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Image Convolutin/Filtering

$$H = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 3 \\ -3 & 0 & 1 \end{bmatrix} \quad X = \begin{bmatrix} 2 & 3 & 1 & 0 & 2 & 2 \\ 1 & 0 & 1 & 1 & 0 & 1 \\ 1 & 2 & 0 & 2 & 3 & 1 \\ 0 & 1 & 0 & 1 & 5 & 0 \\ 1 & 2 & 3 & 0 & 3 & 1 \\ 1 & 2 & 0 & 2 & 2 & 0 \end{bmatrix}$$

Y = H * X =

1. (-1*0) + (0*0) + (1*0) + (-1*0) + (0*2) + (3*3) + (-3*0) + (0*1) + (1*0) = 0 + 0 + 0 + 0 + 0 + 9 + 0 + 0 + 0 = 9

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	0

X

-1	0	1
-1	0	3
-3	0	1

=

9					

2. (-1*0) + (0*0) + (1*0) + (-1*2) + (0*3) + (1*3) + (-3*0) + (0*0) + (1*1) = 0 + 0 + 0 + -2 + 0 + 3 + 0 + 0 + 1 = 2

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	0

X

-1	0	1
-1	0	3
-3	0	1

=

9	2				

3. (-1*0) + (0*0) + (1*0) + (-1*3) + (0*1) + (3*0) + (-3*0) + (0*1) + (1*1) = 0 + 0 + 0 + -3 + 0 + 0 + 0 + 0 + 1 = -2

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2			

4. (-1* 0) + (0*0) + (1*0) + (-1*1) + (0*0) + (3*2) + (-3*1) + (0*1) + (1*0) = 0 + 0 + 0 + -1 + 0 + 6 + -3 + 0 + 0 =2

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2		

5. (-1*0) + (0*0) + (1*0) + (-1*0) + (0*2) + (3*2) + (-3*1) + (0*0) + (1*1) = 0 + 0 + 0 + 0 + 0 + 6 + -3 + 0 + 1 = 4

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	

6. (-1*0) + (0*0) + (1*0) + (-1*2) + (0*2) + (3*0) + (-3*0) + (0*1) + (1*0) = 0 + 0 + 0 + -2 + 0 + 0 + 0 + 0 + 0 = -2

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2

7. (-1*0) + (0*2) + (1*3) + (-1*0) + (0*1) + (3*0) + (-3*0) + (0*1) + (1*2) = 0 + 0 + 3 + 0 + 0 + 0 + 0 + 0 + 2 = 5

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5					

8. (-1*2) + (0*3) + (1*1) + (-1*1) + (0*0) + (3*1) + (-3*1) + (0*2) + (1*0) = -2 + 0 + 1 + -1 + 0 + 3 + -3 + 0 + 0 =-2

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2				

9. (-1*3) + (0*1) + (1*0) + (-1*0) + (0*1) + (3*1) + (-3*2) + (0*0) + (2*1) = -3 + 0 + 0 + 0 + 0 + 3 + -6 + 0 + 2 = -4

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4			

10. (-1*1) + (0*0) + (1*2) + (-1*1) + (0*1) + (3*0) + (-3*0) + (0*2) + (1*3) = -1 + 0 + 2 + -1 + 0 + 0 + 0 + 3 = 3

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3		

11. (-1*0) + (0*2) + (1*2) + (-1*1) + (0*0) + (3*1) + (-3*2) + (0*3) + (1*1) = 0 + 0 + 2 + -1 + 0 + 3 + -6 + 0 + 1 = -3

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3	-3	

12. (-1*2) + (0*2) + (1*0) + (-1*0) + (0*1) + (3*0) + (-3*3) + (0*1) + (1*0) = -2 + 0 + 0 + 0 + 0 + 0 + -9 + 0 + 0 = -11

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3	-3	-11

13. (-1*0) + (0*1) + (1*0) + (-1*0) + (0*1) + (3*2) + (-3*0) + (0*0) + (1*1) = 0 + 0 + 0 + 0 + 0 + 6 + 0 + 0 + 1 = 7

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3	-3	-11
7					

14. (-1*1) + (0*0) + (1*1) + (-1*1) + (0*2) + (3*0) + (-3*0) + (0*1) + (1*0) = -1 + 0 + 1 + -1 + 0 + 0 + 0 + 0 + 0 = -1

