1st Programming Assignment: Corner Detection

CSE 6239 (July 2020)

Report By:
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Description:

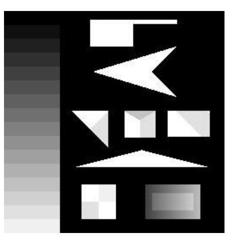
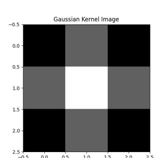
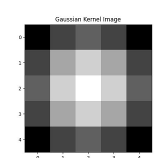
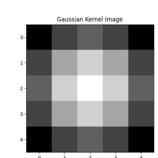
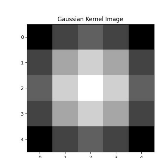
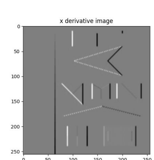
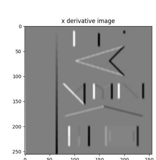
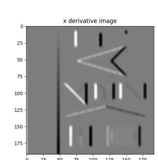
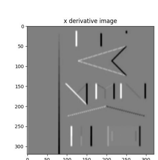
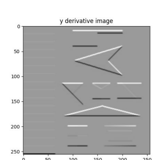
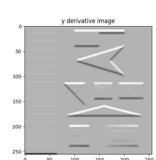
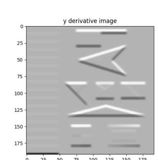
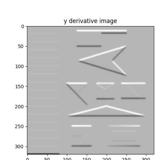
Corner detection executed for 8 images with different criteria is reported below with results.

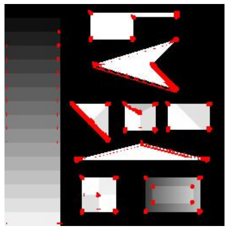
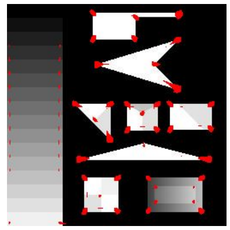
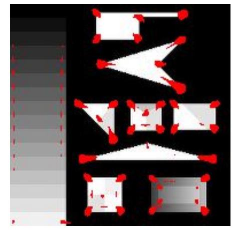
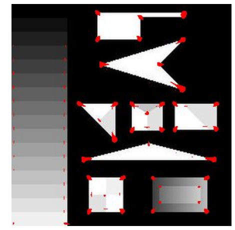
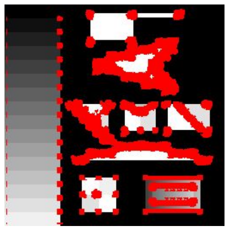
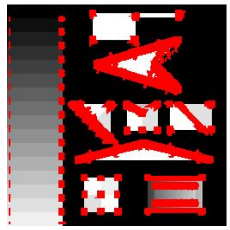
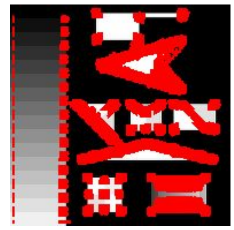
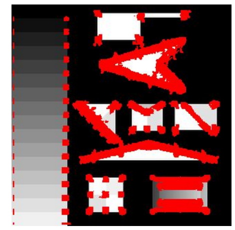
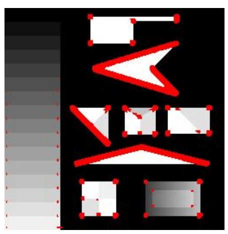
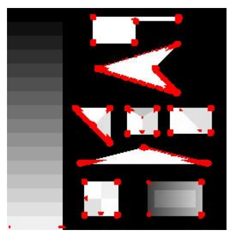
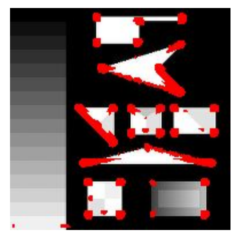
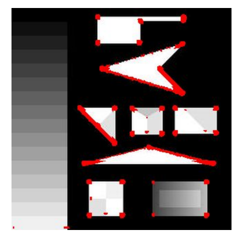
Image: img1.png

