Görüntü İşleme
BLM4540
Assignment 1

Edge Detection

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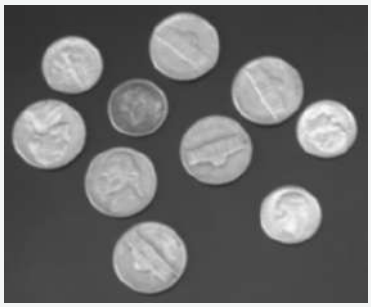
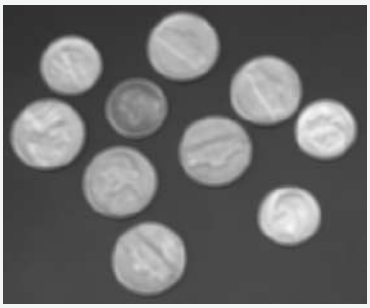
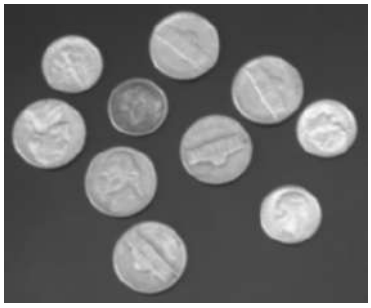
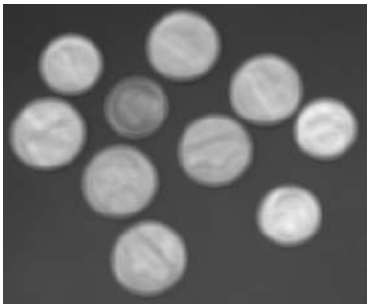
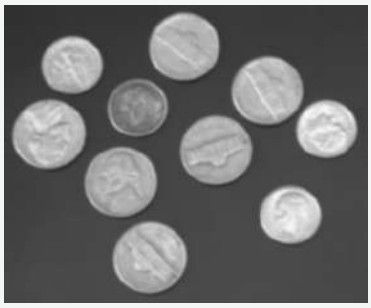
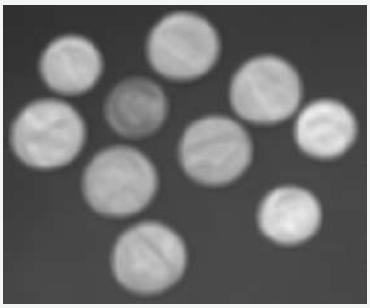
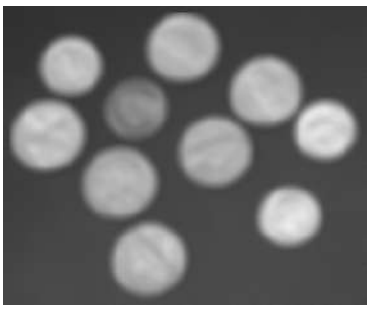
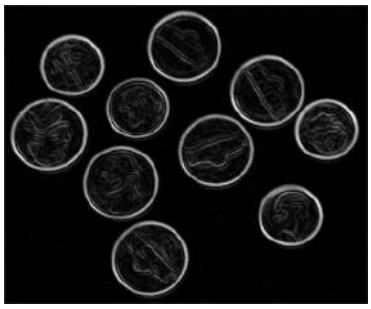
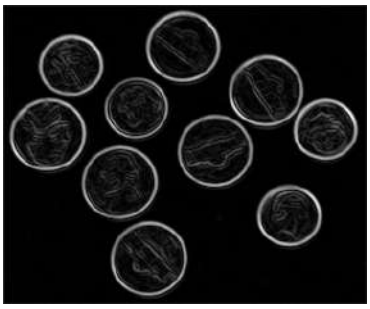
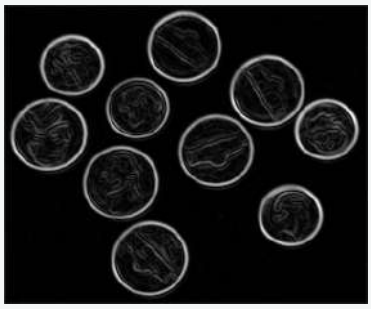
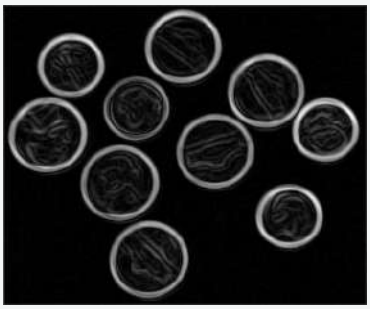
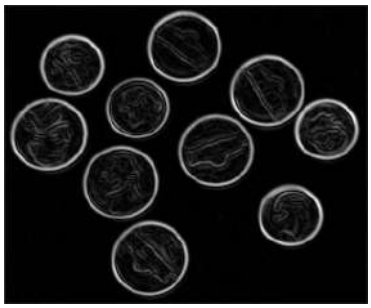
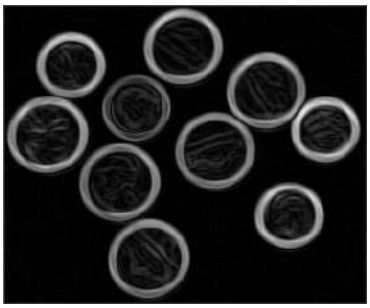
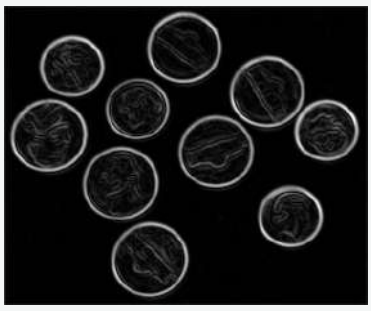
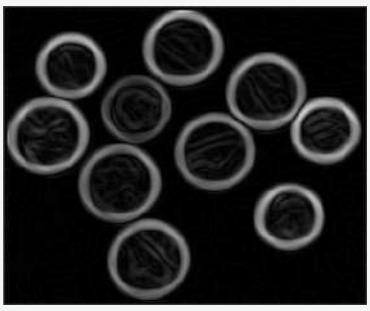
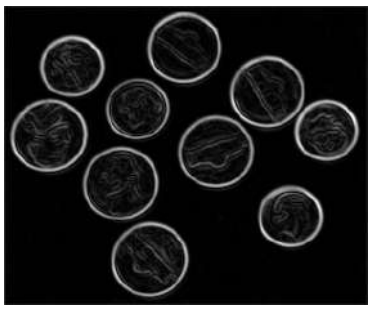
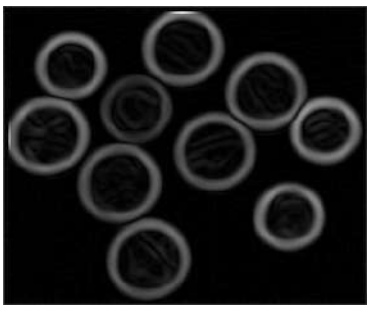
Code General Workflow:

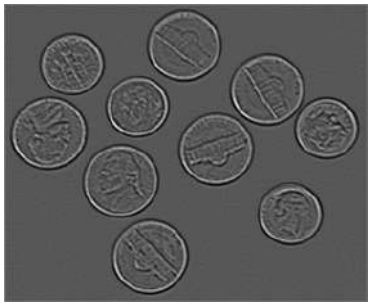
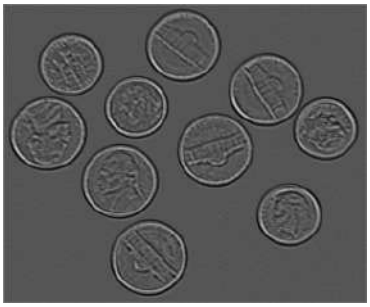
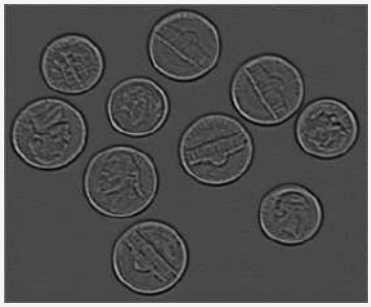
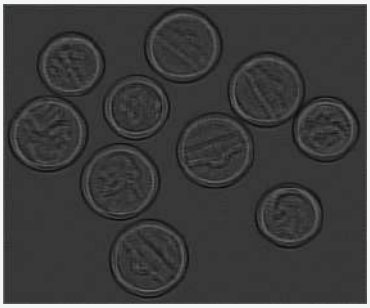
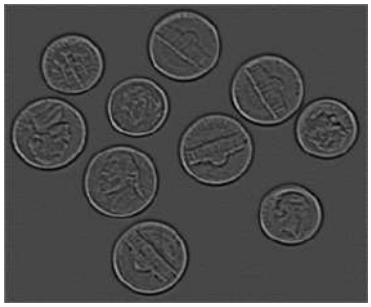
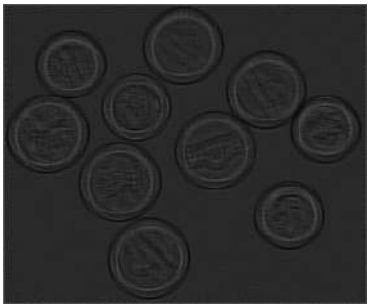
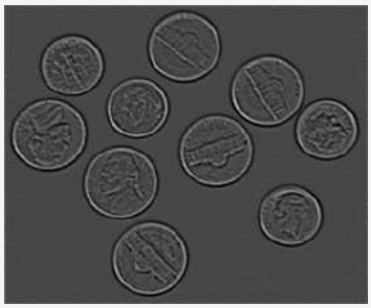
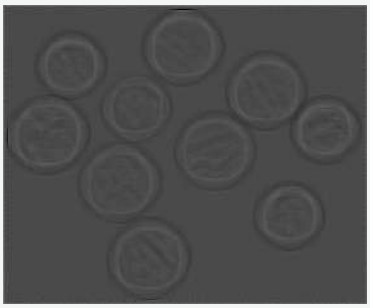
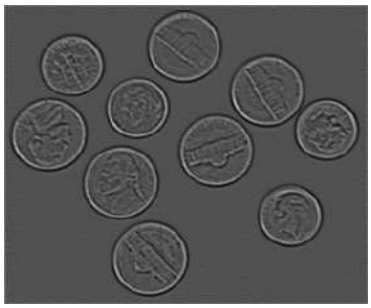
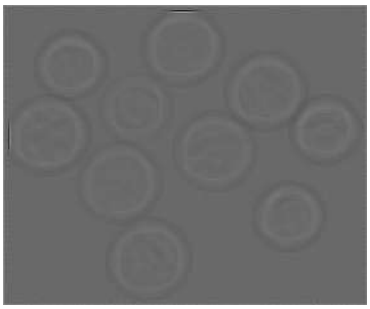
1. ***Read .pgm*** file image according to its signature(magic number) (P2 or P5).
2. **Generate Gaussian filter** according to the given σ and kernel size.
3. **Apply Gaussian filter** to remove the noises in the image.
4. **Normalize** the the pixels values of result of Gaussian filter, then **write the result** as .pgm file with P2 signature.
5. **Generate Sobel Gx** and **Gy** filters and **apply them** on free-noise image, then **obtain Gx,y** from the result of Sobel filters.
6. After obtaining Gx,y **normalize Gx, Gy, and Gx,y** results, and **write the results**.
7. **Generate given Laplacian filters** in the assignment, and **apply them** on free-noise image, and **write the results**.
8. Free the memory.