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3	-3	-11
7	-1				

15. (-1*0) + (0*1) + (1*1) + (-1*2) + (0*0) + (3*2) + (-3*1) + (0*0) + (1*1) = 0 + 0 + 1 + -2 + 0 + 6 + -3 + 0 + 1 = 3

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3	-3	-11
7	-1	3			

16. (-1*1) + (0*1) + (1*0) + (-1*0) + (0*2) + (3*3) + (-3*0) + (0*1) + (1*5) = -1 + 0 + 0 + 0 + 0 + 9 + 0 + 0 + 5 = 13

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3	-3	-11
7	-1	3	13		

17. (-1*1) + (0*0) + (1*1) + (-1*2) + (0*3) + (3*1) + (-3*1) + (0*5) + (1*0) = -1 + 0 + 1 + -2 + 0 + 3 + -3 + 0 + 0 = -2

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3	-3	-11
7	-1	3	13	-2	

18. (-1*0) + (0*1) + (1*0) + (-1*3) + (0*1) + (3*0) + (-3*5) + (0*0) + (1*0) = 0 + 0 + 0 + -3 + 0 + 0 + -15 + 0 + 0 = -18

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3	-3	-11
7	-1	3	13	-2	-18

19. (-1*0) + (0*1) + (1*2) + (-1*0) + (0*0) + (3*1) + (-3*0) + (0*1) + (1*2) = 0 + 0 + 2 + 0 + 0 + 3 + 0 + 0 + 2 = 7

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3	-3	-11
7	-1	3	13	-2	-18
7					

20. (-1*1) + (0*2) + (1*0) + (-1*0) + (0*1) + (3*0) + (-3*1) + (0*2) + (1*3) = -1 + 0 + 0 + 0 + 0 + 0 + -3 + 0 + 3 = -1

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3	-3	-11
7	-1	3	13	-2	-18
7	-1				

21. (-1*2) + (0*0) + (1*2) + (-1*1) + (0*0) + (3*1) + (-3*2) + (0*3) + (1*0) = -2 + 0 + 2 + -1 + 0 + 3 + -6 + 0 + 0 = -4

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3	-3	-11
7	-1	3	13	-2	-18
7	-1	-4			

22. (-1*0) + (0*2) + (1*3) + (-1*0) + (0*1) + (3*5) + (-3*3) + (0*0) + (1*3) = 0 + 0 + 3 + 0 + 0 + 15 + -9 + 0 + 3 = 12

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3	-3	-11
7	-1	3	13	-2	-18
7	-1	-4	12		

23. (-1*2) + (0*3) + (1*1) + (-1*1) + (0*5) + (3*0) + (-3*0) + (0*3) + (1*1) = -2 + 0 + 1 + -1 + 0 + 0 + 0 + 0 + 1 = -3

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3	-3	-11
7	-1	3	13	-2	-18
7	-1	-4	12	-3	

24. (-1*3) + (0*1) + (1*0) + (-1*5) + (0*0) + (3*0) + (-3*3) + (0*1) + (1*0) = -3 + 0 + 0 + -5 + 0 + 0 + -9 + 0 + 0 = -17

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3	-3	-11
7	-1	3	13	-2	-18
7	-1	-4	12	-3	-17

25. (-1*0) + (0*0) + (1*1) + (-1*0) + (0*1) + (3*2) + (-3*0) + (0*1) + (1*2) = 0 + 0 + 1 + 0 + 0 + 6 + 0 + 0 + 2 = 9

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3	-3	-11
7	-1	3	13	-2	-18
7	-1	-4	12	-3	-17
9					

26. (-1*0) + (0*1) + (1*0) + (-1*1) + (0*2) + (3*3) + (-3*1) + (0*2) + (1*0) = 0 + 0 + 0 + -1 + 0 + 3 + -3 + 0 + 0 = -1

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3	-3	-11
7	-1	3	13	-2	-18
7	-1	-4	12	-3	-17
9	-1				

27. (-1*1) + (0*0) + (1*1) + (-1*2) + (0*3) + (3*0) + (-3*2) + (0*0) + (1*2) = -1 + 0 + 1 + -2 + 0 + 0 + -6 + 0 + 2 = 6

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3	-3	-11
7	-1	3	13	-2	-18
7	-1	-4	12	-3	-17
9	-1	6			

28. (-1*0) + (0*1) + (1*5) + (-1*3) + (0*0) + (3*3) + (-3*0) + (0*2) + (1*2) = 0 + 0 + 5 + -3 + 0 + 9 + 0 + 0 + 2 = 13

