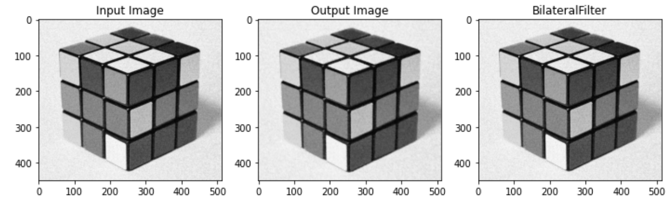
```
[103] for i in range (kernel_size, mimg.shape[0]-kernel_size):
        for j in range(kernel_size, mimg.shape[1]-kernel_size):
            sum = 0
            mid = int(mimg[i][j])
            for p in range(-kernel_size, kernel_size+1):
                for q in range(-kernel_size, kernel_size+1):
                    distance = int(mimg[p+i][q+j])-mid
                    range_filter[p-kernel_size][q-kernel_size]=np.exp(-distance**2/(sigma**2))/(sigma**2)
            filter = np.multiply(gf, range_filter)
            norm = np.sum(filter)
            for p in range(-kernel_size, kernel_size+1):
                for q in range(-kernel_size, kernel_size+1):
                    sum+=mimg[i-(p+kernel_size)][j-(q+kernel_size)]*filter[p+kernel_size][q+kernel_size]
            output[i-kernel_size][j-kernel_size] = sum/norm
```

```
bilFilter = cv2.bilateralFilter(img, kernel_size*2+1, sigma, sigma)

figure , (axis_1, axis_2,axis_3) = plt.subplots(1,3, figsize=(12,12))
axis_1.imshow(img, "gray")
axis_1.set_title("Input Image")
axis_2.imshow(output, "gray")
axis_2.set_title("Output Image")
axis_3.set_title("BilateralFilter")
axis_3.imshow(bilFilter, "gray")
```

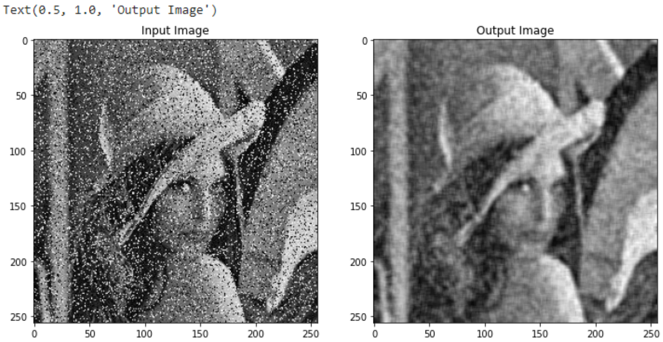
```
<matplotlib.image.AxesImage at 0x7fbe9a1cd950>
```



Mean

```
kernel_size = int(input("Enter Kernel Size: "))
kernel = np.ones((kernel_size, kernel_size), np.float32)
kernel_size=kernel_size//2
output = np.zeros((img.shape[0], img.shape[1]), np.float32)
norm = kernel.sum()
mimg = cv2.copyMakeBorder(img,kernel_size, kernel_size, kernel_size, kernel_size, cv2.BORDER_REPLICATE)
for i in range(2*kernel_size, mimg.shape[0]):
    for j in range(2*kernel_size,mimg.shape[1]):
        sum = 0
        for p in range(-kernel_size, kernel_size+1):
            for q in range(-kernel_size, kernel_size+1):
                sum+=mimg[i-(p+kernel_size)][j-(q+kernel_size)]*kernel[p+kernel_size][q+kernel_size]
        output[i-(2*kernel_size)][j-(2*kernel_size)] = sum
output/=norm
figure, (axis_1, axis_2) = plt.subplots(1,2, figsize=(12,12))
axis_1.imshow(img, "gray")
axis_1.set_title("Input Image")
axis_2.imshow(output, "gray")
axis_2.set_title("Output Image")
```

```
Enter Kernel Size: 5
Text(0.5, 1.0, 'Output Image')
```



