student ID:_____, Last Name , First Name _____

Q1. _____ 10 pts

Q1. Pixel based image processing, read image, display image, intensity adjustment, denoising and edge detection. Please submit your solution electronically. Fill in the required figures and results, as well as matlab code in this document.

[Q1.a: 2pts] Read in the images “lena” and “cameraman”, display the central 100 x 100 pixel portion of images:

Fig. 1a, 100x100 portion of lena	Fig. 1b. 100 x 100 portion of cameraman
	

Matlab Code:

```
cameraman=imread('cameraman.tif');
[nRow,nColumn]=size(cameraman);
cameraman_crop=cameraman(nRow/2-50:nRow/2+49,nColumn/2-50:nColumn/2+49);
figure(1);
imshow(cameraman_crop);

lena=imread('lena.bmp');
[nRow,nColumn]=size(lena);
lena_crop=lena(nRow/2-50:nRow/2+49,nColumn/2-50:nColumn/2+49);
figure(2);
imshow(lena_crop);
```

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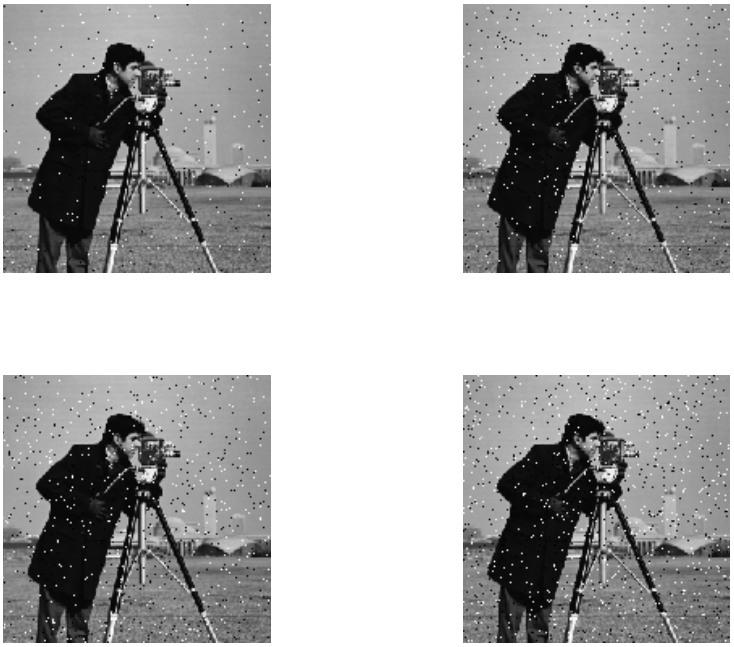
[Q1.b: 8pts] Create noisy images, using imnoise(im, ‘salt&pepper’, lvl) from Matlab, using levels 0.01, 0.02, 0.03 and 0.04, (camera man example shown below):



Show de-noising results with Average and Median filters of size 3x3, 5x5 and 11x11. Do not use the imfilter(), nor the medfilter function from Matlab. Have your own implementation.

Show Matlab code here:

Create Noise

```
cameraman=imread('cameraman.tif');
[nRow, nColumn]=size(cameraman);
cameraman1 = imnoise(cameraman, 'salt & pepper',0.01);
cameraman2 = imnoise(cameraman, 'salt & pepper',0.02);
cameraman3 = imnoise(cameraman, 'salt & pepper',0.03);
cameraman4 = imnoise(cameraman, 'salt & pepper',0.04);
```

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Mean Method
3x3

```
cameraman = imread('cameraman.tif');
[nRow, nColumn]=size(cameraman);
cameraman_noise = imnoise(cameraman,'salt & pepper',0.01);
for i=2:(nRow-1)
for j=2:(nColumn,2)-1)
temp(i, j) = mean(mean(cameraman (i-1:i+1,j-1:j+1)));
end
end
cameraman_denoise = temp;
imshow (cameraman_denoise);
```

5x5

```
cameraman = imread('cameraman.tif');
[nRow, nColumn]=size(cameraman);
cameraman_noise = imnoise(cameraman,'salt & pepper',0.01);
for i=3:(nRow -2)
for j=3:(nColumn-2)
temp(i, j) = mean(mean(cameraman (i-2:i+2,j-2:j+2)));
end
end
cameraman_denoise = temp;
imshow (cameraman_denoise);
```

