[1]:

```
#import important libraries
import cv2
import numpy as np
from matplotlib import pyplot as plt
```

[2]:

```
#reading image and resizing and gray scale conversion
image = cv2.imread('img.jpg',0)
image = cv2.resize(image,(1400,800))
```

[3]:

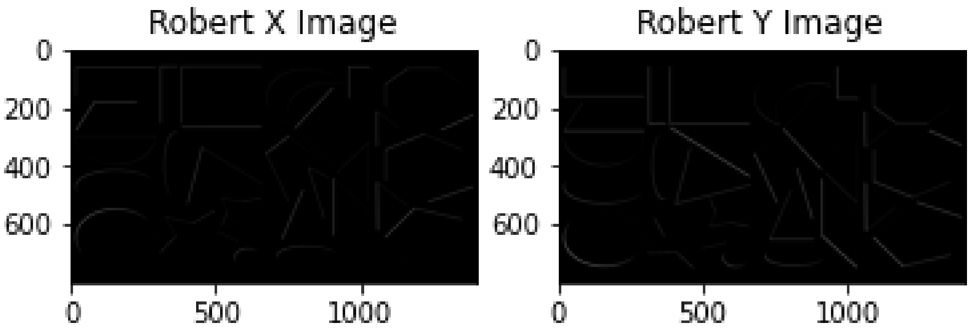
```
 # Robertsedge operator
kernel_Roberts_x = np.array([
    [1, 0],
    [0, -1]
    ])
kernel_Roberts_y = np.array([
    [0, -1],
    [1, 0]
    ])

average_kernel = (kernel_Roberts_x+kernel_Roberts_y)
```

[4]:

```
output_x = cv2.filter2D(image, -1, kernel_Roberts_x)
output_y = cv2.filter2D(image, -1, kernel_Roberts_y)
```

[5]:

```
# Show sharpening effect
plt.subplot(121),plt.imshow(output_x,cmap = 'gray')
plt.title('Robert X Image')
plt.subplot(122),plt.imshow(output_y,cmap = 'gray')
plt.title('Robert Y Image')
```

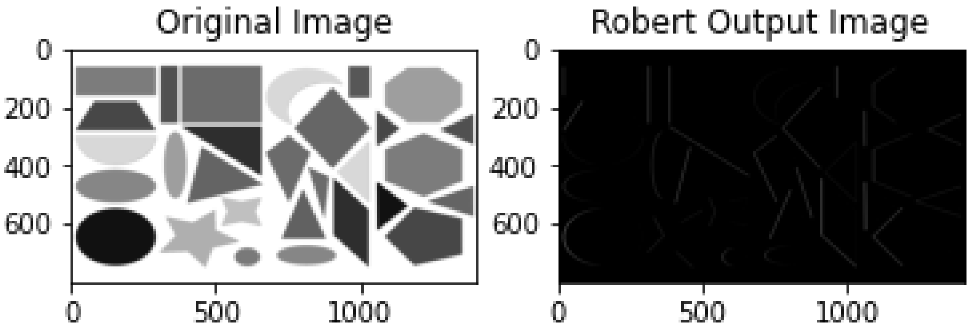


[6]:

```
output_Rav = cv2.filter2D(image, -1, average_kernel)
```

[7]:

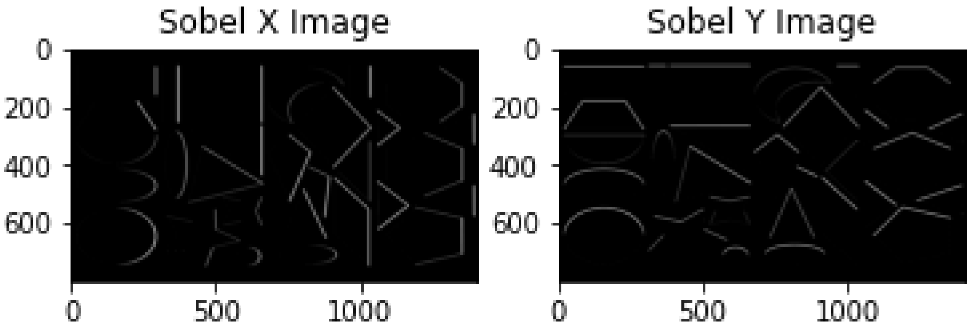
```
plt.subplot(121),plt.imshow(image,cmap = 'gray')
plt.title('Original Image')
plt.subplot(122),plt.imshow(output_Rav,cmap = 'gray')
plt.title('Robert Output Image')
```



