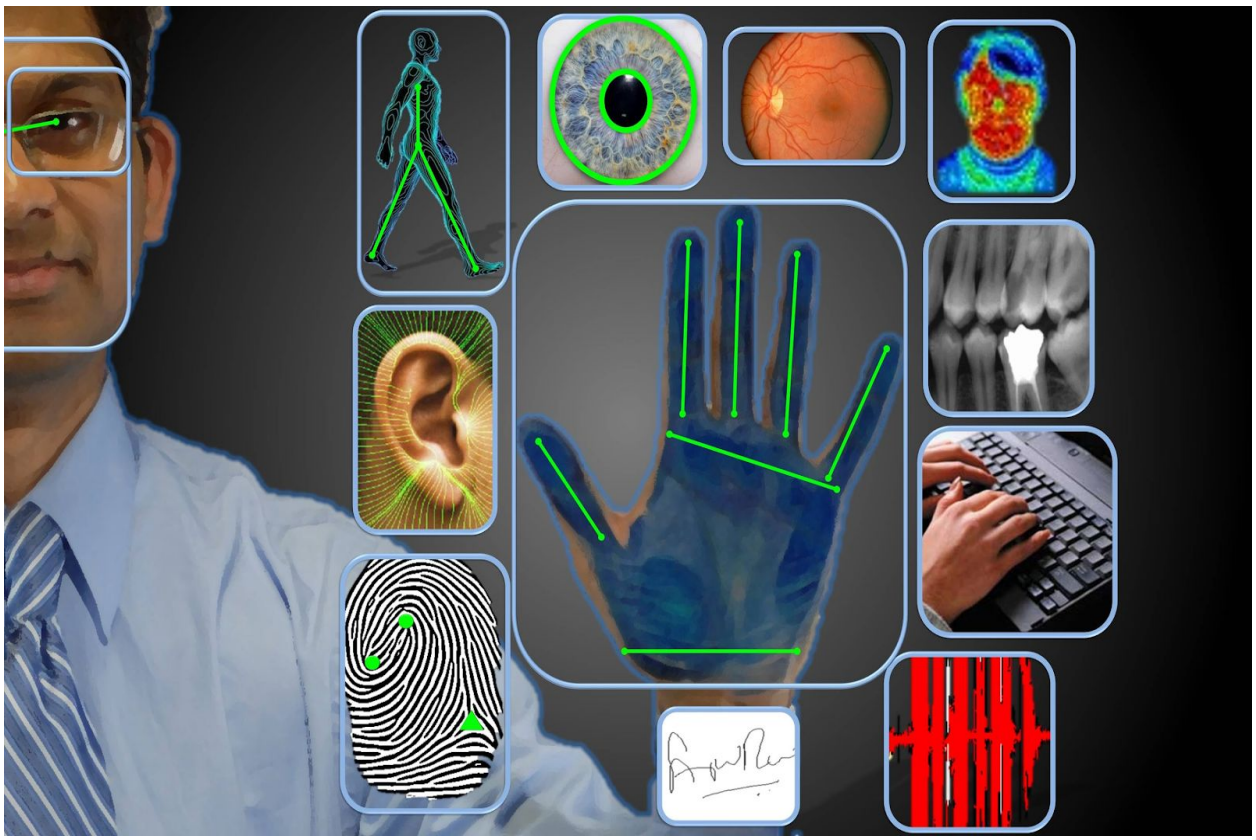

Digital Image Processing

Assignment-2

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20161054

Question-1:

Given Filters,

A = (1/16)[1, 2, 1; 2, 4, 2; 1, 2, 1];

B = (1/256)[1, 4, 6, 4, 1; 4, 16, 24, 16, 4; 6, 24, 36,24, 6; 4, 16, 24, 16, 4; 1, 4, 6, 4, 1]

C = (1/8)[-1, 0, 1; -2, 0, 2; -1, 0, 1]