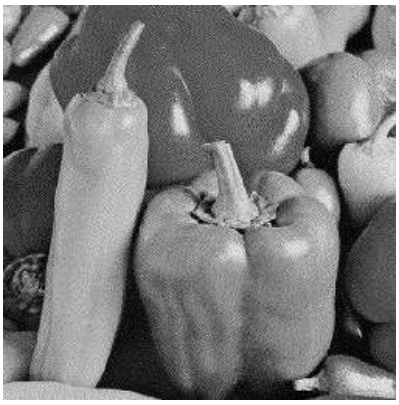
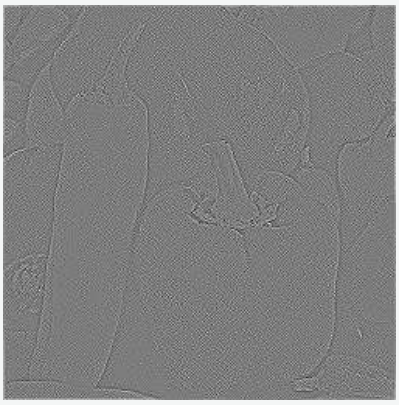
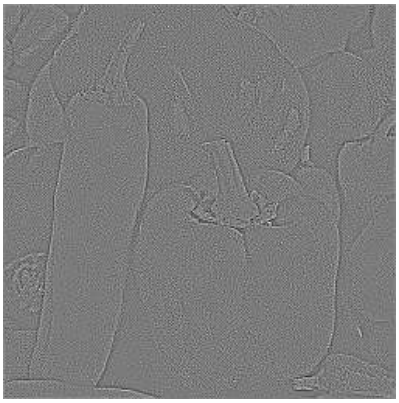
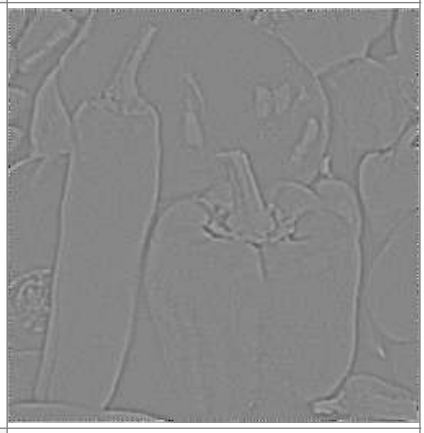
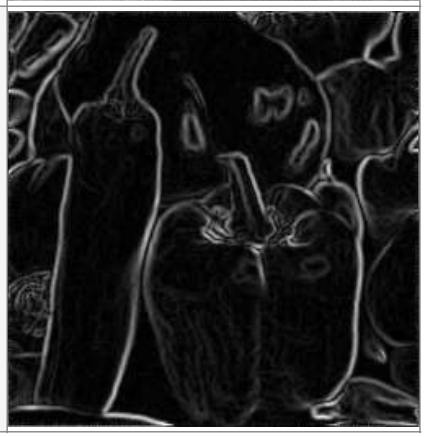
Results:

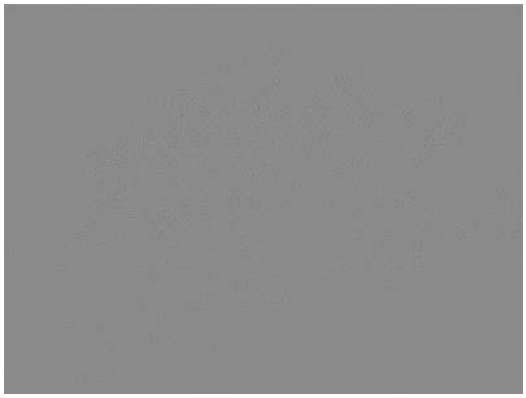
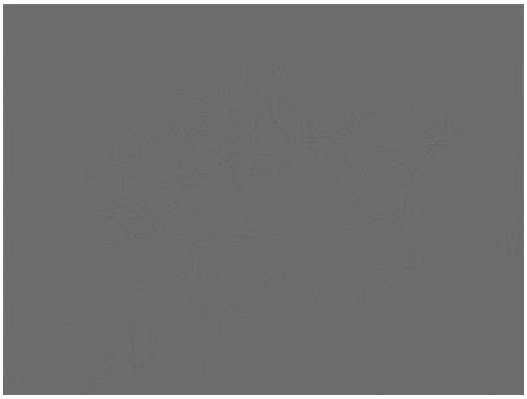
- After examining the results with different σ and kernel size, we can observe that the effect of changing the kernel size is apparent with bigger σ.
- By comparing the Edge Detection results with and without Gaussian filter, We conclude that edge detection gives better results with a smoothed image.

Gaussian Filter Results	$\sigma = 1$	$\sigma = 4$
Gaussian kernel size = 3		
Gaussian kernel size = 5		
Gaussian kernel size = 7		
Gaussian kernel size = 9		
Gaussian kernel size = 11		

Sobel Filter Both Directions Results	$\sigma = 1$	$\sigma = 4$
Gaussian kernel size = 3		
Gaussian kernel size = 5		
Gaussian kernel size = 7		
Gaussian kernel size = 9		
Gaussian kernel size = 11		

Laplacian Filter Results $\begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$	$\sigma = 1$	$\sigma = 4$
Gaussian kernel size = 3		
Gaussian kernel size = 5		
Gaussian kernel size = 7		
Gaussian kernel size = 9		
Gaussian kernel size = 11		

	Original Without Gaussian Filter	With Gaussian Filter σ = 1 , kernel size = 5
Image		
Laplacian kernel1		
Laplacian kernel2		
Sobel Gx,y		