Kernel: Gaussian

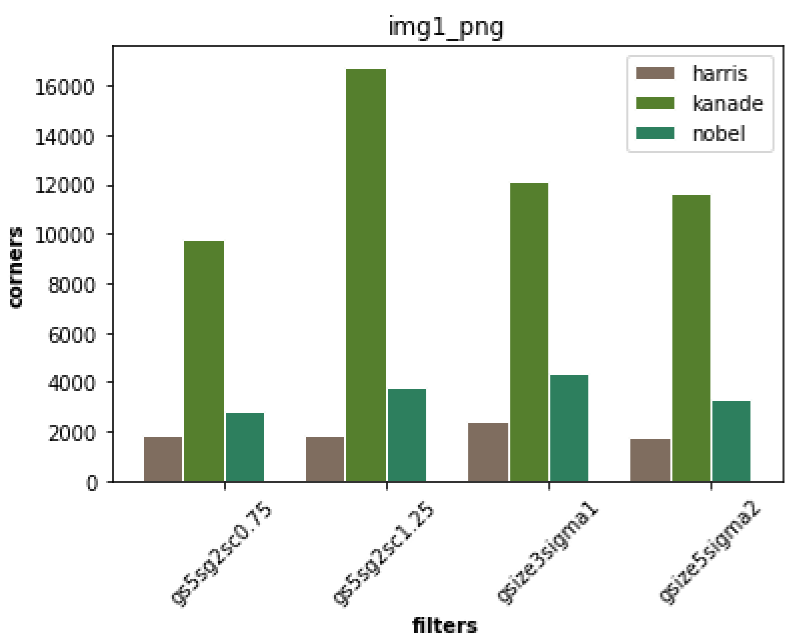
```python
def dnorm(x, sd):
    return 1 / (np.sqrt(2 * np.pi) * sd) * np.e ** (-np.power(x / sd, 2) / 2)
```

```python
def myGaussianKernel(size, sigma=1, verbose=False):
    kernel_1D = np.linspace(-(size // 2), size // 2, size)
    for i in range(size):
        kernel_1D[i] = dnorm(kernel_1D[i], sigma)
    print(kernel_1D)

    kernel_2D = np.outer(kernel_1D, kernel_1D)
    kernel_2D *= 1.0 / kernel_2D.max()

    plt.imshow(kernel_2D, interpolation='none', cmap='gray')
    plt.title("Gaussian Kernel Image")

    if verbose:
        plt.show()
    else:
        plt.savefig(os.path.join("output", f"gk{size}_{sigma}.png"))

    return kernel_2D
```

	Size: 3 Sigma: 1	Size: 5 Sigma: 2	Size: 5 Sigma: 2 Scale: 0.75	Size: 5 Sigma: 2 Scale: 1.25
Kernel				
X Derivative				
Y Derivative				

Harris R Threshold = 10000.00				
Kanade R Threshold = 100.00				
Nobel R Threshold = 1.00				

Bar chart for above **Gaussian** filter

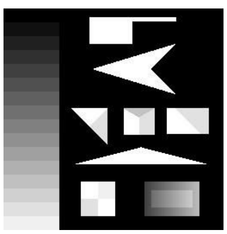
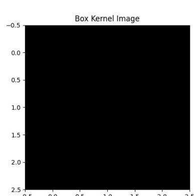
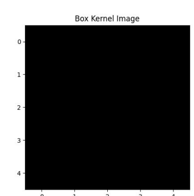
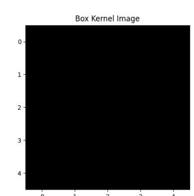
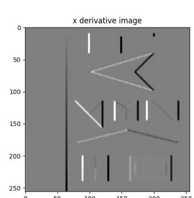
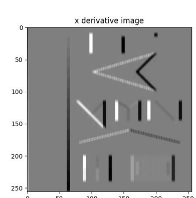
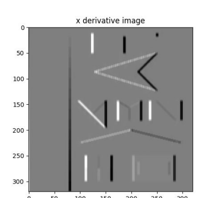


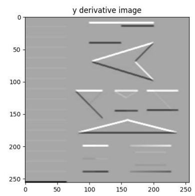
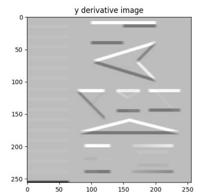
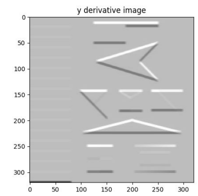
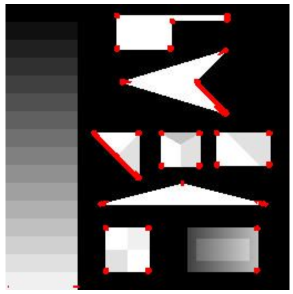
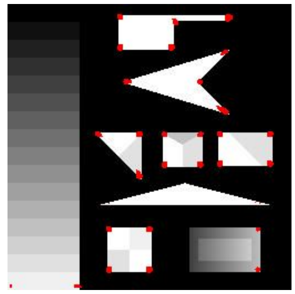
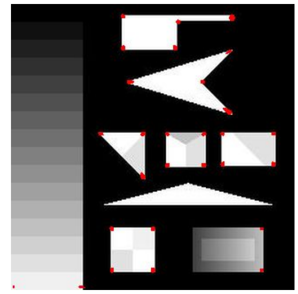
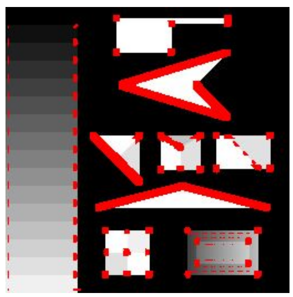
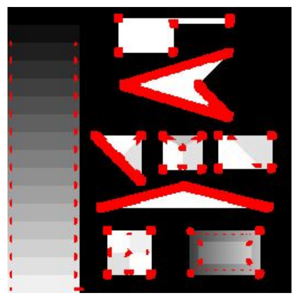
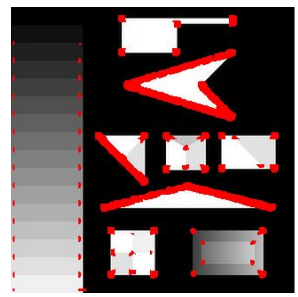
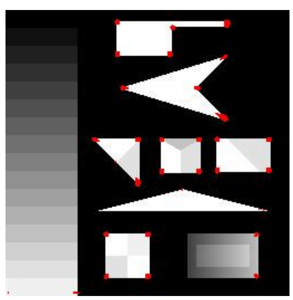
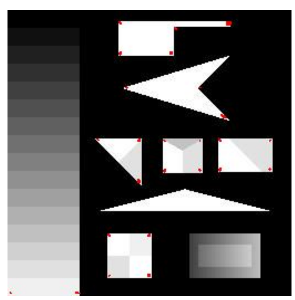
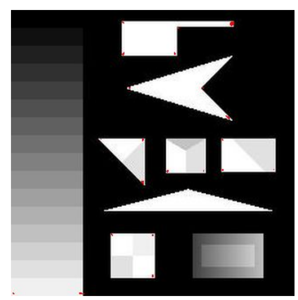
Comments:

1. Harris algorithm has worked well.
2. Kanade works very bad
3. Scale up detected more accurate corners
4. 15.5% corners are found common for 3 algorithms

Kernel: Box

```python
def myBoxKernel(size, verbose=False):
    kernel_2D = np.ones((size, size)) / 9

    plt.imshow(kernel_2D, interpolation='none', cmap='gray')
    plt.title("Box Kernel Image")

    if verbose:
        plt.show()
    else:
        plt.savefig(os.path.join("output", f"box{size}.png"))

    return kernel_2D
```

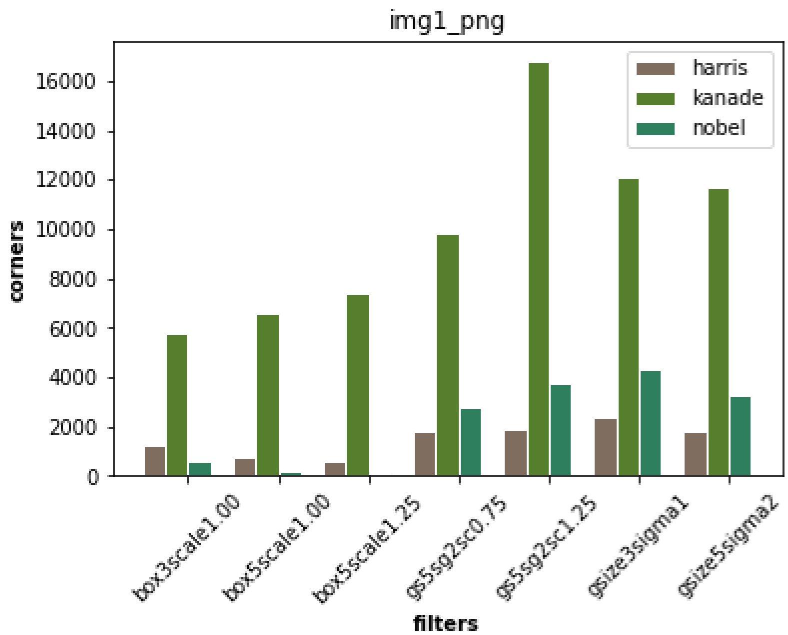
	Size: 3	Size: 5	Size: 5 Scale: 1.25
Kernel			
X Derivative			

Y Derivative			
Harris			
Kanade			
Nobel			

Code from myImageFilter() conv by kernel:

```
for row in range(image_row):
    for col in range(image_col):
        output[row, col] = np.sum(kernel * padded_image[row:row + kernel_row, col:col + kernel_col])
        if average:
            output[row, col] /= kernel.shape[0] * kernel.shape[1]

print("Output Image Size : {}".format(output.shape))
```

Bar chart for above **Gaussian + Box** filter



Comments:

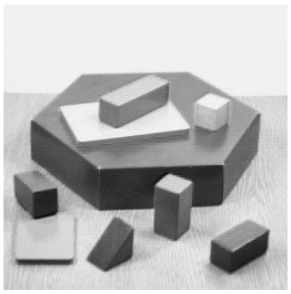
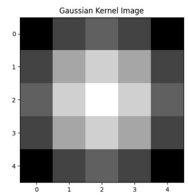
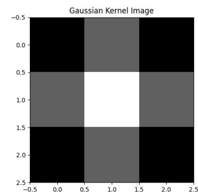
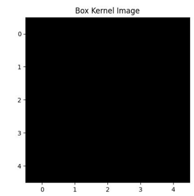
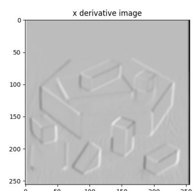
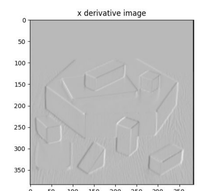
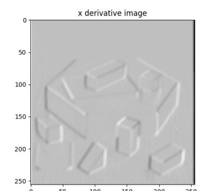
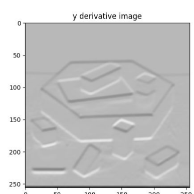
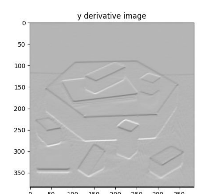
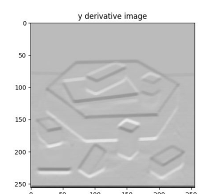
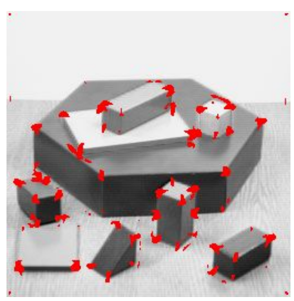
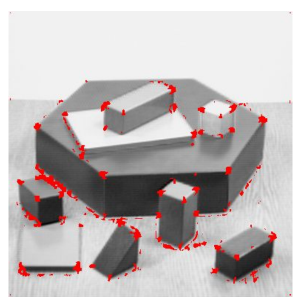
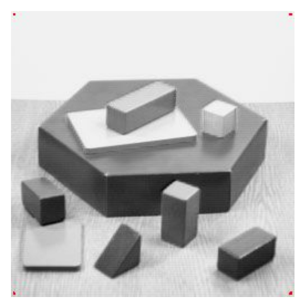
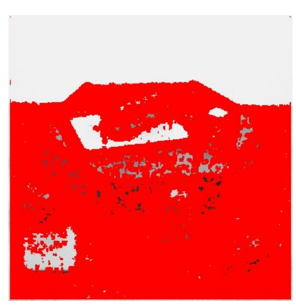
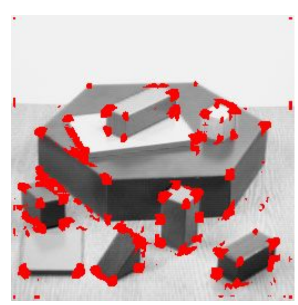
5. Less corner detected in box filter
6. Again scaling up detect more corners

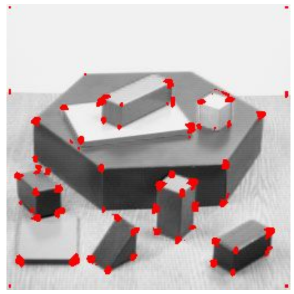
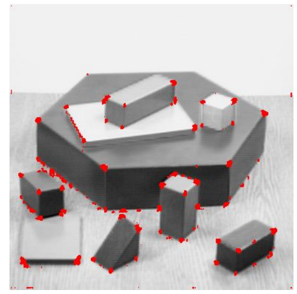
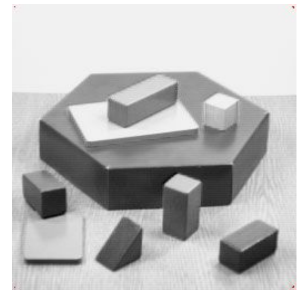
Code for R calculation:

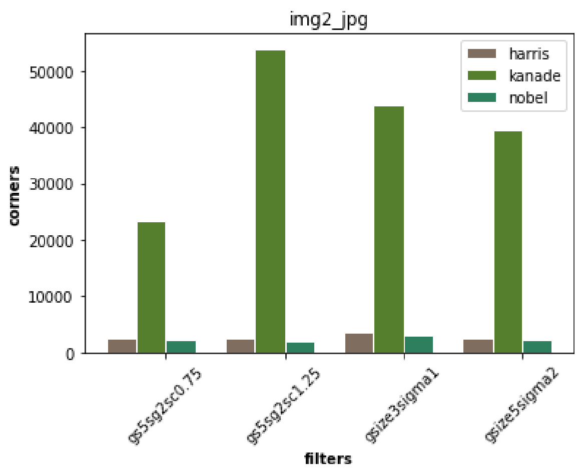
```
# Calculate r for Harris Corner equation
title = "Harris"
k = 0.04
r = det - k * (trace ** 2)
threshold = 10000.00
if r > threshold:
    harris_corner_list.append([x, y, r])
    # cv2.circle(output_img, (x, y), 1, 255, -1)
    harris_output_img[y, x] = (0, 0, 255)

# Calculate r for Kanade & Tomasi Corner equation
title = "Kanade & Tomasi"
# lamda1 * lamda2 = det
# lamda1 + lamda2 = trace
w, v = np.linalg.eig(M)
r = np.min(w)
threshold = 1.00
if r > threshold:
    kanade_corner_list.append([x, y, r])
    kanade_output_img[y, x] = (0, 0, 255)

# Calculate r for Nobel Corner equation
title = "Nobel"
e = 1
r = det / (trace + e)
threshold = 100.00
if r > threshold:
    nobel_corner_list.append([x, y, r])
    nobel_output_img[y, x] = (0, 0, 255)
```