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3	-3	-11
7	-1	3	13	-2	-18
7	-1	-4	12	-3	-17
9	-1	6	13		

29. (-1*1) + (0*5) + (1*0) + (-1*0) + (0*3) + (3*1) + (-3*2) + (0*2) + (1*4) = -1 + 0 + 0 + 0 + 0 + 3 + -6 + 0 + 4 = 0

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3	-3	-11
7	-1	3	13	-2	-18
7	-1	-4	12	-3	-17
9	-1	6	13	0	

30. (-1*5) + (0*0) + (1*0) + (-1*3) + (0*1) + (3*0) + (-3*2) + (0*4) + (1*0) = -5 + 0 + 0 + -3 + 0 + 0 + -6 + 0 + 0 = -14

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3	-3	-11
7	-1	3	13	-2	-18
7	-1	-4	12	-3	-17
9	-1	6	13	0	-14

31. (-1*0) + (0*1) + (1*2) + (-1*0) + (0*1) + (3*2) + (-3*0) + (0*0) + (1*0) = 0 + 0 + 2 + 0 + 0 + 6 + 0 + 0 + 0 = 8

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3	-3	-11
7	-1	3	13	-2	-18
7	-1	-4	12	-3	-17
9	-1	6	13	0	-14
8					

32. (-1*1) + (0*2) + (1*3) + (-1*1) + (0*2) + (3*0) + (-3*0) + (0*0) + (1*0) = -1 + 0 + 3 + -1 + 0 + 0 + 0 + 0 + 0 = 1

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3	-3	-11
7	-1	3	13	-2	-18
7	-1	-4	12	-3	-17
9	-1	6	13	0	-14
8	1				

33. (-1*2) + (0*3) + (1*0) + (-1*2) + (0*0) + (3*2) + (-3*0) + (0*0) + (1*0) = -2 + 0 + 0 + -2 + 0 + 6 + 0 + 0 + 0 = 2

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3	-3	-11
7	-1	3	13	-2	-18
7	-1	-4	12	-3	-17
9	-1	6	13	0	-14
8	1	2			

34. (-1*3) + (0*0) + (1*3) + (-1*0) + (0*2) + (3*2) + (-3*0) + (0*0) + (1*0) = -3 + 0 + 3 + 0 + 0 + 6 + 0 + 0 + 0 = 6

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3	-3	-11
7	-1	3	13	-2	-18
7	-1	-4	12	-3	-17
9	-1	6	13	0	-14
8	1	2	6		

35. (-1*0) + (0*3) + (1*1) + (-1*2) + (0*2) + (3*4) + (-3*0) + (0*0) + (1*0) = 0 + 0 + 1 + -2 + 0 + 12 + 0 + 0 + 0 = 11

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3	-3	-11
7	-1	3	13	-2	-18
7	-1	-4	12	-3	-17
9	-1	6	13	0	-14
8	1	2	6	11	

36. (-1*3) + (0*1) + (1*0) + (-1*2) + (0*4) + (3*0) + (-3*0) + (0*0) + (1*0) = -3 + 0 + 0 + -2 + 0 + 0 + 0 + 0 = -5

2	3	1	0	2	2
1	0	1	1	0	1
1	2	0	2	3	1
0	1	0	1	5	0
1	2	3	0	3	1
1	2	0	2	2	4

X

-1	0	1
-1	0	3
-3	0	1

=

9	2	-2	2	4	-2
5	-2	-4	3	-3	-11
7	-1	3	13	-2	-18
7	-1	-4	12	-3	-17
9	-1	6	13	0	-14
8	1	2	6	11	-5

Mengimplementasikan dalam bentuk Codingan

Menggunakan Gaussian Blur

convolusi.py

```python
import cv2
import numpy as np
from scipy import signal
from matplotlib import pyplot as plt
imgc = cv2.imread('gambarr.jpg')
img = cv2.cvtColor(imgc, cv2.COLOR_BGR2GRAY)


w_k = np.array([[0, -1, 0],
[-1,5, -1],
[0, -1, 0],],
dtype='float')

w_k = np.rot90(w_k, 2)

print (img.shape, w_k.shape)
f = signal.convolve2d(img, w_k, 'valid')
print(np.min(f))

plt.subplot(121),plt.imshow(img,'gray'),plt.title('original')
plt.xticks([]), plt.yticks([])
plt.subplot(122),plt.imshow(f,'gray'),plt.title('gaussian Blur')
plt.xticks([]), plt.yticks([])
plt.show()
```