Original Without Gaussian Filter	With Gaussian Filter σ = 2 , kernel size = 9
	
 Laplacian kernel1	 Laplacian kernel1
 Laplacian kernel2	 Laplacian kernel2

Original Without Gaussian Filter	With Gaussian Filter σ = 2 , kernel size = 9
	
Sobel Gx,y	Sobel Gx,y

Gaussian Filter Sittings	σ = 1, kernel size = 5	σ = 1, kernel size = 7	σ = 1, kernel size = 9
	1 4 7 4 1 4 20 33 20 4 7 33 54 33 7 4 20 33 20 4 1 4 7 4 1 sum = 330 coeff = 0.003030303030303	1 12 54 90 54 12 1 12 148 665 1096 665 148 12 54 665 2980 4914 2980 665 54 90 1096 4914 8103 4914 1096 90 54 665 2980 4914 2980 665 54 12 148 665 1096 665 148 12 1 12 54 90 54 12 1 sum = 50867 coeff = 0.000019659111015	1 33 403 1808 2980 1808 403 33 1 33 1096 13359 59874 98715 59874 13359 1096 33 403 13359 162754 729416 1202604 729416 162754 13359 403 1808 59874 729416 3269017 5389698 3269017 729416 59874 1808 2980 98715 1202604 5389698 8886110 5389698 1202604 98715 2980 1808 59874 729416 3269017 5389698 3269017 729416 59874 1808 403 13359 162754 729416 1202604 729416 162754 13359 403 33 1096 13359 59874 98715 59874 13359 1096 33 1 33 403 1808 2980 1808 403 33 1 sum = 55832714 coeff = 0.000000017910646
Original Image			
Gaussian Filter Result			

Gaussian Filter Sittings	σ = 1, kernel size = 5	σ = 1, kernel size = 7	σ = 1, kernel size = 9
Sobel Horizontal direction = h 1 2 1 0 0 0 -1 -2 -1			
Sobel Vertical direction = v 1 0 -1 2 0 -2 1 0 -1			

```
   1      4      7      4      1
   4     20     33     20      4
   7     33     54     33      7
   4     20     33     20      4
   1      4      7      4      1
sum = 330
coeff = 0.003030303030303
```

```
   1     12     54     90     54     12      1
  12    148    665   1096    665    148     12
  54    665   2980   4914   2980    665     54
  90   1096   4914   8103   4914   1096     90
  54    665   2980   4914   2980    665     54
  12    148    665   1096    665    148     12
   1     12     54     90     54     12      1
sum = 50867
coeff = 0.000019659111015
```

```
   1     33    403   1808   2980   1808    403     33      1
  33   1096  13359  59874  98715  59874  13359   1096     33
 403  13359 162754 729416 1202604 729416 162754  13359    403
1808  59874 729416 3269017 5389698 3269017 729416 59874   1808
2980  98715 1202604 5389698 8886110 5389698 1202604 98715 2980
1808  59874 729416 3269017 5389698 3269017 729416 59874   1808
 403  13359 162754 729416 1202604 729416 162754  13359    403
  33   1096  13359  59874  98715  59874  13359   1096     33
   1     33    403   1808   2980   1808    403     33      1
sum = 55832714
coeff = 0.000000017910646
```

Gaussian Filter Sittings	σ = 1, kernel size = 5	σ = 1, kernel size = 7	σ = 1, kernel size = 9
	1 4 7 4 1 4 20 33 20 4 7 33 54 33 7 4 20 33 20 4 1 4 7 4 1 sum = 330 coeff = 0.003030303030303	1 12 54 90 54 12 1 12 148 665 1096 665 148 12 54 665 2980 4914 2980 665 54 90 1096 4914 8103 4914 1096 90 54 665 2980 4914 2980 665 54 12 148 665 1096 665 148 12 1 12 54 90 54 12 1 sum = 50867 coeff = 0.000019659111015	1 33 403 1808 2980 1808 403 33 1 33 1096 13359 59874 98715 59874 13359 1096 33 403 13359 162754 729416 1202604 729416 162754 13359 403 1808 59874 729416 3269017 5389698 3269017 729416 59874 1808 2980 98715 1202604 5389698 8886110 5389698 1202604 98715 2980 1808 59874 729416 3269017 5389698 3269017 729416 59874 1808 403 13359 162754 729416 1202604 729416 162754 13359 403 33 1096 13359 59874 98715 59874 13359 1096 33 1 33 403 1808 2980 1808 403 33 1 sum = 55832714 coeff = 0.000000017910646
Sobel Both Directions			

Gaussian Filter Sittings	σ = 1, kernel size = 5	σ = 1, kernel size = 7	σ = 1, kernel size = 9
Laplacian kernel1			
Laplacian kernel2			

```
   1      4      7      4      1
   4     20     33     20      4
   7     33     54     33      7
   4     20     33     20      4
   1      4      7      4      1
sum = 330
coeff = 0.003030303030303
```

