09/18/2024 CS415 Mini Project-1 Grokhulnath Thirumaran 675086474

1) Q1) i) Goal of the computer vision is to extract useful information from the image so that that information can be interepted by the computer. Its goal is to extract Semantic (objects) and Geometric (distance, shape, etc...) information from the image

2) i) Edge detection:- This cv task can be useful in segmenting an object from the rest of the image. For example, this can be used to remove a foreground object from the background or can be used to introduce blur effect to the bg of the object.

Object detection:- This is one of the most interesting task in cv, as this gives the computer the intelligence to interupt the object from an image. This can be used in various application such as in self driving car to detect and drive through the obstacles.

Face recognition:- Each face has its own unique feature and depth map. Using cv we can harness the information and recognise unique faces. Used in security to detect and verify the face identity of a person.

3) Digital RGB image, is nothing but a 3-dimensional array matrix that each cell is referred to as pixel. The values in pixel ranges from 0-255 and based on the intensity of Red, Green, Blue the image can be achieved correspondingly.

Q2). i) Linear filtering is a process of applying a kernel over an image to modify the image based on the users need. We can use it enhance or remove features from an image. Basically the pixel in image is modified based on a local neighborhood pixels.

Eg.

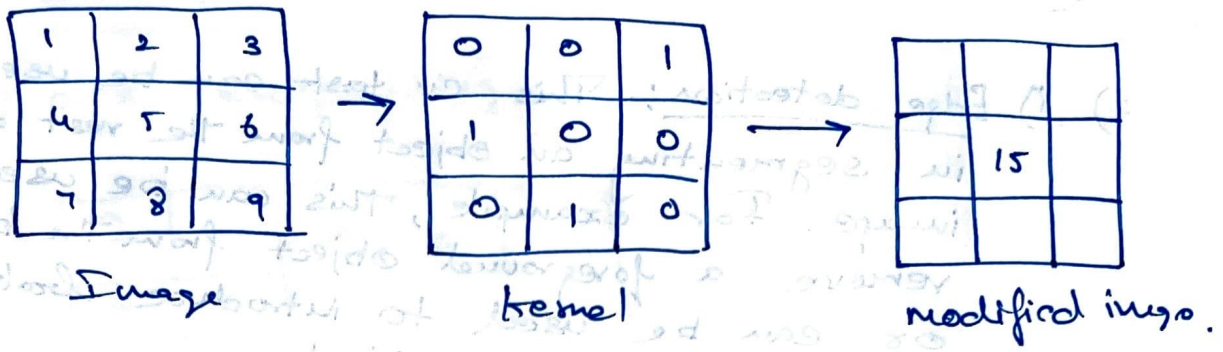


Image → kernel → modified image.

2) Similarities of correlation & convolutions are

i) Both perform element wise product follow by summation.

ii) Both slide through the image

Difference:

i) In Convolution the kernel is flipped horizontally and vertically and applied to the image. Where as in correlation it is applied as such.

Q3)

1	0	2
2	2	1
2	1	0

image.

2	1	1
1	2	0
0	0	1

kernel

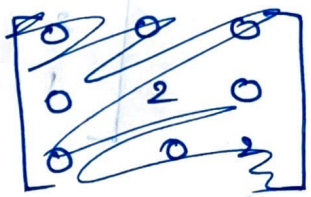
Correlation

i) add zero padding

0	0	0	0	0
0	1	0	2	0
0	2	2	1	0
0	2	1	0	0
0	0	0	0	0

position 1. :-

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 2 & 2 \end{bmatrix} \cdot \begin{bmatrix} 2 & 1 & 1 \\ 1 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$



$= (0\times2) + (0\times1) + (0\times1) + (0\times1) + (1\times2) + (0\times0) + (0\times0) + (2\times0) + (2\times1) + = 4$

Position 2:-

$$\begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & 2 \\ 2 & 2 & 1 \end{bmatrix} \cdot \begin{bmatrix} 2 & 1 & 1 \\ 1 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix} = 2$$

Position 3:

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 2 & 0 \\ 2 & 1 & 0 \end{bmatrix} \cdot \begin{bmatrix} 2 & 1 & 1 \\ 1 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix} = 4$$

Position 4:

$$\begin{bmatrix} 0 & 1 & 0 \\ 0 & 2 & 2 \\ 0 & 2 & 1 \end{bmatrix} \cdot \begin{bmatrix} 2 & 1 & 1 \\ 1 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix} = 6$$

Position 5:

$$\begin{bmatrix} 1 & 0 & 2 \\ 2 & 2 & 1 \\ 2 & 1 & 0 \end{bmatrix} \cdot \begin{bmatrix} 2 & 1 & 1 \\ 1 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix} = 10$$