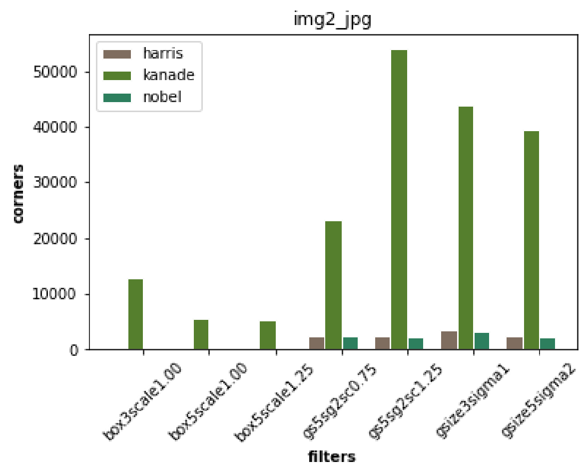
Similar process applied for all other provided images and For more programming reference please visit here.

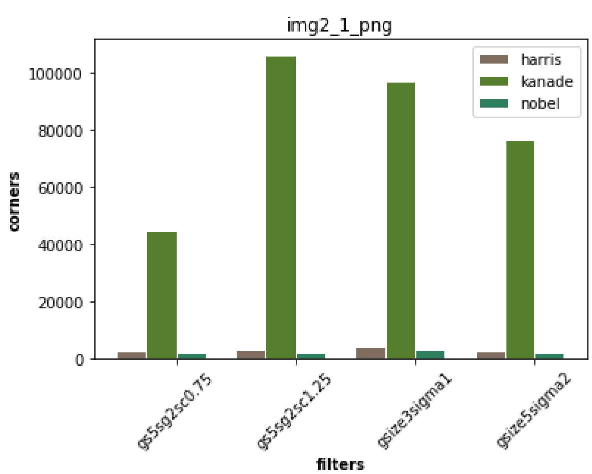
Image: img2.jpg

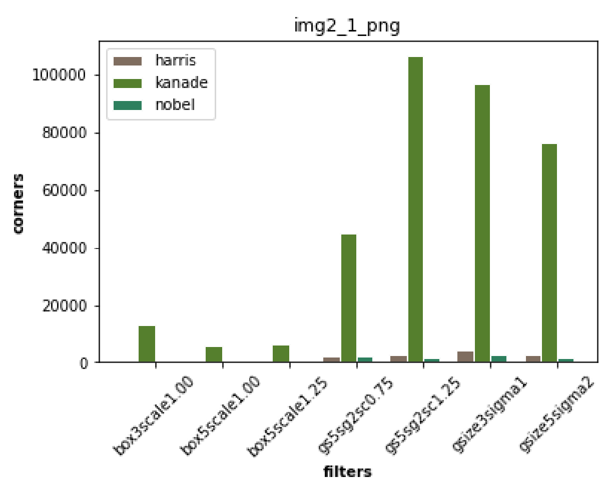
			
X Derivative			
Y Derivative			
Harris			
Kanade			

Nobel			



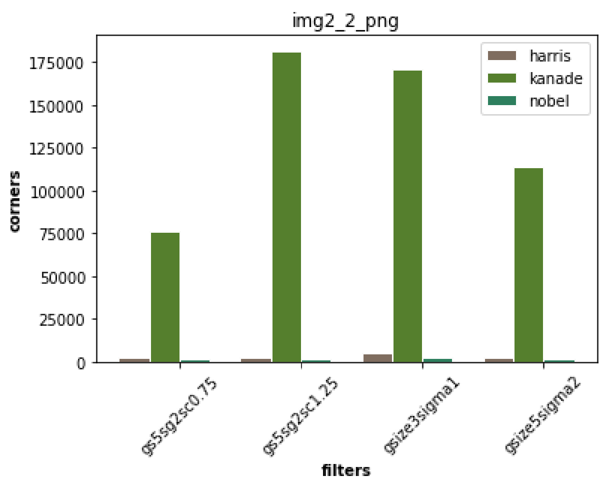






Comments:

1. Harris and Nobel algorithms do not perform well with the box kernel but work well with the gaussian kernel.
2. So much noise is found in the Kanade algorithm with the gaussian kernel. But with the box kernel Kanade algorithm works well.
3. Here 95% corners are common for kernel size difference