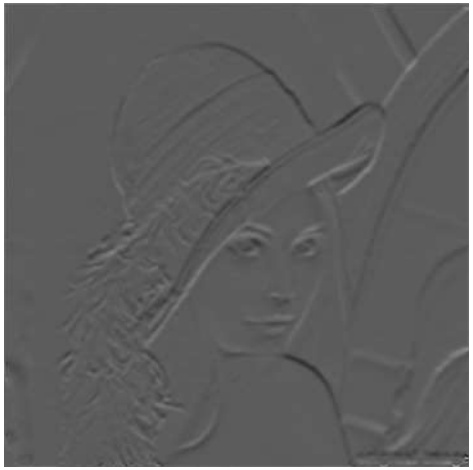
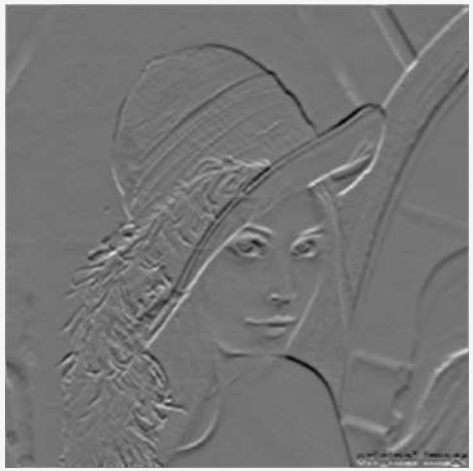
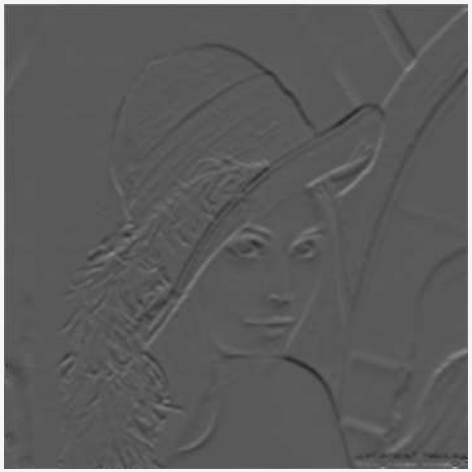
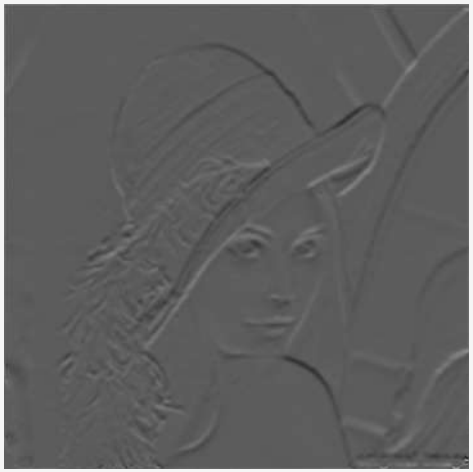
```
   1     12     54     90     54     12      1
  12    148    665   1096    665    148     12
  54    665   2980   4914   2980    665     54
  90   1096   4914   8103   4914   1096     90
  54    665   2980   4914   2980    665     54
  12    148    665   1096    665    148     12
   1     12     54     90     54     12      1
sum = 50867
coeff = 0.000019659111015
```

```
   1     33    403   1808   2980   1808    403     33      1
  33   1096  13359  59874  98715  59874  13359   1096     33
 403  13359 162754 729416 1202604 729416 162754  13359    403
1808  59874 729416 3269017 5389698 3269017 729416 59874   1808
2980  98715 1202604 5389698 8886110 5389698 1202604 98715 2980
1808  59874 729416 3269017 5389698 3269017 729416 59874   1808
 403  13359 162754 729416 1202604 729416 162754  13359    403
  33   1096  13359  59874  98715  59874  13359   1096     33
   1     33    403   1808   2980   1808    403     33      1
sum = 55832714
coeff = 0.000000017910646
```