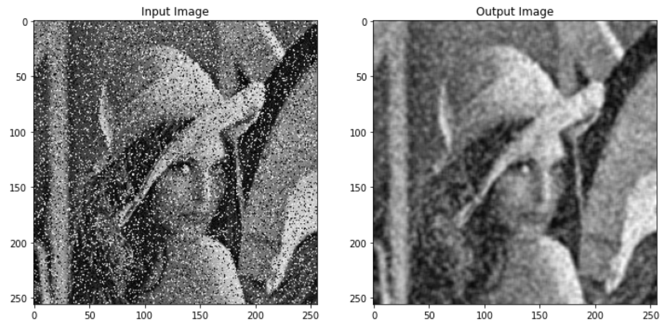
Gaushian

```
[108] def conv(kernel_size,filter):
        output = np.zeros((img.shape[0], img.shape[1]), np.float32)
        mimg = cv2.copyMakeBorder(img,kernel_size, kernel_size, kernel_size, kernel_size, cv2.BORDER_REPLICATE)
        for i in range(2*kernel_size, mimg.shape[0]):
            for j in range(2*kernel_size,mimg.shape[1]):
                sum = 0
                for p in range(-kernel_size, kernel_size+1):
                    for q in range(-kernel_size, kernel_size+1):
                        sum+=mimg[i-(p+kernel_size)][j-(q+kernel_size)]*filter[p+kernel_size][q+kernel_size]
                output[i-(2*kernel_size)][j-(2*kernel_size)] = sum

        return output
```

```
[109] def gaussian_kernel():
        kernel_size = int(input("Enter kernel Size: "))
        kernel_size = kernel_size//2
        sigma = 0.3*((kernel_size-1)*0.5-1)+0.8
        sigma = sigma*3
        gf = np.zeros((2*kernel_size+1, 2*kernel_size+1), np.float32)

        for i in range(-kernel_size, kernel_size+1):
            for j in range (-kernel_size, kernel_size+1):
                gf[i+kernel_size][j+kernel_size]=np.exp(-(pow(i,2)+pow(j,2))/(2*pow(sigma,2)))
        return gf, kernel_size
```

```
kernel, kernel_size = gaussian_kernel()
output  = conv(kernel_size, kernel)
figure, (axis_1, axis_2) = plt.subplots(1,2, figsize=(12,12))
axis_1.imshow(img, "gray")
axis_1.set_title("Input Image")
axis_2.imshow(output, "gray")
axis_2.set_title("Output Image")
```

```
Enter kernel Size: 5
Text(0.5, 1.0, 'Output Image')
```

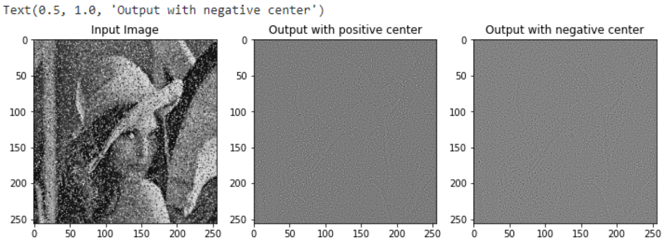


Laplacian

```
def laplacian_kernelp():
    lf = [[0,-1,0],[-1,4,-1],[0,-1,0]]
    return lf

def laplacian_kerneln():
    lf = [[0,1,0],[1,-4,1],[0,1,0]]
    return lf
```

```
kernel = laplacian_kernelp()
kernel = np.array(kernel)
outputp = conv(kernel.shape[0]//2, kernel)

kernel = laplacian_kerneln()
kernel = np.array(kernel)
outputn=conv(kernel.shape[0]//2, kernel)


figure, (axis_1, axis_2, axis_3) = plt.subplots(1,3, figsize=(12,12))
axis_1.imshow(img, "gray")
axis_1.set_title("Input Image")
axis_2.imshow(outputp, "gray")
axis_2.set_title("Output with positive center")
axis_3.imshow(outputn, "gray")
axis_3.set_title("Output with negative center")
```

```
Text(0.5, 1.0, 'Output with negative center')
```