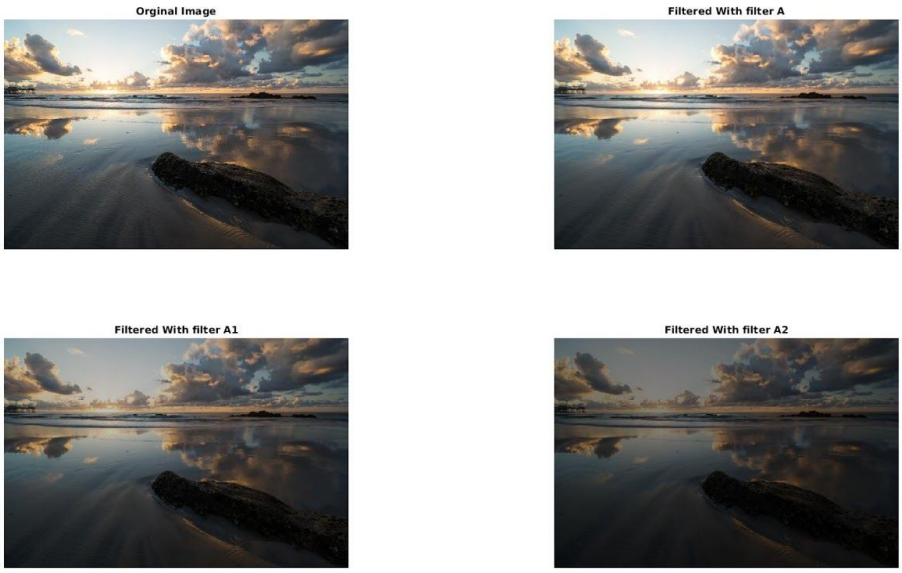
Modified Instances of above filters are

A1 = (1/16)[1, 2, 1; 0, 4, 0; 1, 2, 1];

A2 = (1/16)[0, 2, 0;0, 4, 0; 0, 2, 0];

sky.jpeg: ---> sky_A_A1_A2.jpg

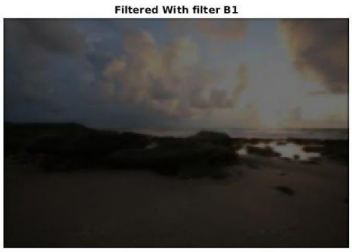
sky2.jpg : -------> sky2_A_A1_A2.jpg

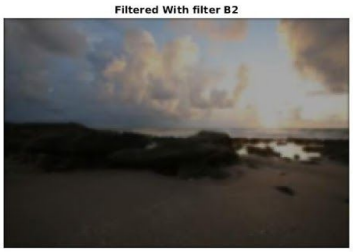


B1 = (1/256)[2, 1, 1, 1, 2; 2, 4, 6, 4, 2; 6, 8, 36,8, 6; 2, 4, 6, 4, 2; 2, 1, 1, 1, 2];

B2 = (1/256)[1, 4, 4, 4, 1; 4, 4, 16, 4, 4; 4, 16, 36,16, 4; 4, 4, 16, 4, 4; 1, 4, 4, 4, 1];