Position 6:

$$\begin{bmatrix} 0 & 2 & 0 \\ 2 & 1 & 0 \\ 1 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 2 & 1 & 1 \\ 1 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix} = 6$$

Position 7:

$$\begin{bmatrix} 0 & 2 & 2 \\ 0 & 2 & 1 \\ 0 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 2 & 1 & 1 \\ 1 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix} = 8$$

Position 8:

$$\begin{bmatrix} 2 & 2 & 1 \\ 2 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 2 & 1 & 1 \\ 1 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix} = 11$$

Position 9:

$$\begin{bmatrix} 2 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 2 & 1 & 1 \\ 1 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix} = 6$$

Final correlation o/p matrix:-

4	2	4
6	10	6
8	11	6

Convolution :-

1	0	2
2	2	1
2	1	0

The kernel needs to be flipped horizontaly and vertically.

$$\text{Kernel} = \begin{bmatrix} 2 & 1 & 1 \\ 1 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\text{Flipped Kernel} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 1 \\ 1 & 1 & 2 \end{bmatrix}$$

Zero padded image:

0	0	0	0	0
0	1	0	2	0
0	2	2	1	0
0	2	1	0	0
0	0	0	0	0

Position 1:

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 2 & 2 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 1 \\ 1 & 1 & 2 \end{bmatrix} = 8$$

Position 2:

$$\begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & 2 \\ 2 & 2 & 1 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 1 \\ 1 & 1 & 2 \end{bmatrix} = 8$$

Position 3:

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 2 & 0 \\ 2 & 1 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 1 \\ 1 & 1 & 2 \end{bmatrix} = 7$$

Position 4:

$$\begin{bmatrix} 0 & 1 & 0 \\ 0 & 2 & 2 \\ 0 & 2 & 1 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 1 \\ 1 & 1 & 2 \end{bmatrix} = 10$$

Position 5:

$$\begin{bmatrix} 1 & 0 & 2 \\ 2 & 2 & 1 \\ 2 & 1 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 1 \\ 1 & 1 & 2 \end{bmatrix} = 9$$

Position 6:

$$\begin{bmatrix} 0 & 2 & 0 \\ 2 & 1 & 0 \\ 1 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 1 \\ 1 & 1 & 2 \end{bmatrix} = 3$$

Position 7:

$$\begin{bmatrix} 0 & 2 & 2 \\ 0 & 2 & 1 \\ 0 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 1 \\ 1 & 1 & 2 \end{bmatrix} = 5$$

Position 8:

$$\begin{bmatrix} 2 & 2 & 1 \\ 2 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 1 \\ 1 & 1 & 2 \end{bmatrix} = 4$$

Position 9:

$$\begin{bmatrix} 2 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 1 \\ 1 & 1 & 2 \end{bmatrix} = 2$$

After convolution,

8	8	7
10	9	3
5	4	2

Position 7:

$$\begin{bmatrix} 0 & 2 & 2 \\ 0 & 2 & 1 \\ 0 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 1 \\ 1 & 1 & 2 \end{bmatrix} = 5$$

Position 8:

$$\begin{bmatrix} 2 & 2 & 1 \\ 2 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 1 \\ 1 & 1 & 2 \end{bmatrix} = 4$$

Position 9:

$$\begin{bmatrix} 2 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 1 \\ 1 & 1 & 2 \end{bmatrix} = 2$$

After convolution,

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10	9	3
5	4	2

Position 7:

$$\begin{bmatrix} 0 & 2 & 2 \\ 0 & 2 & 1 \\ 0 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 1 \\ 1 & 1 & 2 \end{bmatrix} = 5$$

Position 8:

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Position 9:

$$\begin{bmatrix} 2 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 1 \\ 1 & 1 & 2 \end{bmatrix} = 2$$

After convolution,

8	8	7
10	9	3
5	4	2

Position 7:

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Position 9:

$$\begin{bmatrix} 2 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 1 \\ 1 & 1 & 2 \end{bmatrix} = 2$$

After convolution,

8	8	7
10	9	3
5	4	2

Position 7:

$$\begin{bmatrix} 0 & 2 & 2 \\ 0 & 2 & 1 \\ 0 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 1 \\ 1 & 1 & 2 \end{bmatrix} = 5$$

Position 8:

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Position 9:

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After convolution,

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10	9	3
5	4	2

Position 7:

$$\begin{bmatrix} 0 & 2 & 2 \\ 0 & 2 & 1 \\ 0 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 1 \\ 1 & 1 & 2 \end{bmatrix} = 5$$

Position 8:

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Position 9:

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After convolution,

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10	9	3
5	4	2

Position 7:

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Position 8:

$$\begin{bmatrix} 2 & 2 & 1 \\ 2 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 1 \\ 1 & 1 & 2 \end{bmatrix} = 4$$