Hasil

```
PS E:\Kuliah\Semester 5\Pengolahan Citra\Pertemuan 6> & C:/Users/Filsafalasafi/AppData/Local/Programs/Python/Python310/python.exe "e:/Kuliah/Semester 5/Pengolahan Citra/Pertemuan 6/convolusi.py"
(1893, 1573) (3, 3)
-157.0
```

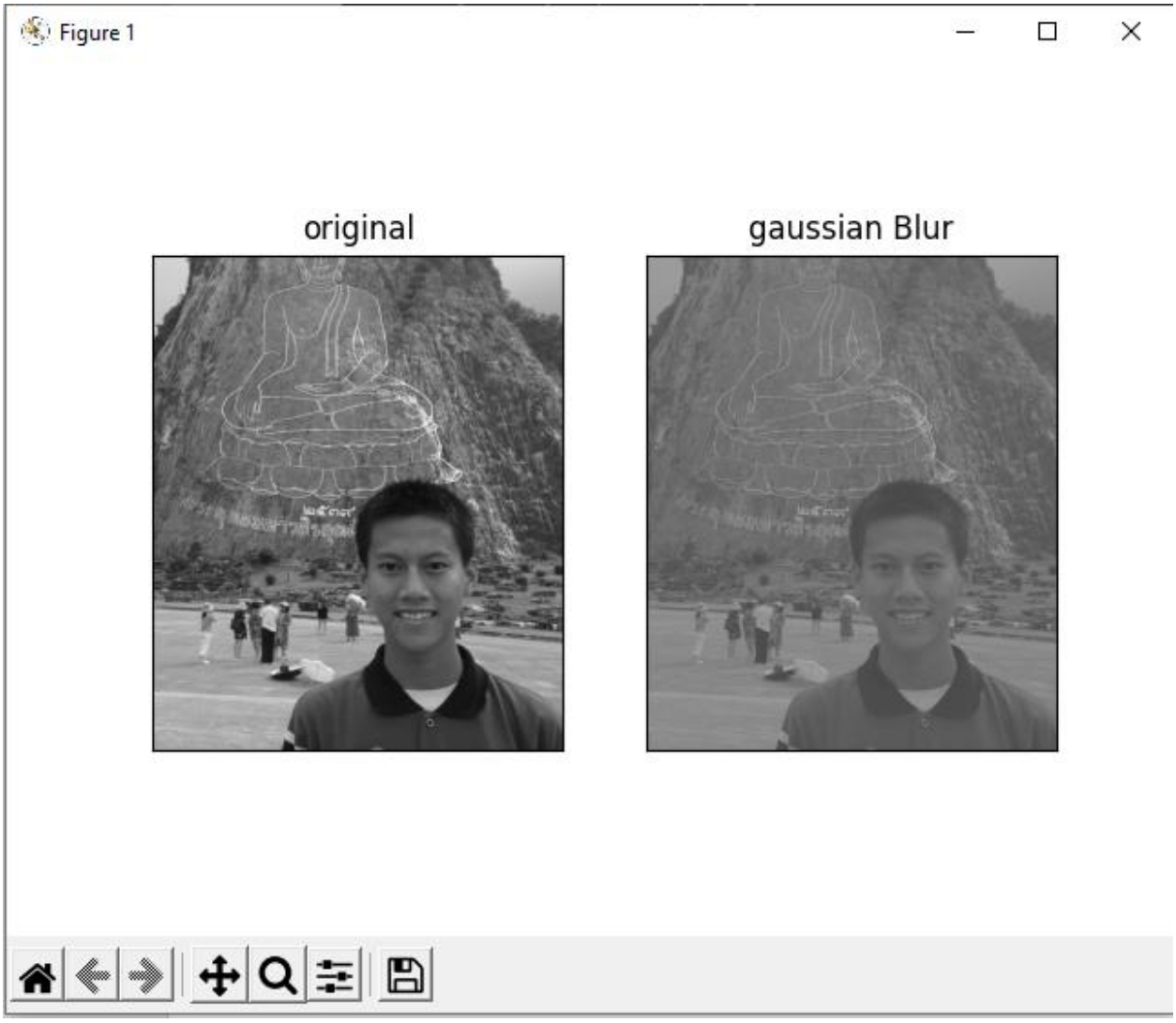
Figure 1
original
gaussian Blur