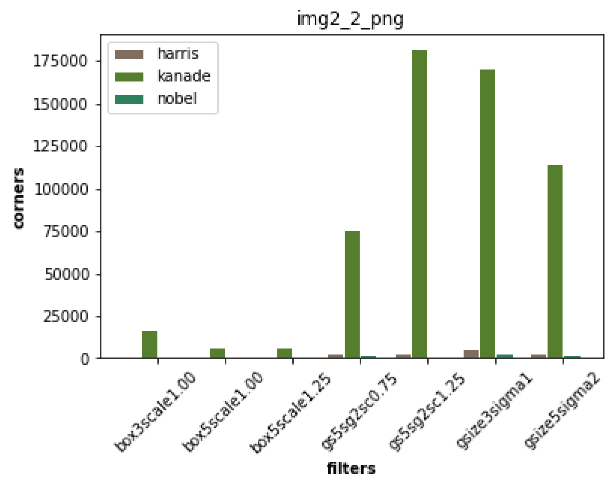
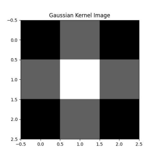
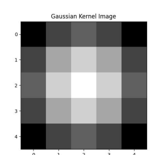
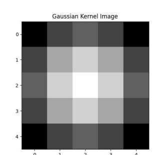
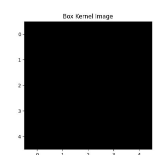
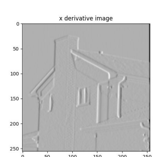
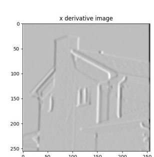
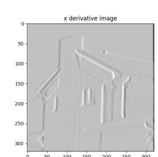
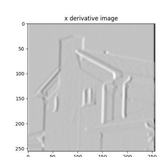
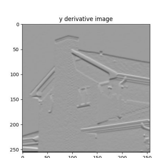
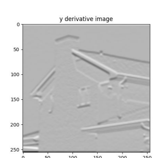
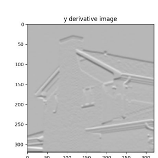
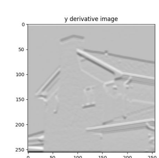
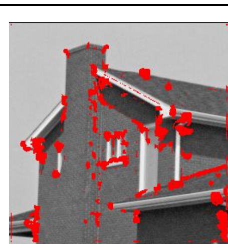
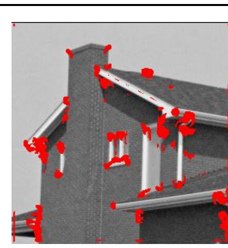
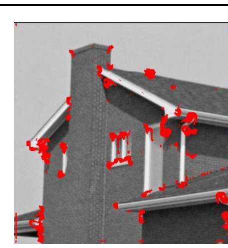
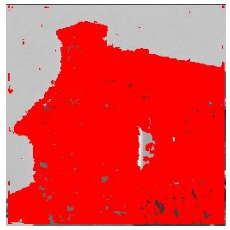
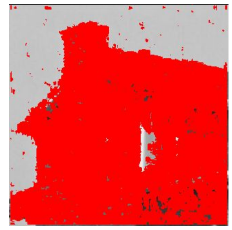
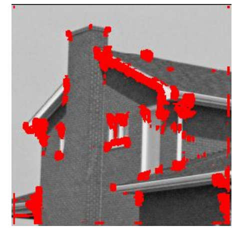
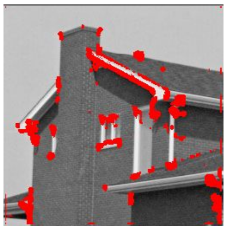
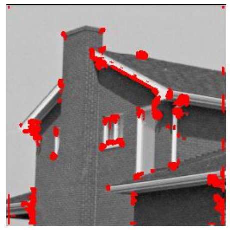
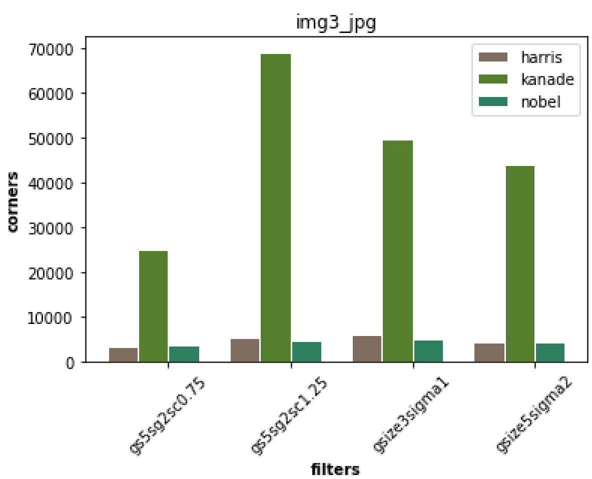