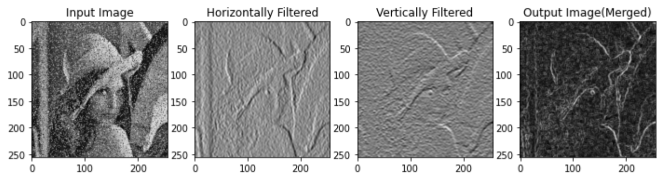


Sobel

```python
[89] def horizontal_sobel_kernel(kernel_size: int):

        row_value = [[0 for i in range(kernel_size)] for j in range(1)]
        col_value = [[1 for i in range(1)] for j in range(kernel_size)]
        center = kernel_size//2
        col_value[center][0] = 2
        for i in range(1):
            for j in range(kernel_size):
                row_value[i][j]=center
                center-=1
        horizontal_sobel_kernel = [[0 for i in range(kernel_size)] for j in range(kernel_size)]
        horizontal_sobel_kernel = np.matmul(col_value, row_value)
        return horizontal_sobel_kernel

    def vertical_sobel_kernel(kernel_size: int):

        col_value = [[0 for i in range(1)] for j in range(kernel_size)]
        row_value = [[1 for i in range(kernel_size)] for j in range(1)]
        center = kernel_size//2
        row_value[0][center]=2
        for i in range(kernel_size):
            for j in range(1):
                col_value[i][j]=center
                center-=1
        vertical_sobel_kernel = [[0 for i in range(kernel_size)] for j in range(kernel_size)]
        vertical_sobel_kernel = np.matmul(col_value, row_value)
        return vertical_sobel_kernel
```

```python
kernel_size = int(input("Enter Kernel Size"))
kernel = horizontal_sobel_kernel(kernel_size)
kernel = np.array(kernel)

h = conv(kernel_size//2, kernel)


kernel = vertical_sobel_kernel(kernel_size)
kernel = np.array(kernel)

v = conv(kernel_size//2, kernel)

output = np.zeros((v.shape[0], v.shape[1]), np.float32)
#gradient Magnitude
for i in range(v.shape[0]):
    for j in range(v.shape[1]):
        output[i][j] = np.sqrt(pow(h[i][j],2)+pow(v[i][j],2))


figure, (axis_1, axis_2, axis_3, axis_4) = plt.subplots(1,4, figsize=(12,12))
axis_1.imshow(img, "gray")
axis_1.set_title("Input Image")
axis_2.imshow(h, "gray")
axis_2.set_title("Horizontally Filtered")
axis_3.imshow(v, "gray")
axis_3.set_title("Vertically Filtered")
axis_4.imshow(output, "gray")
axis_4.set_title("Output Image(Merged)")
```

```
Enter Kernel Size5
Text(0.5, 1.0, 'Output Image(Merged)')
```

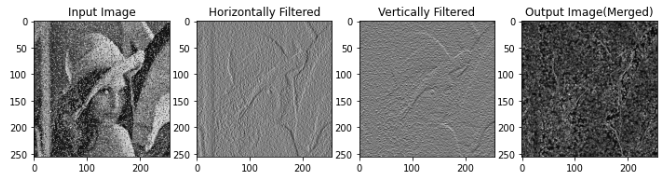


Schar

[91]
```python
def horizontal_scharr_kernel():
    horizontal_schar_kernel = [[3,0,-3],[10,0,-10],[3,0,-3]]
    return horizontal_schar_kernel

def vertical_scharr_kernel():
    vertical_schar_kernel = [[3,10,3],[0,0,0],[-3,-10,-3]]
    return vertical_schar_kernel
```

[92]
```python
kernel = vertical_scharr_kernel()
kernel = np.array(kernel)
v = conv(kernel.shape[0]//2, kernel)

output = np.zeros((v.shape[0], v.shape[1]), np.float32)
#gradient Magnitude
for i in range(v.shape[0]):
    for j in range(v.shape[1]):
        output[i][j] = np.sqrt(pow(h[i][j],2)+pow(v[i][j],2))

figure, (axis_1, axis_2, axis_3, axis_4) = plt.subplots(1,4, figsize=(12,12))
axis_1.imshow(img, "gray")
axis_1.set_title("Input Image")
axis_2.imshow(h, "gray")
axis_2.set_title("Horizontally Filtered")
axis_3.imshow(v, "gray")
axis_3.set_title("Vertically Filtered")
axis_4.imshow(output, "gray")
axis_4.set_title("Output Image(Merged)")
```

```
Text(0.5, 1.0, 'Output Image(Merged)')
```