[8]:
```
# Sobel edge operator
kernel_Sobel_x = np.array([
    [-1, 0, 1],
    [-2, 0, 2],
    [-1, 0, 1]])
kernel_Sobel_y = np.array([
    [1, 2, 1],
    [0, 0, 0],
    [-1, -2, -1]])

average_kernel = (kernel_Sobel_x+kernel_Sobel_y)/2
```

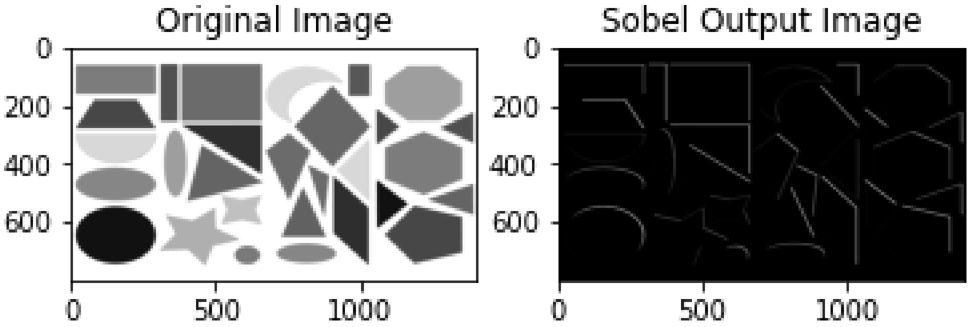
[9]:
```
output_Sx = cv2.filter2D(image, -1, kernel_Sobel_x)
output_Sy = cv2.filter2D(image, -1, kernel_Sobel_y)
```

[10]:
```
#sobel output image
plt.subplot(121),plt.imshow(output_Sx,cmap = 'gray')
plt.title('Sobel X Image')
plt.subplot(122),plt.imshow(output_Sy,cmap = 'gray')
plt.title('Sobel Y Image')
```



[11]:
```
output_Sav = cv2.filter2D(image, -1, average_kernel)
```

[12]:
```
plt.subplot(121),plt.imshow(image,cmap = 'gray')
plt.title('Original Image')
plt.subplot(122),plt.imshow(output_Sav,cmap = 'gray')
plt.title('Sobel Output Image')
```


Original Image
Sobel Output Image
0
200
400
600
0
500
1000
0
200
400
600
0
500
1000

[13]:

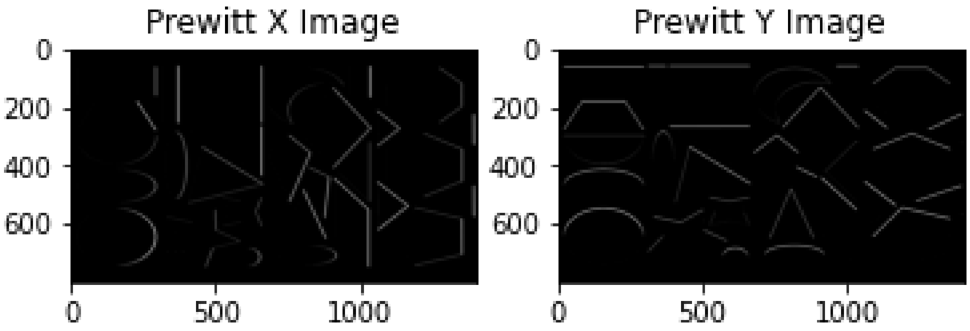
```
# Prewitt edge operator
kernel_Prewitt_x = np.array([
    [-1, 0, 1],
    [-1, 0, 1],
    [-1, 0, 1]])
kernel_Prewitt_y = np.array([
    [1, 1, 1],
    [0, 0, 0],
    [-1, -1, -1]])

average_kernel = kernel_Prewitt_x+kernel_Prewitt_y
```