11x11

```
cameraman = imread('cameraman.tif');
[nRow, nColumn]=size(cameraman);
cameraman_noise = imnoise(cameraman,'salt & pepper',0.01);
for i=6:(nRow-5)
for j=6:(nColumn-5)
temp(i, j) = mean(mean(cameraman (i-5:i+5,j-5:j+5)));
end
end
cameraman_denoise = temp;
imshow (cameraman_denoise);
```

Median Method

3x3

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```
cameraman = imread('cameraman.tif');
[nRow, nColumn]=size(cameraman);
cameraman_noise = imnoise(cameraman,'salt & pepper',0.01);
for i=2:(nRow-1)
for j=2:(nColumn-1)
temp(i, j) = median(median(cameraman1 (i-1:i+1,j-1:j+1)));
end
end
cameraman_denoise = temp;
imshow (cameraman_denoise);
```

5x5

```
cameraman = imread('cameraman.tif');
[nRow, nColumn]=size(cameraman);
cameraman_noise = imnoise(cameraman,'salt & pepper',0.01);
for i=3:(nRow-2)
for j=3:(nColumn-2)
temp(i, j) = median(median(cameraman1 (i-1:i+1,j-1:j+1)));
end
end
cameraman_denoise = temp;
imshow (cameraman_denoise);
```

11x11

```
cameraman = imread('cameraman.tif');
[nRow, nColumn]=size(cameraman);
cameraman_noise = imnoise(cameraman,'salt & pepper',0.01);
for i=6:(nRow-5)
for j=6:(nColumn-5)
temp(i, j) = median(median(cameraman1 (i-1:i+1,j-1:j+1)));
end
end
cameraman_denoise = temp;
imshow (cameraman_denoise);
```

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Show denoising results here:

Mean

Cameraman Mean (3x3):

Level 0.01	Level 0.02
	
	
Level 0.03	Level 0.04

Cameraman Mean (5x5):

Level 0.01	Level 0.02
	
	
Level 0.03	Level 0.04

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Cameraman Mean(11x11):

Level 0.01	Level 0.02
   	
Level 0.03	Level 0.04

Median

Cameraman Median(3x3)

Level 0.01	Level 0.02
   	
Level 0.03	Level 0.04

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Cameraman Median(5x5)

Level 0.01	Level 0.02
 	 
Level 0.03	Level 0.04

Cameraman Median(11x11)

Level 0.01	Level 0.02
 	 
Level 0.03	Level 0.04

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Q2.
_____
10 pts

Q2. [10 pts] For the data array given below:

x1 = [1.8554 2.8300 -3.4981 0.6945 -0.4125 -1.0623 1.6799 -0.5219];
x2 = [2.6543 5.8297 -4.7017 1.1631 -0.2586 -1.6712 1.3317 0.9221];

Q2a [3pts] please compute the mean, variance of x1 and x2, show the formula used to compute mean and variance.

$$mean(X) = \frac{1}{n}\sum_{i=1}^{n} x_i$$

mean(x1) = 0.1956;
mean(x2) = 0.6587;

$$Var(X) = \frac{1}{n-1}\sum_{i=1}^{n} (x_i - \overline{x})^2$$

var(x1) = 4.0368;
var(x2) = 9.5003;

Q2b [3 pts] compute the covariance between x1 and x2, show the formula also.

$$\text{cov}(X,Y) = E((X - \overline{X})(Y - \overline{Y}))$$

The covariance between x1 and x2 is 5.8978.

Covariance Matrix is defined as:

$$\begin{pmatrix} \text{var}(x_1) & \text{cov}(x_1, x_2) \\ \text{cov}(x_2, x_1) & \text{var}(x_2) \end{pmatrix}$$

cov(x1,x2) =
4.0368 5.8978
5.8978 9.5003

The covariance between x1 and x2 is 5.8978.

Q2c [4 pts] Compute the eigen value and eigen vectors of the covariance between x1 and x2.

cov(x1,x2) =
4.0368 5.8978
5.8978 9.5003

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To calculate the eigenvalue and eigenvector of a matrix X, we calculate:
$\det(X - \lambda I) = 0$;

X=
4.0368 5.8978
5.8978 9.5003

And we obtain
$\lambda_1 = 0.2688; \lambda_2 = 13.2683$

To obtain the eigenvector, we calculate $Xv = \lambda v$; correspondingly, we obtain two normalized eigenvector $v_1 = [-0.8427, 0.5384]^T; v_2 = [0.5384, 0.8427]^T$

Therefore,
eig_vector =

-0.8427 0.5384
0.5384 0.8427