sky.jpeg ----> sky_B_B1_B2.jpg



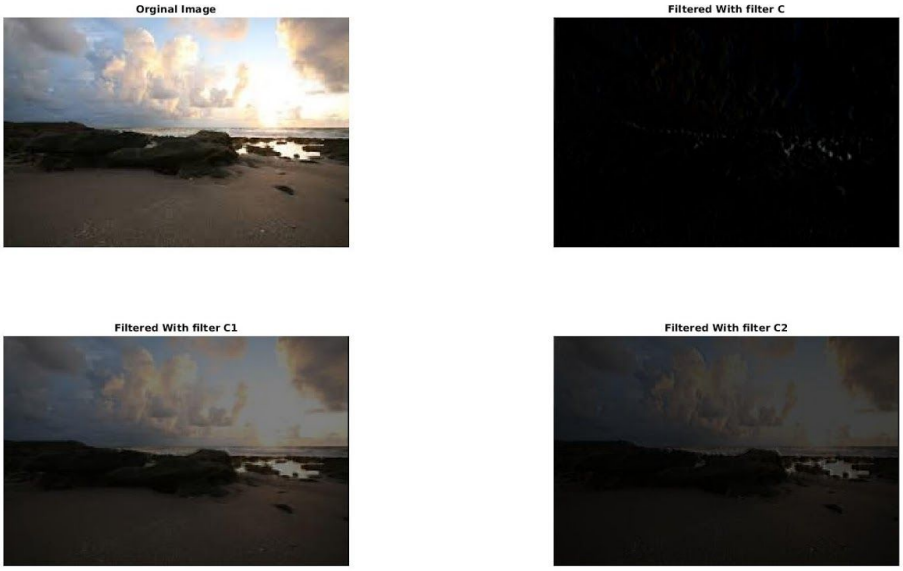


sky2.jpg -----> sky2_B_B1_B2.jpg

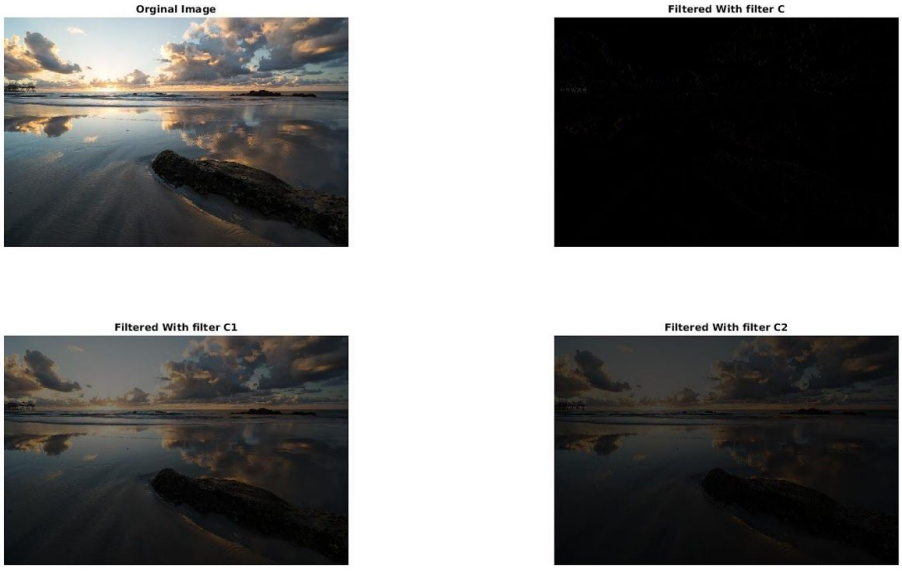
C1 = (1/8)[-1, 0 ,1; 2, 0, 2; -1, 0, 1];

C2 = (1/8)[-1, 0, 1; 0, 2, 0; -1, 0, 1];

sky.jpeg --------> sky_C_C1_C2.jpg;



sky2.jpg -------> sky2_C_C1_C2.jpg;



From the above results, we can draw some information that the pixel intensity value in original Image is somehow carried to output image, when given filter is applied. This is not observed in case modified filters, which changes/deletes some information contained in the image. So, filter coefficients must be sum to 0 or 1.

Some filter coefficients sum to 1 while others sum to 0, because, some are for blurring the image and some are for the edge detection. Filters which do edge detection must contain the negative terms so the change is resulted , as we don't need the pixel value contirbution there.

Question-2:

2.1)

A = operator which returns the first of the image when applied on a image.

It is a Linear Operator.

Because,

$$A(pI1 + qI2) = pA(I1) + qA(I2) \text{ holds for all images } I1, I2$$

Where I1, I2 are two same size images.p, q are +ve integers.