[14]:

```
output_Px = cv2.filter2D(image, -1, kernel_Prewitt_x)
output_Py = cv2.filter2D(image, -1, kernel_Prewitt_y)
```

[15]:

```
plt.subplot(121),plt.imshow(output_Px,cmap = 'gray')
plt.title('Prewitt X Image')
plt.subplot(122),plt.imshow(output_Py,cmap = 'gray')
plt.title('Prewitt Y Image')
```

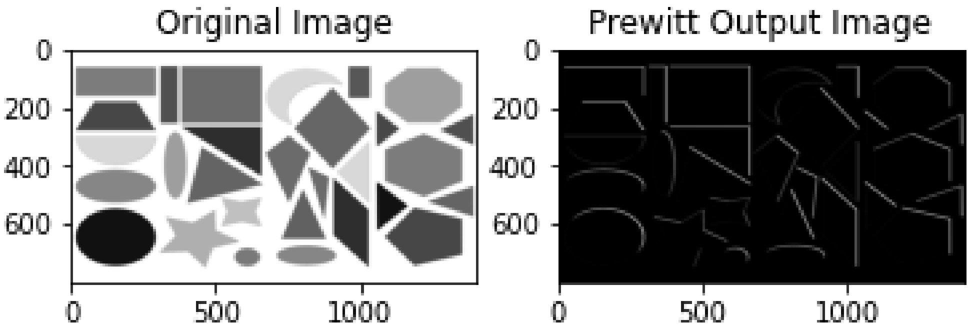


[16]:

```
output_Pav = cv2.filter2D(image, -1, average_kernel)
```

[17]:

```
plt.subplot(121),plt.imshow(image,cmap = 'gray')
plt.title('Original Image')
plt.subplot(122),plt.imshow(output_Pav,cmap = 'gray')
plt.title('Prewitt Output Image')
```


Original Image
Prewitt Output Image
0
200
400
600
0
500
1000
0
200
400
600
0
500
1000