Image: img3.jpg

			 Scale: 1.25	
X Derivative				
Y Derivative				
Harris				

Kanade				
Nobel				



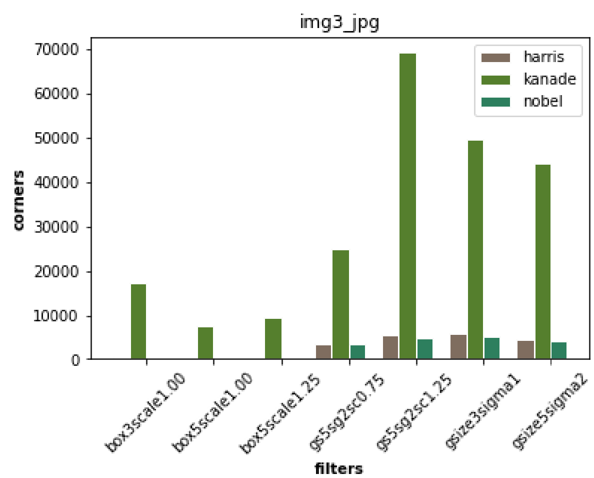
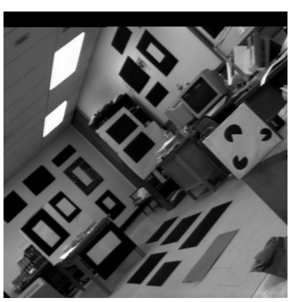
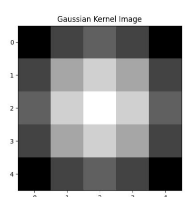
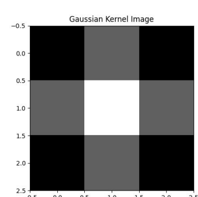
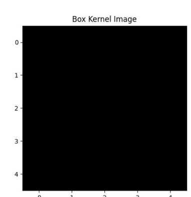
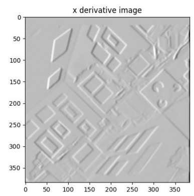
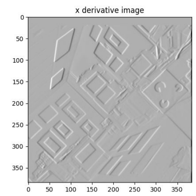
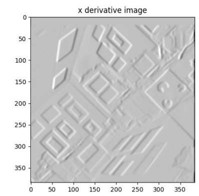
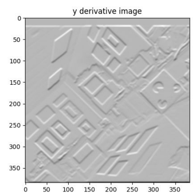
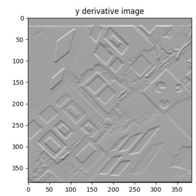
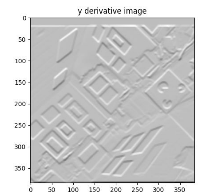
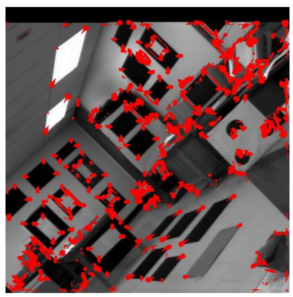
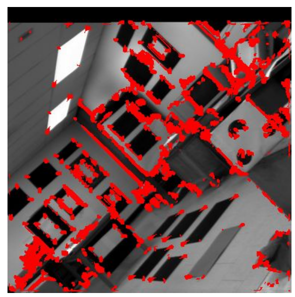
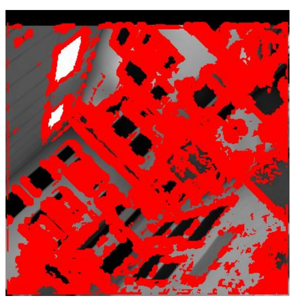
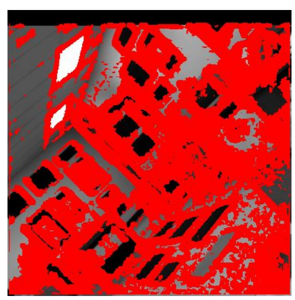
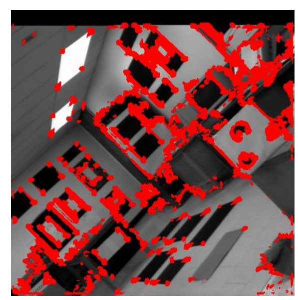
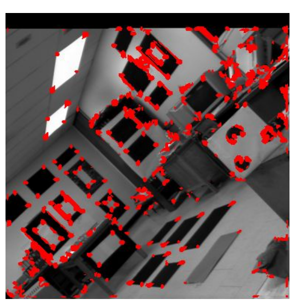
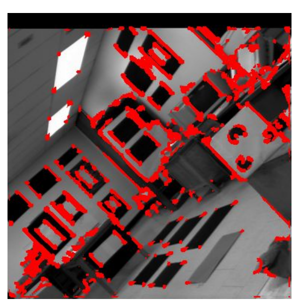
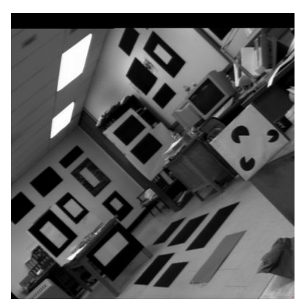
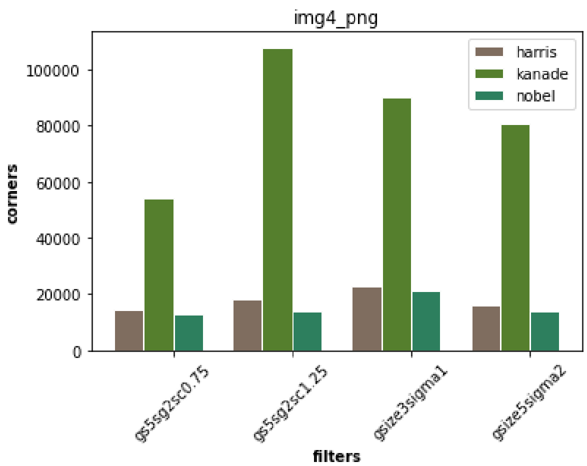


