Assignment 2

(Due on October 4 by 11:59pm)

I. Questions (46%):

(1) (10%) Given following four masks, order them in that generating smooth images from light smoothness to heavy smoothness, Explain why.

M1:

1	1	1
1	1	1
1	1	1

M2:

1	2	1
2	4	2
1	2	1

M3:

0	1	0
1	4	1
0	1	0

M4:

0	0	0
0	1	0
0	0	0

M4 – Least Smooth – neighboring pixels are not affecting the overall smoothness of image
M3 – Smooth – 4/8 of image
M2 – More Smooth – 4/16 of image – more smooth than M3
M1 – Heavy Smooth – all neighboring pixels are contributing equally to smooth image

(2) (8%) The filter for image enhancement can be designed by first-order derivatives and second-order derivatives. Compare the first-order derivatives and the second-order derivatives, which one is better for image enhancement. Explain why.

First Order: retains noise, good for edge thickness of images, weak response to fine details

Second Order: less noise, finer edges in images, stronger response to fine details

(3) (8%) An edge image (E) is generated by filtering a gray scale image (I) by a Laplacian mask (M). The sharpening image can be obtained by simply adding the original image (I) and the edge image (E). Show a single mask (S) based on the mask M such that the image sharpening can be implemented with one pass of the single mask.

$$M = \begin{bmatrix} 1 & 1 & 1 \\ 1 & -8 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

$$S = \begin{matrix} 1 & 1 & 1 \\ 1 & -7 & 1 \\ 1 & 1 & 1 \end{matrix}$$

(4) (8%) To extract edge information of an image, people can either

(a) Blur the image first, then apply edge detector
or

(b) Apply edge detector first, then do the image blurring.

Which way is better, explain why.

A is better. First blurring the image will reduce the noise currently present in the image. Hence, when we apply the edge detector, it will only pick up the most significant edges that we want to see.

(5) (12%) Apply the median filter to remove the noises in the following image I:

4	4	4	4	4	4	4	4
4	4	4	48	4	4	4	4
4	4	64	64	64	64	4	4
4	17	64	64	96	64	4	4
4	4	64	85	64	64	8	4
4	4	64	64	64	64	4	4
4	56	4	4	23	4	4	4
4	4	4	4	4	4	4	4

(note: assume that all the pixels outside the image have value: 4)

(a) Use 3*3 square-shape median filter to filter image I, obtain image M1;

4	4	4	4	4	4	4	4
4	4	4	4	4	4	4	4
4	4	48	64	64	4	4	4
4	4	64	64	64	64	4	4
4	4	64	64	64	64	4	4
4	4	56	64	64	23	4	4
4	4	4	4	4	4	4	4
4	4	4	4	4	4	4	4

(b) Use 5*5 cross-shape median filter to filter image I, obtain image M2;

4	4	4	4	4	4	4	4
4	4	4	4	4	4	4	4
4	4	64	64	64	64	4	4
4	4	64	64	64	64	4	4
4	4	64	64	64	64	4	4
4	4	64	64	64	64	4	4
4	4	4	4	4	4	4	4
4	4	4	4	4	4	4	4

(c) Compare M1 and M2, indicate which filter is better, and explain why.

The square filter is better. It takes into account more of the image as a whole. The cross filter fails to take into account the diagonals of the surrounding pixels. The square filter maintains more of the original image.