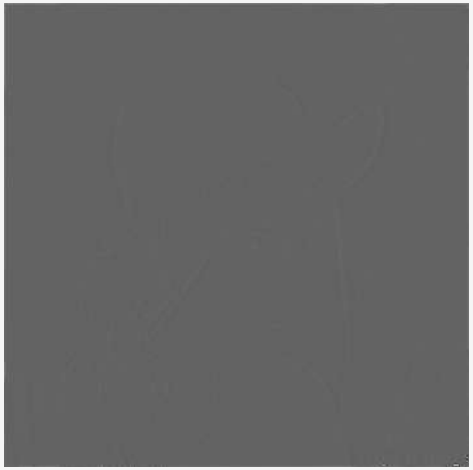
Laplacian kernel1
0	−1	0
−1	4	−1
0	−1	0

Laplacian kernel2
−1	−1	−1
−1	8	−1
−1	−1	−1

Gaussian Filter Sittings	σ = 2, kernel size = 5	σ = 2, kernel size = 7	σ = 2, kernel size = 9
	1 1 1 1 1 1 2 2 2 1 1 2 2 2 1 1 2 2 2 1 1 1 1 1 1 sum = 34 coeff = 0.029411764705882	1 1 2 3 2 1 1 1 3 5 5 5 3 1 2 5 7 8 7 5 2 3 5 8 9 8 5 3 2 5 7 8 7 5 2 1 3 5 5 5 3 1 1 1 2 3 2 1 1 sum = 181 coeff = 0.005524861878453	
Original Image			
Gaussian Filter Result			

Gaussian Filter Sittings	σ = 2, kernel size = 5	σ = 2, kernel size = 7	σ = 2, kernel size = 9
	1 1 1 1 1 1 2 2 2 1 1 2 2 2 1 1 2 2 2 1 1 1 1 1 1 sum = 34 coeff = 0.029411764705882	1 1 2 3 2 1 1 1 3 5 5 5 3 1 2 5 7 8 7 5 2 3 5 8 9 8 5 3 2 5 7 8 7 5 2 1 3 5 5 5 3 1 1 1 2 3 2 1 1 sum = 181 coeff = 0.005524861878453	
Sobel Horizontal direction = h 1 2 1 0 0 0 -1 -2 -1			
Sobel Vertical direction = v 1 0 -1 2 0 -2 1 0 -1			

Gaussian Filter Sittings	σ = 2, kernel size = 5	σ = 2, kernel size = 7	σ = 2, kernel size = 9
	1 1 1 1 1 1 2 2 2 1 1 2 2 2 1 1 2 2 2 1 1 1 1 1 1 sum = 34 coeff = 0.029411764705882	1 1 2 3 2 1 1 1 3 5 5 5 3 1 2 5 7 8 7 5 2 3 5 8 9 8 5 3 2 5 7 8 7 5 2 1 3 5 5 5 3 1 1 1 2 3 2 1 1 sum = 181 coeff = 0.005524861878453	
Sobel Both Directions			

Gaussian Filter Sittings	σ = 2, kernel size = 5	σ = 2, kernel size = 7	σ = 2, kernel size = 9
Laplacian kernel1			
Laplacian kernel2			

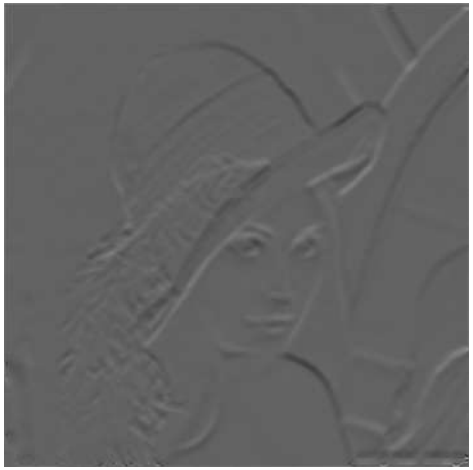
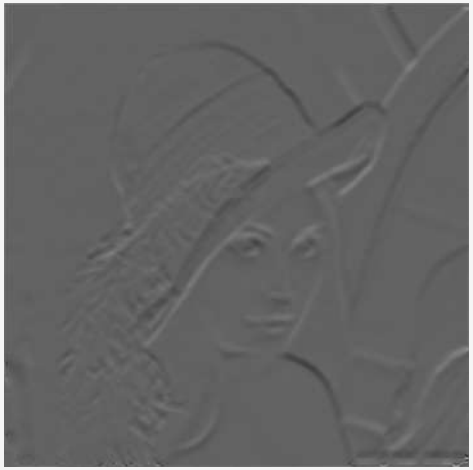
```
1  1  1  1  1
1  2  2  2  1
1  2  2  2  1
1  2  2  2  1
1  1  1  1  1
sum = 34
coeff = 0.029411764705882
```

```
1  1  2  3  2  1  1
1  3  5  5  5  3  1
2  5  7  8  7  5  2
3  5  8  9  8  5  3
2  5  7  8  7  5  2
1  3  5  5  5  3  1
1  1  2  3  2  1  1
sum = 181
coeff = 0.005524861878453
```