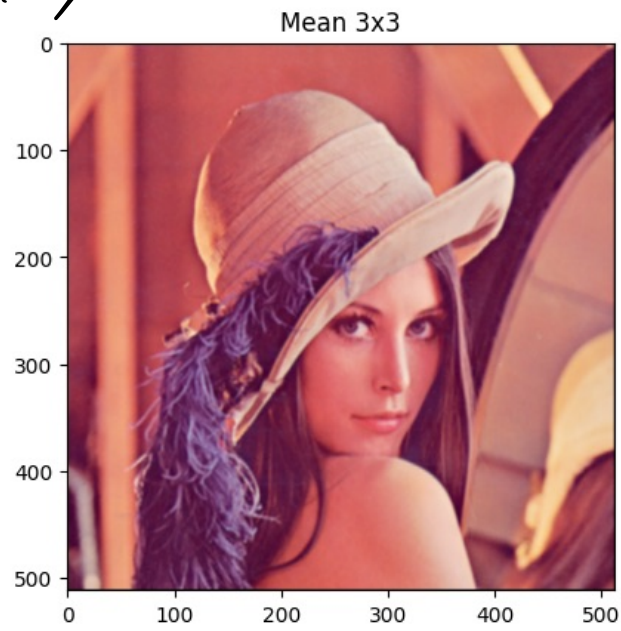
Position 9:

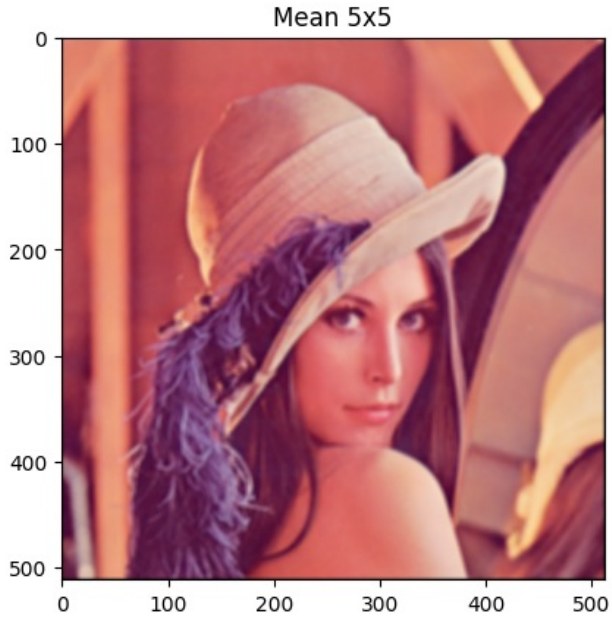
$$\begin{bmatrix} 2 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 1 \\ 1 & 1 & 2 \end{bmatrix} = 2$$