2.2)

Cosinder “I” be m x n image the size of the flattened image will be 1 x mn.

Image (I) ---> m x n

Flattened Image(I’) ----> 1 x mn

Result of the operator ---> 1 x n

⇒ A must be “mn x n” size matrix to obtain same effect on the result.

$$\Rightarrow \quad flat\_Img_{(1 \times mn)} \cdot A_{(mn \times n)} = first\_row\_Img_{(1 \times n)}$$

⇒ matrix A which results the first row of flat image is

$$A_{ij} = \quad \text{if (i==j and i,j<=n) “1” otherwise “0”}$$

2.3)

Images in the nullspace of a operator A have property that

First row of the Image contains all zeros.

Question-3:

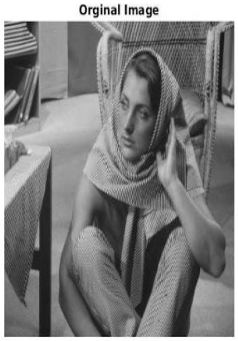
Answered in seperate pdf.

Question-4:

Prewitt: $M_x = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$; $M_y = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{bmatrix}$

barbara.jpg ----> barbara_q4_prewitt.jpg

Orginal Image



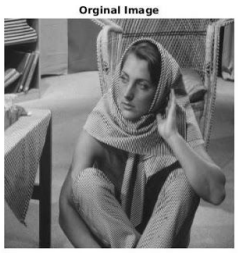
Result of Prewitt

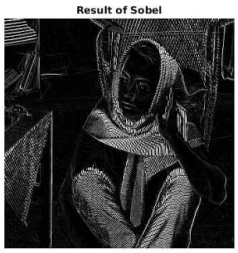
In Horizontal Direction

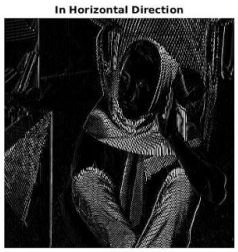
In Vertical Direction

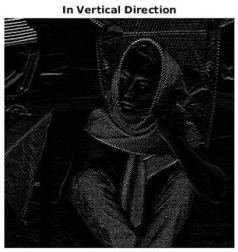
Sobel: $M_x = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$; $M_y = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}$

barbara.jpg -----> barbara_q4_sobel.jpg



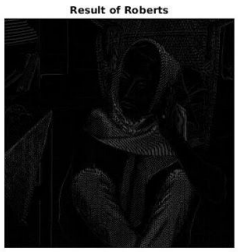


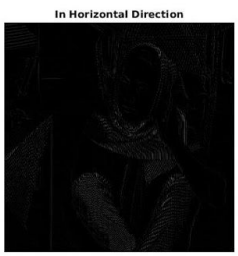


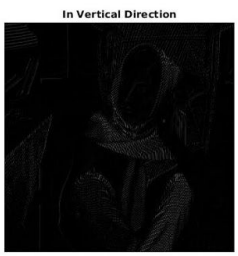


Roberts: $M_x = \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$; $M_y = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$