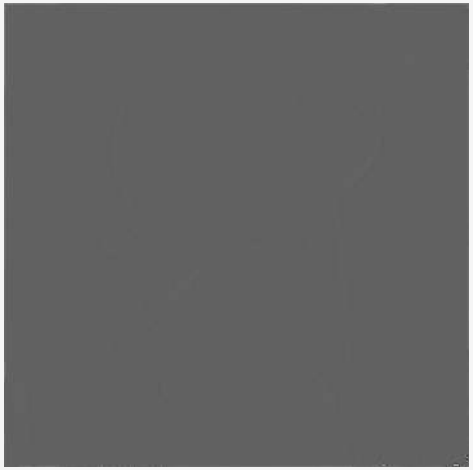
0	−1	0
−1	4	−1
0	−1	0

−1	−1	−1
−1	8	−1
−1	−1	−1

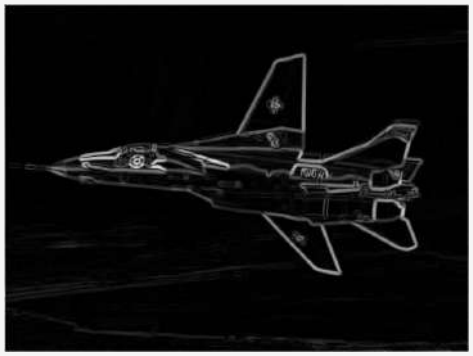
Gaussian Filter Sittings	σ = 4, kernel size = 5	σ = 4, kernel size = 7	σ = 4, kernel size = 9
	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 sum = 25 coeff = 0.040000000000000	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 sum = 49 coeff = 0.020408163265306	1 1 1 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 1 1 2 2 2 2 2 1 1 1 1 2 2 2 2 2 1 1 1 2 2 2 2 2 2 2 1 1 1 2 2 2 2 2 1 1 1 1 2 2 2 2 2 1 1 1 1 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 sum = 110 coeff = 0.009090909090909
Original Image			
Gaussian Filter Result			

Gaussian Filter Sittings	σ = 4, kernel size = 5	σ = 4, kernel size = 7	σ = 4, kernel size = 9
	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 sum = 25 coeff = 0.040000000000000	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 sum = 49 coeff = 0.020408163265306	1 1 1 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 1 1 2 2 2 2 2 1 1 1 1 2 2 2 2 2 1 1 1 2 2 2 2 2 2 2 1 1 1 2 2 2 2 2 1 1 1 1 2 2 2 2 2 1 1 1 1 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 sum = 110 coeff = 0.009090909090909
Sobel Horizontal direction = h 1 2 1 0 0 0 -1 -2 -1			
Sobel Vertical direction = v 1 0 -1 2 0 -2 1 0 -1			

Gaussian Filter Sittings	σ = 4, kernel size = 5	σ = 4, kernel size = 7	σ = 4, kernel size = 9
	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 sum = 25 coeff = 0.040000000000000	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 sum = 49 coeff = 0.020408163265306	1 1 1 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 1 1 2 2 2 2 2 1 1 1 1 2 2 2 2 2 1 1 1 2 2 2 2 2 2 2 1 1 1 2 2 2 2 2 1 1 1 1 2 2 2 2 2 1 1 1 1 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 sum = 110 coeff = 0.009090909090909
Sobel Both Directions			

Gaussian Filter Sittings	σ = 4, kernel size = 5	σ = 4, kernel size = 7	σ = 4, kernel size = 9
	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 sum = 25 coeff = 0.040000000000000	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 sum = 49 coeff = 0.020408163265306	1 1 1 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 1 1 2 2 2 2 2 1 1 1 1 2 2 2 2 2 1 1 1 2 2 2 2 2 2 2 1 1 1 2 2 2 2 2 1 1 1 1 2 2 2 2 2 1 1 1 1 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 sum = 110 coeff = 0.009090909090909
Laplacian kernel1 0 −1 0 −1 4 −1 0 −1 0			
Laplacian kernel2 −1 −1 −1 −1 8 −1 −1 −1 −1			

Gaussian Filter Result	$\sigma = 1$	$\sigma = 2$	$\sigma = 4$
kernel size = 3			
kernel size = 5			
kernel size = 7			

Sobel Both Directions Result	$\sigma = 1$	$\sigma = 2$	$\sigma = 4$
kernel size = 3			
kernel size = 5			
kernel size = 7