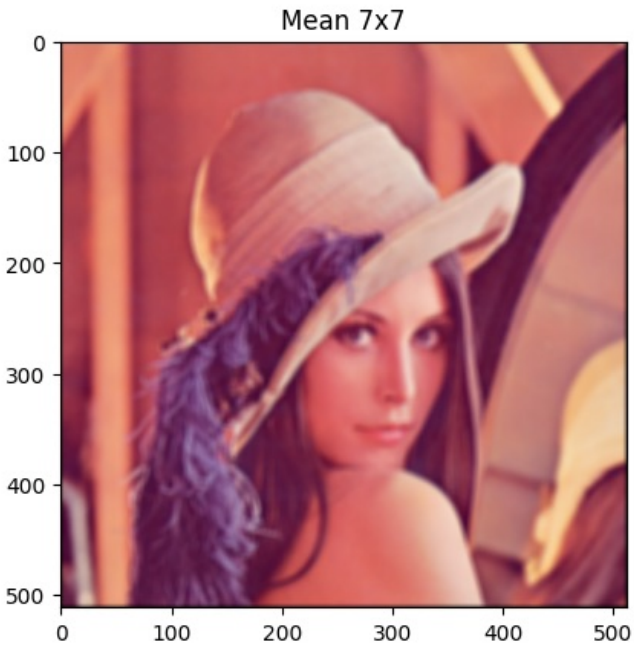
After convolution,

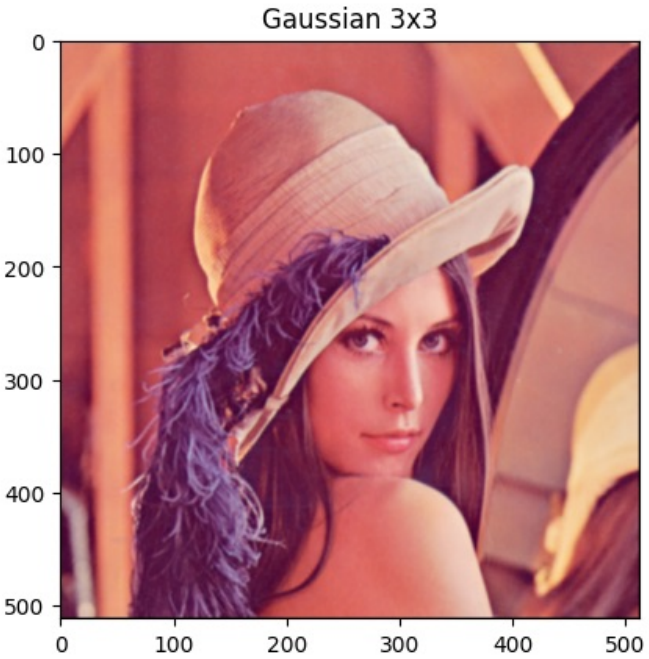
8	8	7
10	9	3
5	4	2

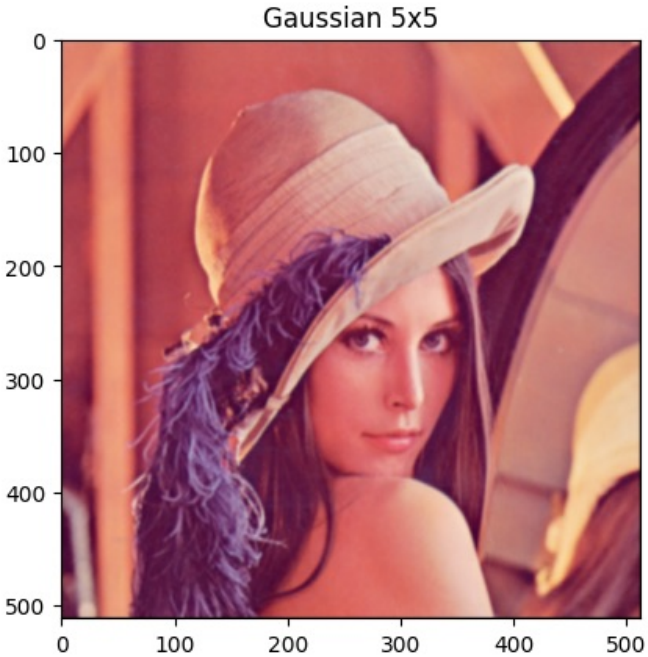
2) P1)