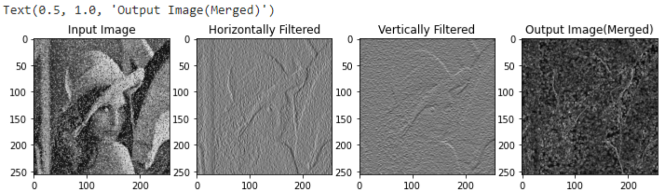


Prewitt

[93]
```python
def horizontal_prewitt_kernel():
    horizontal_prewitt_kernel = [[1,0,-1],[1,0,-1],[1,0,-1]]
    return horizontal_prewitt_kernel

def vertical_prewitt_kernel():
    vertical_prewitt_kernel = [[1,1,1],[0,0,0],[-1,-1,-1]]
    return vertical_prewitt_kernel
```

```python
kernel = horizontal_prewitt_kernel()
kernel = np.array(kernel)
h = conv(kernel.shape[0]//2, kernel)


kernel = vertical_prewitt_kernel()
kernel = np.array(kernel)
v = conv(kernel.shape[0]//2, kernel)

output = np.zeros((v.shape[0], v.shape[1]), np.float32)
#gradient Magnitude
for i in range(v.shape[0]):
    for j in range(v.shape[1]):
        output[i][j] = np.sqrt(pow(h[i][j],2)+pow(v[i][j],2))

figure, (axis_1, axis_2, axis_3, axis_4) = plt.subplots(1,4, figsize=(12,12))
axis_1.imshow(img, "gray")
axis_1.set_title("Input Image")
axis_2.imshow(h, "gray")
axis_2.set_title("Horizontally Filtered")
axis_3.imshow(v, "gray")
axis_3.set_title("Vertically Filtered")
axis_4.imshow(output, "gray")
axis_4.set_title("Output Image(Merged)")
```

```
Text(0.5, 1.0, 'Output Image(Merged)')
```

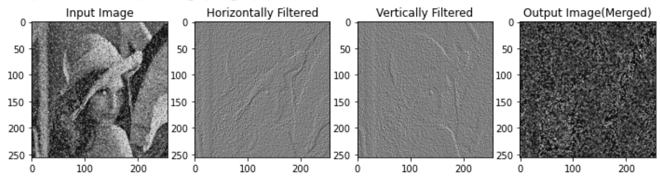


Robert

```
[95] def horizontal_roberts_kernel():
         horizontal_roberts_kernel = [[0,0,0],[0,1,0],[0,0,-1]]
         return horizontal_roberts_kernel

     def vertical_roberts_kernel():
         vertical_roberts_kernel = [[0,0,0],[0,0,1],[0,-1,0]]
         return vertical_roberts_kernel
```

```
[96] kernel = horizontal_roberts_kernel()
     kernel = np.array(kernel)
     h = conv(kernel.shape[0]//2, kernel)
[96]
     kernel = vertical_roberts_kernel()
     kernel = np.array(kernel)
     v = conv(kernel.shape[0]//2, kernel)

     output = np.zeros((v.shape[0], v.shape[1]), np.float32)
     #gradient Magnitude
     for i in range(v.shape[0]):
         for j in range(v.shape[1]):
             output[i][j] = np.sqrt(pow(h[i][j],2)+pow(v[i][j],2))

     figure, (axis_1, axis_2, axis_3, axis_4) = plt.subplots(1,4, figsize=(12,12))
     axis_1.imshow(img, "gray")
     axis_1.set_title("Input Image")
     axis_2.imshow(h, "gray")
     axis_2.set_title("Horizontally Filtered")
     axis_3.imshow(v, "gray")
     axis_3.set_title("Vertically Filtered")
     axis_4.imshow(output, "gray")
     axis_4.set_title("Output Image(Merged)")
```

```
Text(0.5, 1.0, 'Output Image(Merged)')
```



Midean

```
kernel_size = int(input("Enter Kernel Size: "))
kernel = np.ones((kernel_size, kernel_size), np.float32)

kernel_size=kernel_size//2
total = kernel_size*kernel_size
mimg = cv2.copyMakeBorder(img,kernel_size, kernel_size, kernel_size, kernel_size, cv2.BORDER_REPLICATE)

output = np.zeros((img.shape[0], img.shape[1]), np.float32)
for i in range(2*kernel_size, mimg.shape[0]):
    for j in range(2*kernel_size,mimg.shape[1]):
        values = []
        for p in range(-kernel_size, kernel_size+1):
            for q in range(-kernel_size, kernel_size+1):
                values.append(mimg[i-(p+kernel_size)][j-(q+kernel_size)]*kernel[p+kernel_size][q+kernel_size])
        values.sort()
        median = len(values)//2
        output[i-(2*kernel_size)][j-(2*kernel_size)] = values[median]/total


figure, (axis_1, axis_2) = plt.subplots(1,2, figsize=(12,12))
axis_1.imshow(img, "gray")
axis_1.set_title("Input Image")
axis_2.imshow(output, "gray")
axis_2.set_title("Output Image")
```

```
Enter Kernel Size: 5
Text(0.5, 1.0, 'Output Image')
```