barbara.jpg -----> barbara_q4_roberts.jpg







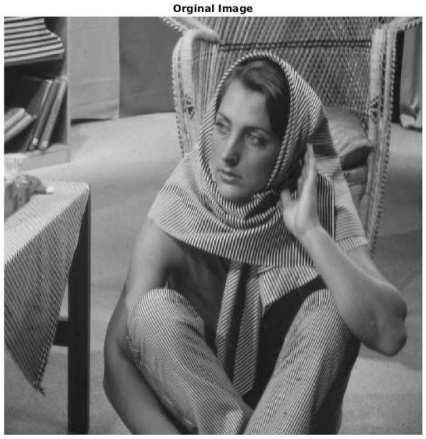
0	-1	0
-1	4	-1
0	-1	0

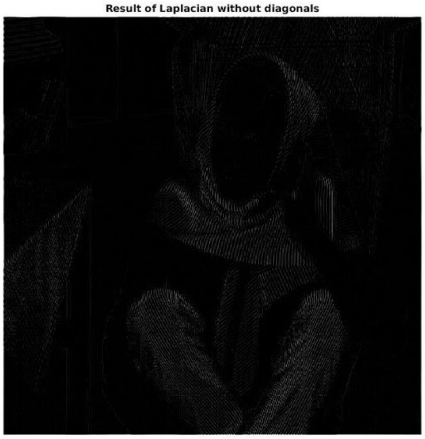
The laplacian operator

-1	-1	-1
-1	8	-1
-1	-1	-1

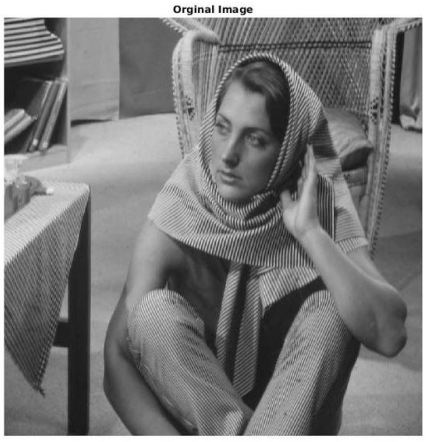
The laplacian operator
(include diagonals)

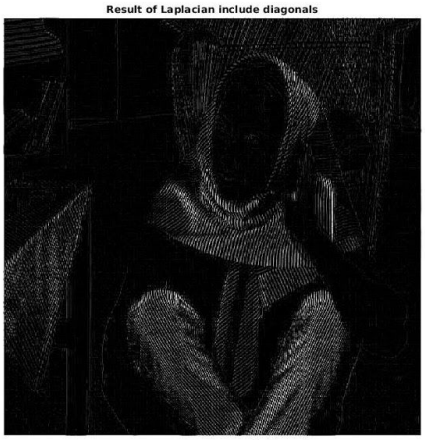
barbara.jpg ------> barbara_q4_laplacian.jpg





barbara.jpg -----> barbara_q4_laplacian_dia.jpg





As we compare that the

Question-5:

Answered in seperate pdf.

Question-6:

Answered in seperate pdf.

Question-7:

Answered in seperate pdf.

Question-8:

Answered in seperate pdf.

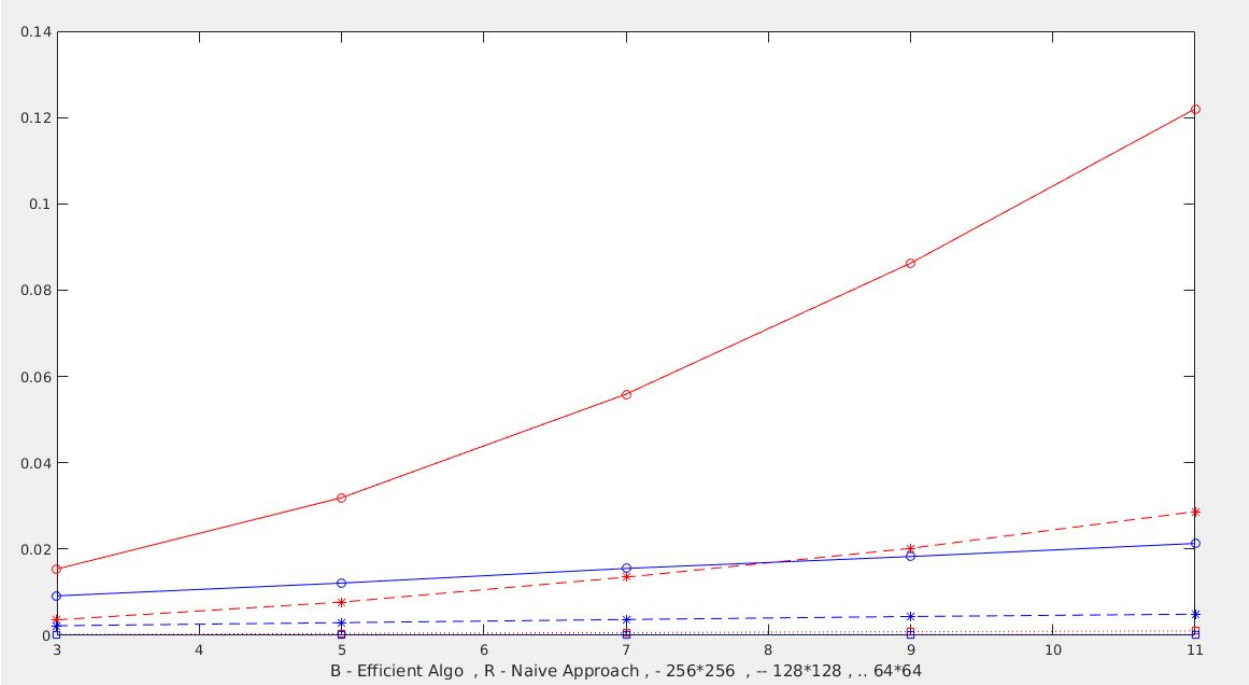
Question-9:

1)

Results on applying a low-pass filter with K=3.

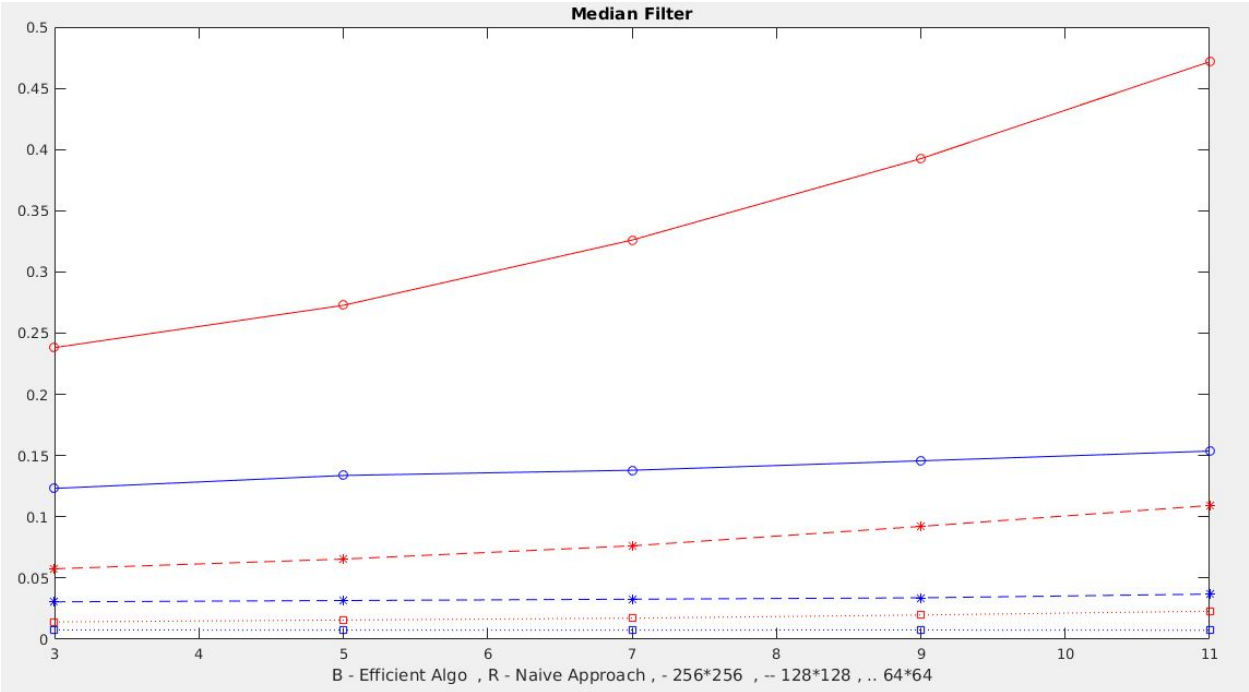
2)