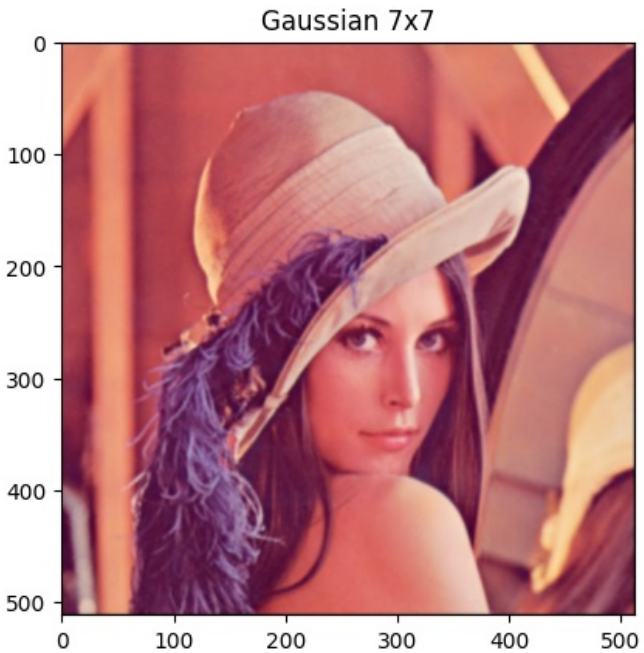

Mean 3x3
0
100
200
300
400
500
0
100
200
300
400
500

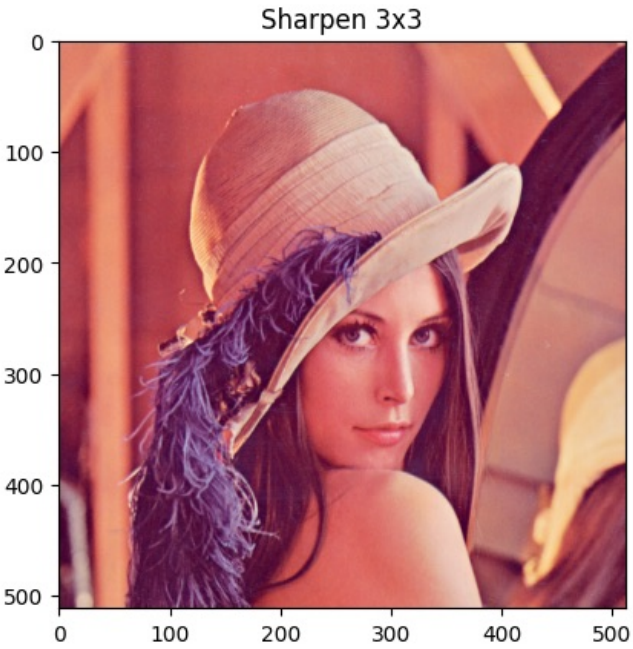

Mean 5x5
0
100
200
300
400
500
0
100
200
300
400
500


Mean 7x7
0
100
200
300
400
500
0
100
200
300
400
500


Gaussian 3x3
0
100
200
300
400
500
0
100
200
300
400
500


Gaussian 5x5
0
100
200
300
400
500
0
100
200
300
400
500


Gaussian 7x7
0
100
200
300
400
500
0
100
200
300
400
500


Sharpen 3x3
0
100
200
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400
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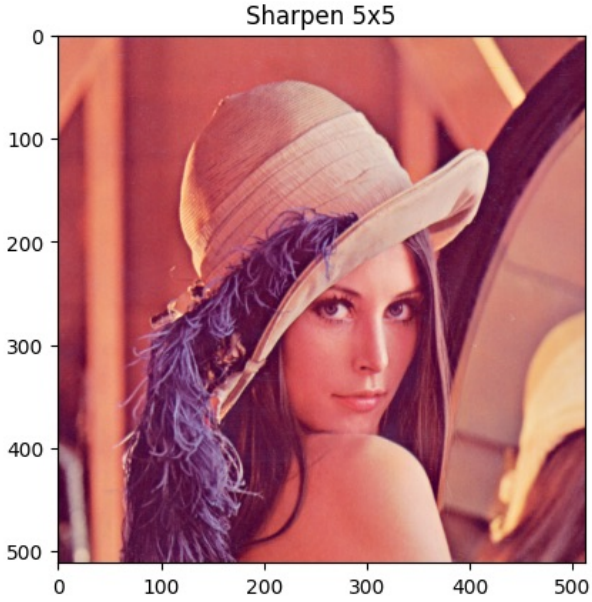
400
500


Sharpen 5x5
0
100
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300
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500
0
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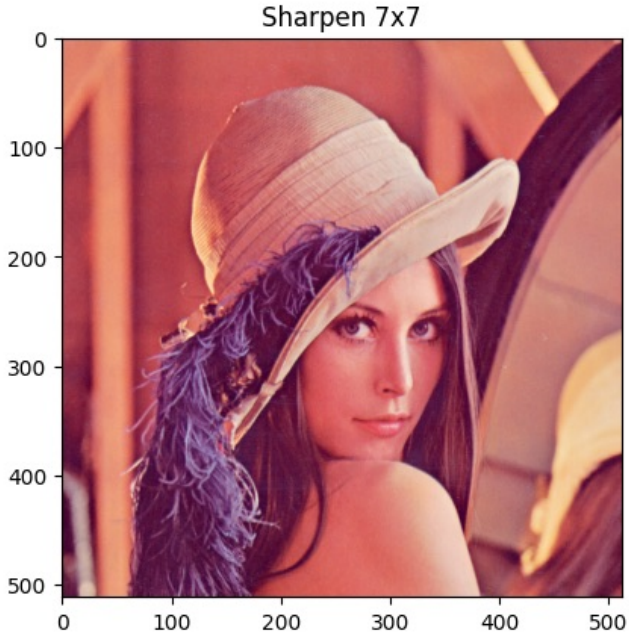
300
400
500


Sharpen 7x7
0
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0
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200
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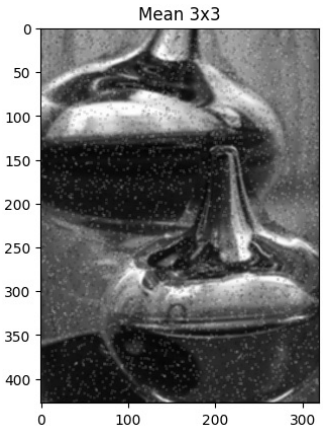
400
500

2) P2)


Mean 3x3
0
50
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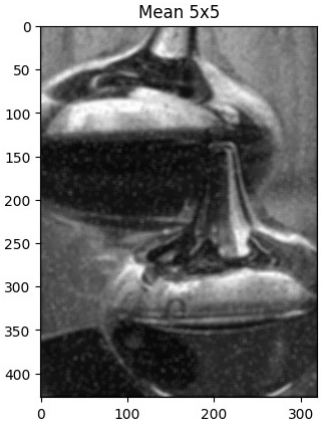
0
100
200
300