Image: img4.png

X Derivative			
Y Derivative			
Harris			
Kanade			
Nobel			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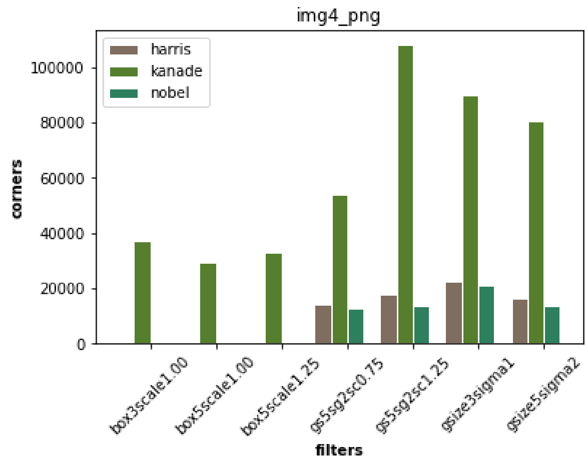
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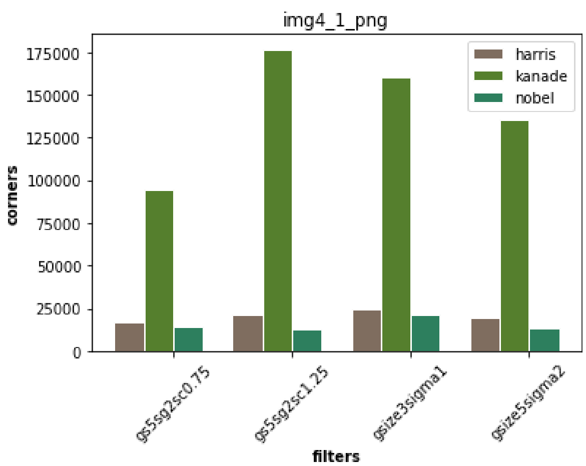
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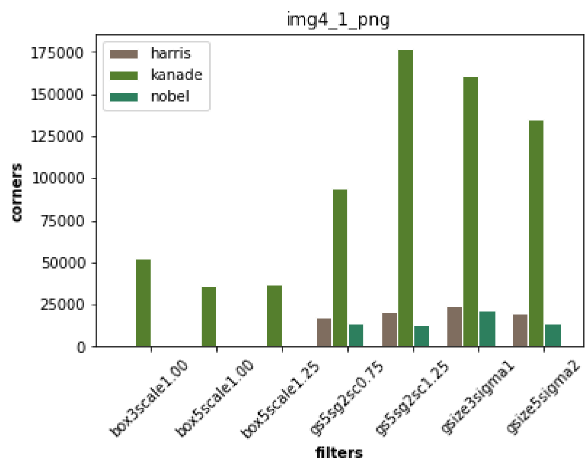
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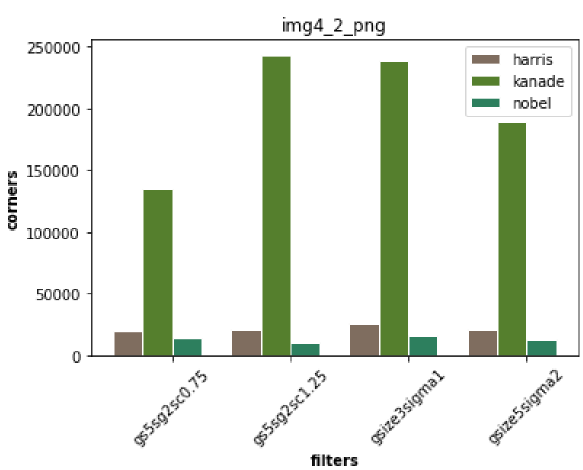
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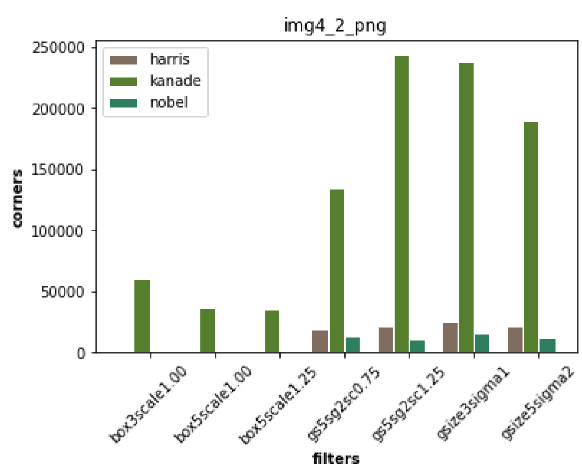
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