[18]:

```
# Kirsch edge detection operator
def kirsch(image):
    m,n = image.shape
    list=[]
    kirsch = np.zeros((m,n))
    for i in range(2,m-1):
        for j in range(2,n-1):
            d1 = np.square(5 * image[i - 1, j - 1] + 5 * image[i - 1, j] + 5 *␣
 ↪image[i - 1, j + 1] -
                  3 * image[i, j - 1] - 3 * image[i, j + 1] - 3 * image[i + 1, j␣
 ↪- 1] -
                  3 * image[i + 1, j] - 3 * image[i + 1, j + 1])
            d2 = np.square((-3) * image[i - 1, j - 1] + 5 * image[i - 1, j] + 5␣
 ↪* image[i - 1, j + 1] -
                  3 * image[i, j - 1] + 5 * image[i, j + 1] - 3 * image[i + 1, j␣
 ↪- 1] -
                  3 * image[i + 1, j] - 3 * image[i + 1, j + 1])
            d3 = np.square((-3) * image[i - 1, j - 1] - 3 * image[i - 1, j] + 5␣
 ↪* image[i - 1, j + 1] -
                  3 * image[i, j - 1] + 5 * image[i, j + 1] - 3 * image[i + 1, j␣
 ↪- 1] -
                  3 * image[i + 1, j] + 5 * image[i + 1, j + 1])
            d4 = np.square((-3) * image[i - 1, j - 1] - 3 * image[i - 1, j] - 3␣
 ↪* image[i - 1, j + 1] -
                  3 * image[i, j - 1] + 5 * image[i, j + 1] - 3 * image[i + 1, j␣
 ↪- 1] +
                  5 * image[i + 1, j] + 5 * image[i + 1, j + 1])
            d5 = np.square((-3) * image[i - 1, j - 1] - 3 * image[i - 1, j] - 3␣
 ↪* image[i - 1, j + 1] - 3
                  * image[i, j - 1] - 3 * image[i, j + 1] + 5 * image[i + 1, j -␣
 ↪1] +
                  5 * image[i + 1, j] + 5 * image[i + 1, j + 1])
            d6 = np.square((-3) * image[i - 1, j - 1] - 3 * image[i - 1, j] - 3␣
 ↪* image[i - 1, j + 1] +
                  5 * image[i, j - 1] - 3 * image[i, j + 1] + 5 * image[i + 1, j␣
 ↪- 1] +
                  5 * image[i + 1, j] - 3 * image[i + 1, j + 1])
            d7 = np.square(5 * image[i - 1, j - 1] - 3 * image[i - 1, j] - 3 *␣
 ↪image[i - 1, j + 1] +
                  5 * image[i, j - 1] - 3 * image[i, j + 1] + 5 * image[i + 1, j␣
 ↪- 1] -
                  3 * image[i + 1, j] - 3 * image[i + 1, j + 1])
            d8 = np.square(5 * image[i - 1, j - 1] + 5 * image[i - 1, j] - 3 *␣
 ↪image[i - 1, j + 1] +
                  5 * image[i, j - 1] - 3 * image[i, j + 1] - 3 * image[i + 1, j␣
 ↪- 1] - 3 * image[i + 1, j] - 3 * image[i + 1, j + 1])
```

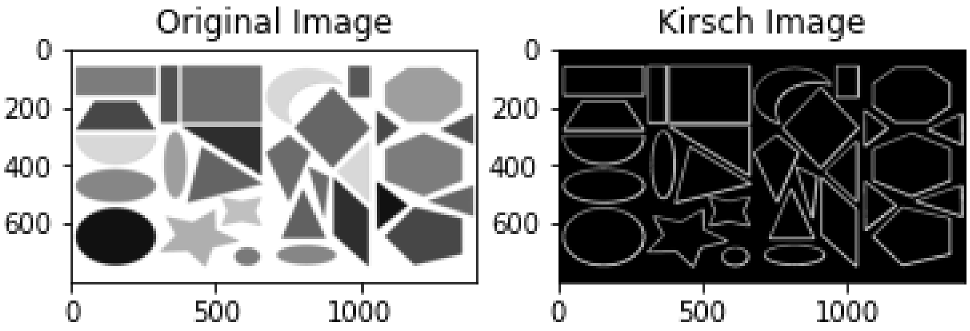
```
# : Take the maximum value in each direction, the effect is not good, use another method
            list=[d1, d2, d3, d4, d5, d6, d7, d8]
            kirsch[i,j]= int(np.sqrt(max(list)))
# : Rounding the die length in all directions
#kirsch[i, j] =int(np.sqrt(d1+d2+d3+d4+d5+d6+d7+d8))
    for i in range(m):
        for j in range(n):
            if kirsch[i,j]>127:
                kirsch[i,j]=255
            else:
                kirsch[i,j]=0
    return kirsch
```

[19]:

```
output_K = kirsch(image)
```

[20]:

```
plt.subplot(121),plt.imshow(image,cmap = 'gray')
plt.title('Original Image')
plt.subplot(122),plt.imshow(output_K,cmap = 'gray')
plt.title('Kirsch Image')
```



[21]:

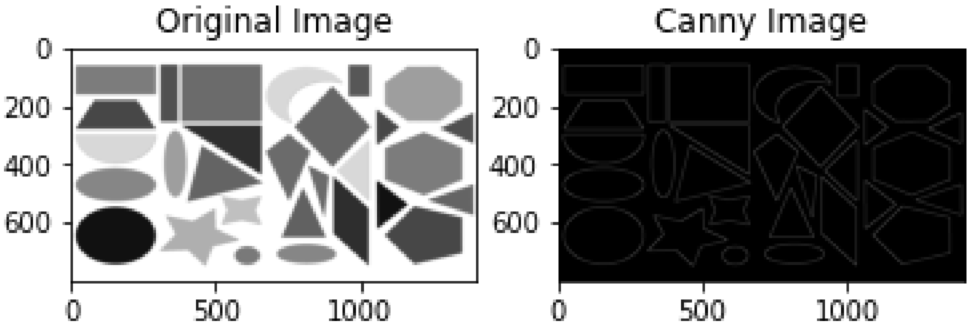
```
# Canny Edge Detection k is the Gaussian kernel size, t1, t2 is the threshold␣
 ↪size
def Canny(image,k,t1,t2):
    img = cv2.GaussianBlur(image, (k, k), 0)
    canny = cv2.Canny(img, t1, t2)
    return canny
```

[22]:

```
output_5 = Canny(image,3,50,150)
```

[23]:

```
plt.subplot(121),plt.imshow(image,cmap = 'gray')
plt.title('Original Image')
plt.subplot(122),plt.imshow(output_5,cmap = 'gray')
plt.title('Canny Image')
```



[24]:

```
#
kernel_Laplacian_1 = np.array([
    [0, 1, 0],
    [1, -4, 1],
    [0, 1, 0]])
kernel_Laplacian_2 = np.array([
    [1, 1, 1],
    [1, -8, 1],
    [1, 1, 1]])
```

[25]:

```
 # Two convolution kernels do not have rotation invariance
kernel_Laplacian_3 = np.array([
    [2, -1, 2],
    [-1, -4, -1],
    [2, 1, 2]])
kernel_Laplacian_4 = np.array([
    [-1, 2, -1],
    [2, -4, 2],
    [-1, 2, -1]])

kernel_average = (kernel_Laplacian_3+kernel_Laplacian_4+kernel_Laplacian_1+kernel_Laplacian_2)/4
```

[26]:

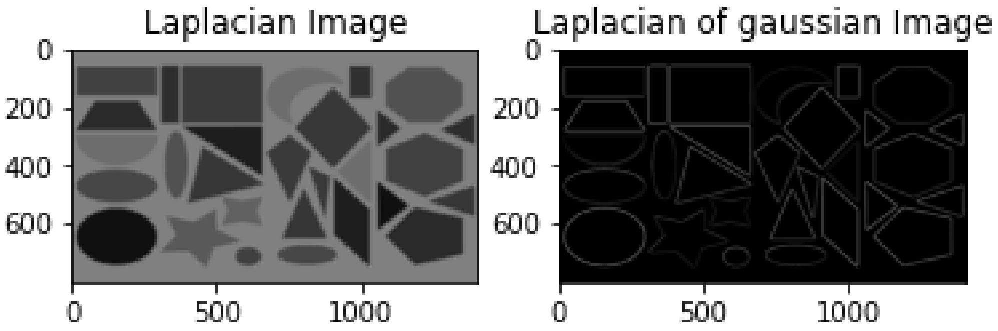
```
# 5*5 LoG Convolution Template
kernel_LoG = np.array([
                       [0, 0, -1, 0, 0],
                       [0, -1, -2, -1, 0],
                       [-1, -2, 16, -2, -1],
                       [0, -1, -2, -1, 0],
                       [0, 0, -1, 0, 0]])
```

[27]:

```
 # convolution
output_Lav = cv2.filter2D(image, -1, kernel_average)
output_LoG = cv2.filter2D(image, -1, kernel_LoG)
```

[28]:

```
plt.subplot(121),plt.imshow(output_Lav,cmap = 'gray')
plt.title('Laplacian Image')
plt.subplot(122),plt.imshow(output_LoG,cmap = 'gray')
plt.title('Laplacian of gaussian Image')
```


Laplacian Image
Laplacian of gaussian Image
0
200
400
600
0
500
1000
0
200
400
600
0
500
1000