Mean 5x5
0
50
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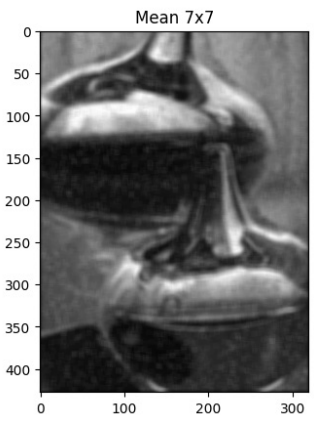
Mean 7x7
0
50
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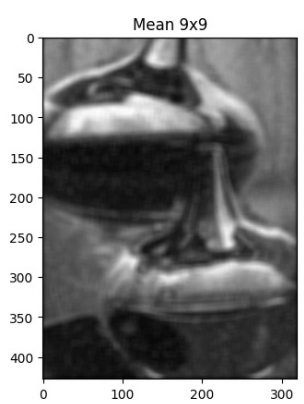
Mean 9x9
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50
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150
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0
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200
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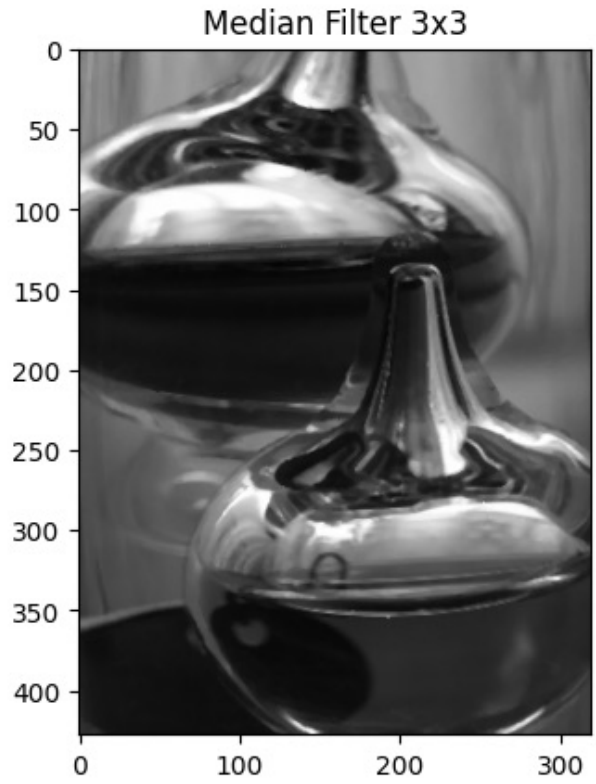
Median Filter 3x3
0
50
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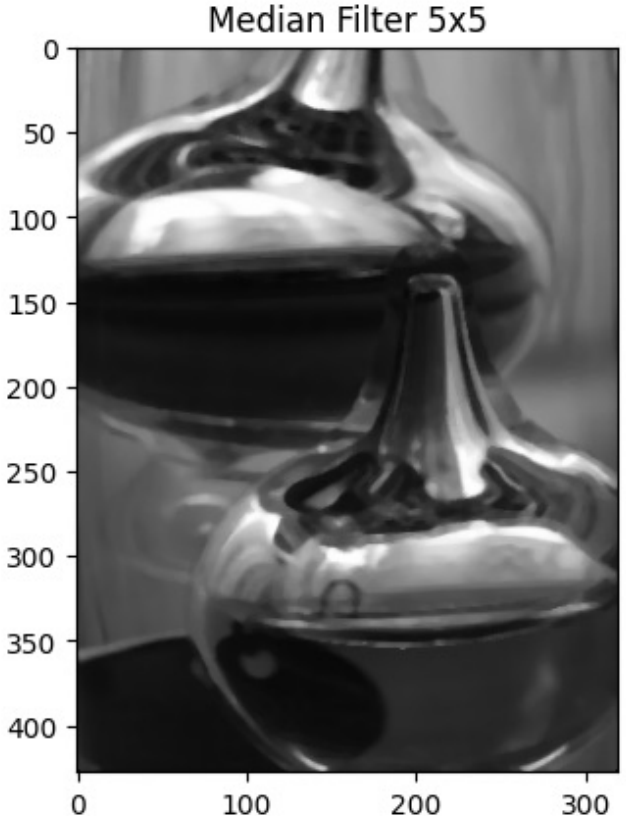
0
100
200
300