Plots for Averaging filter



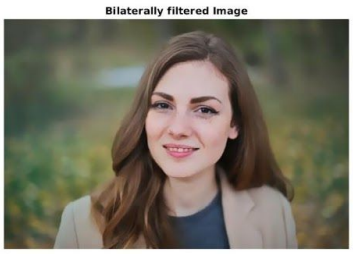
3)

Plots for Median Filter.



Question-10:

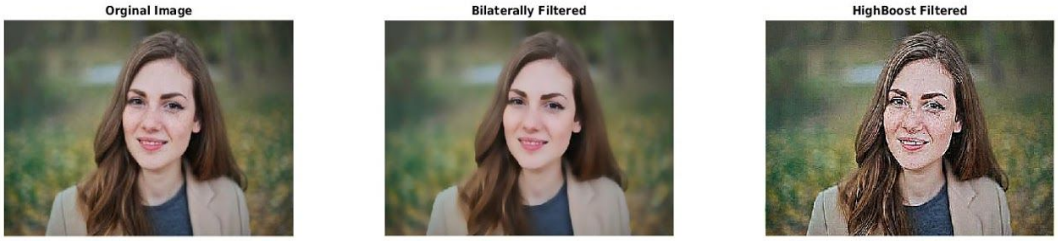
1)



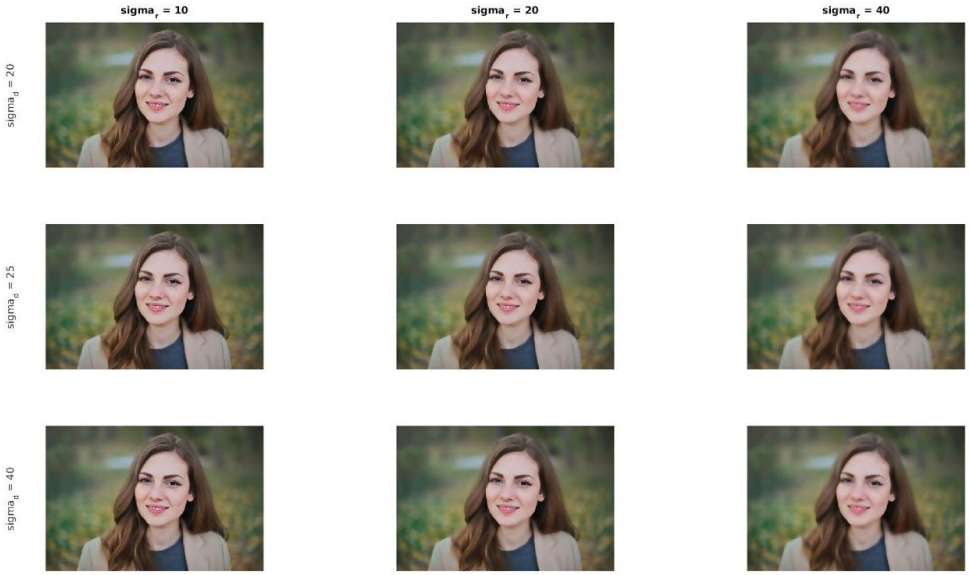
Results are for

sigma_d = 25, sigma_r = 10, mask_size=11.

2)



3)



Bilateral filter is controlled by two parameters sigma_d and sigma_r

- As the range parameter sigma_r increases, the bilateral filter gradually approximates Gaussian convolution more closely because the range Gaussian G(sigma_r) widens and flattens, i.e., is nearly constant over the intensity interval of the image.

-As the spatial parameter sigma_d increases it smooths the edges in the image, So it should not be so large.