Image Gradients

Goal

In this chapter, we will learn to:

- Find Image gradients, edges etc
- We will see following functions : **cv.Sobel()**, **cv.Scharr()**, **cv.Laplacian()** etc

Theory

OpenCV provides three types of gradient filters or High-pass filters, Sobel, Scharr and Laplacian. We will see each one of them.

1. Sobel and Scharr Derivatives

Sobel operators is a joint Gausssian smoothing plus differentiation operation, so it is more resistant to noise. You can specify the direction of derivatives to be taken, vertical or horizontal (by the arguments, yorder and xorder respectively). You can also specify the size of kernel by the argument ksize. If ksize = -1, a 3x3 Scharr filter is used which gives better results than 3x3 Sobel filter. Please see the docs for kernels used.

2. Laplacian Derivatives

It calculates the Laplacian of the image given by the relation, $\Delta src = \frac{\partial ^2{src}}{\partial x^2} + \frac{\partial ^2{src}}{\partial y^2}$ where each derivative is found using Sobel derivatives. If ksize = 1, then following kernel is used for filtering:

$$kernel = \begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$$

Code

Below code shows all operators in a single diagram. All kernels are of 5x5 size. Depth of output image is passed -1 to get the result in np.uint8 type.

```
import numpy as np
import cv2 as cv
from matplotlib import pyplot as plt

img = cv.imread('dave.jpg',0)

laplacian = cv.Laplacian(img,cv.CV_64F)
sobelx = cv.Sobel(img,cv.CV_64F,1,0,ksize=5)
sobely = cv.Sobel(img,cv.CV_64F,0,1,ksize=5)

plt.subplot(2,2,1),plt.imshow(img,cmap = 'gray')
plt.title('Original'), plt.xticks([]), plt.yticks([])
plt.subplot(2,2,2),plt.imshow(laplacian,cmap = 'gray')
plt.title('Laplacian'), plt.xticks([]), plt.yticks([])
plt.subplot(2,2,3),plt.imshow(sobelx,cmap = 'gray')
plt.title('Sobel X'), plt.xticks([]), plt.yticks([])
plt.subplot(2,2,4),plt.imshow(sobely,cmap = 'gray')
plt.title('Sobel Y'), plt.xticks([]), plt.yticks([])

plt.show()
```

Result:

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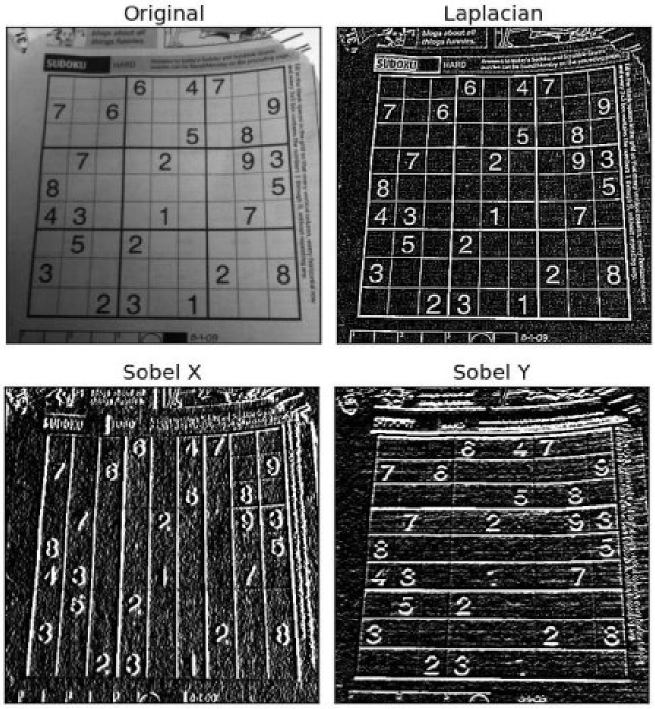

Original
Laplacian
Sobel X
Sobel Y

image

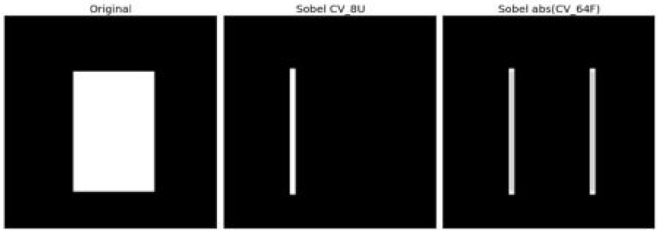
One Important Matter!

In our last example, output datatype is cv.CV_8U or np.uint8. But there is a slight problem with that. Black-to-White transition is taken as Positive slope (it has a positive value) while White-to-Black transition is taken as a Negative slope (It has negative value). So when you convert data to np.uint8, all negative slopes are made zero. In simple words, you miss that edge.

If you want to detect both edges, better option is to keep the output datatype to some higher forms, like cv.CV_16S, cv.CV_64F etc, take its absolute value and then convert back to cv.CV_8U. Below code demonstrates this procedure for a horizontal Sobel filter and difference in results.

```
import numpy as np
import cv2 as cv
from matplotlib import pyplot as plt

img = cv.imread('box.png',0)

# Output dtype = cv.CV_8U
sobelx8u = cv.Sobel(img,cv.CV_8U,1,0,ksize=5)

# Output dtype = cv.CV_64F. Then take its absolute and convert to cv.CV_8U
sobelx64f = cv.Sobel(img,cv.CV_64F,1,0,ksize=5)
abs_sobel64f = np.absolute(sobelx64f)
sobel_8u = np.uint8(abs_sobel64f)

plt.subplot(1,3,1),plt.imshow(img,cmap = 'gray')
plt.title('Original'), plt.xticks([]), plt.yticks([])
plt.subplot(1,3,2),plt.imshow(sobelx8u,cmap = 'gray')
plt.title('Sobel CV_8U'), plt.xticks([]), plt.yticks([])
plt.subplot(1,3,3),plt.imshow(sobel_8u,cmap = 'gray')
plt.title('Sobel abs(CV_64F)'), plt.xticks([]), plt.yticks([])

plt.show()
```

Check the result below:


Original
Sobel CV_8U
Sobel abs(CV_64F)

image

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Additional Resources

Exercises

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