Median Filter 5x5
0
50
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200
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300
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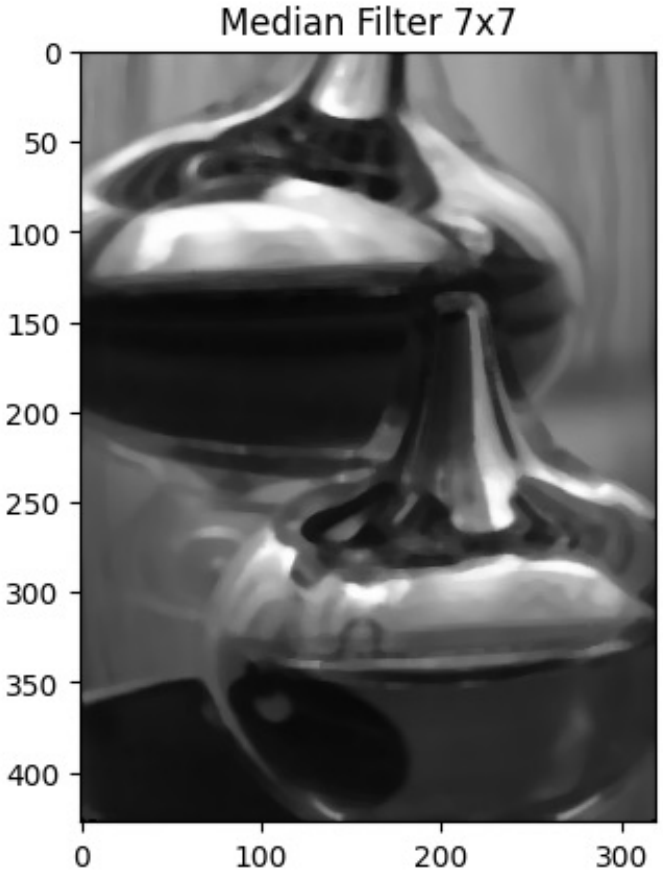
200
300


