

CS 355 Homework #3:

Basic Image Processing Operations

The purpose of this homework is to have you do on paper the math/algorithms that you'll need to implement for Lab 3, especially Functions 6–10 respectively.

For all of the problems that follow, if you need to use pixel values outside of the given images, use 0 padding, i.e., assume pixel values of 0 for all pixels outside the images. For questions 1-4, round to the nearest integer value. For question 5, round to one decimal point.

1. What is the result of 3×3 mean filtering (averaging pixels with their 8-connected neighbors) for the following image?

10	11	9	25	22
8	10	9	26	28
9	99	9	24	25
11	11	12	23	22
10	11	9	22	25

Input Image

4	6	10	13	11
16	19	26	20	17
16	20	25	20	16
17	20	24	18	16
5	7	10	13	10

Output Image

2. What is the result of median filtering (using 8-connected neighbors) for the following image?

10	11	9	25	22
8	10	9	26	28
9	99	9	24	25
11	11	12	23	22
10	11	9	22	25

Input Image

10	10	11	24	26
10	9	11	24	25
11	10	12	23	25
11	11	12	22	24
11	11	12	22	23

Output Image

3. Spatially filter (convolve) the image on the left with the 3×3 mask (kernel) shown.

0	0	0	0	0
0	0	1	0	0
0	1	2	1	0
0	0	3	0	0
0	0	0	0	0

Input Image

1	2	1
2	4	2
1	2	1

Mask

=

0	1	2	1	0
1	6	8	6	1
2	11	20	11	2
1	10	18	10	1
0	3	6	3	0

Output Image

4. What is the result of unsharp masking using an $A = 1$ (a 5 in the center) mask?

10	11	9	25	22
8	10	9	26	28
9	8	9	24	25
11	11	12	23	22
10	11	9	22	25

Input Image

31	26	0	68	57
11	14	-9	44	67
18	1	-8	37	51
25	13	8	35	37
28	25	0	53	81

Output Image

5. This question walks through the computational steps for gradient-magnitude edge detection for the following image: (For this question, don't worry about the border pixels.)

10	11	9	25	22
8	10	9	26	28
9	8	9	24	25
11	11	12	23	22
10	11	9	22	25

Input Image

- (a) What is the result of applying the x -derivative Sobel filter? (Remember to divide by 8.)

X	X	X	X	X
X	.1	78	87	X
X	3	75	76	X
X	1	64	65	X
X	X	X	X	X

- (b) What is the result of applying the y -derivative Sobel filter? (Remember to divide by 8.)

X	X	X	X	X
X	-9	-5	1	X
X	1	5	-11	X
X	9	1	-5	X
X	X	X	X	X

- (c) What is the gradient magnitude at each pixel?

X	X	X	X	X
X	.9	78	87	X
X	1	75	77	X
X	9	64	65	X
X	X	X	X	X