Median Filter 7x7
0
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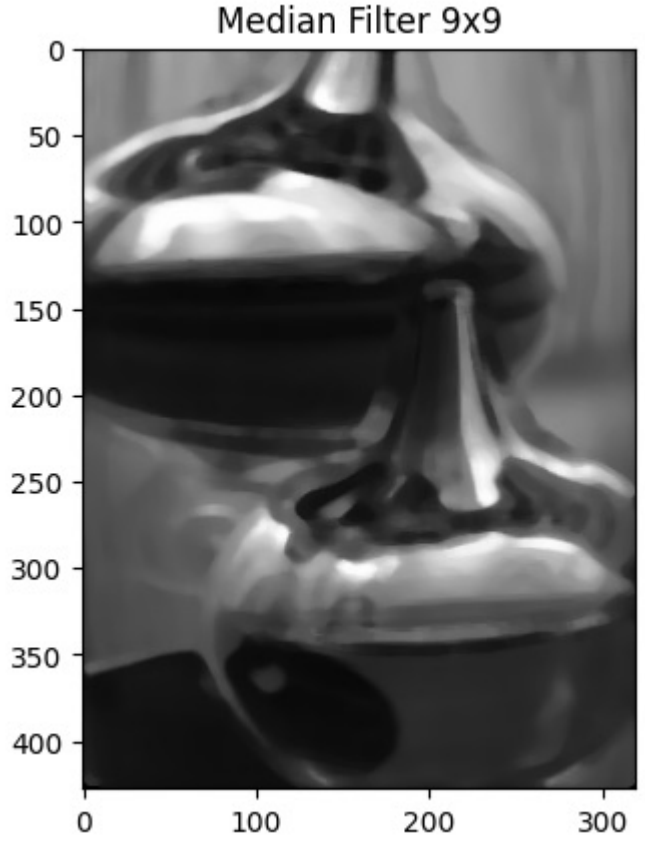
Median Filter 9x9
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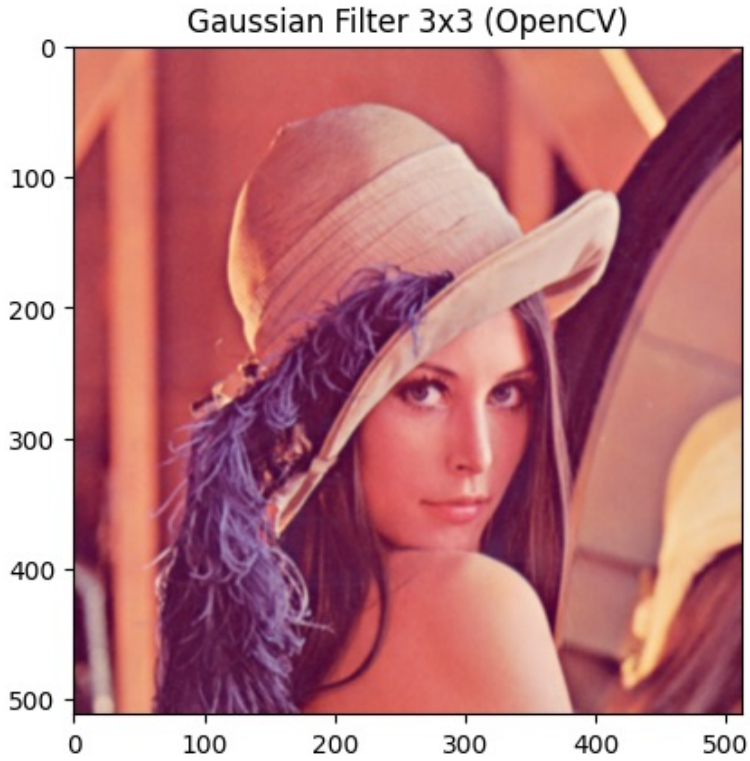
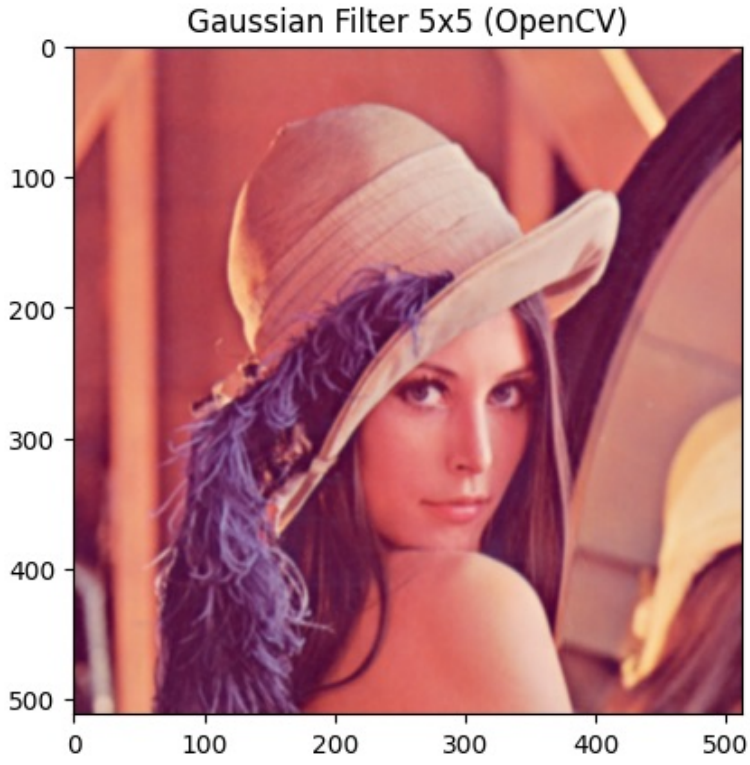
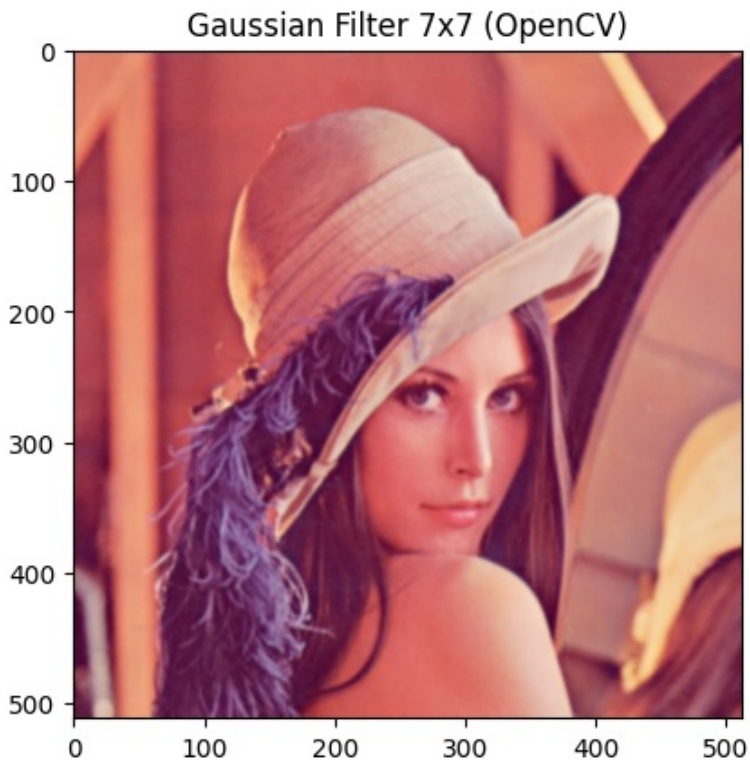
2) P3)







Yes, the output from opencv gaussian was similar to the output of the P1.