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Computer Vision

Lab 4: Detection of Corner

Lab Task 1 – Harris Corner Detector

Implement the Harris Corner Detector by completing the following steps:

(a) Compute the horizontal and vertical image derivatives (I_x, I_y) using Sobel or any suitable operator.

(b) Compute the product of the derivatives:

- $A= I_x^2$
- $B= I_y^2$
- $C= I_x I_y$

(c) Apply Gaussian smoothing (or any suitable blurring method) to each of the product images A, B, C to reduce noise.

(d) Compute the Harris corner response function:

$R=(AB-C^2)-k(A+B)^2$

where K is a sensitivity constant (typically 0.04–0.06).

(e) Apply thresholding on R to identify strong corner points and mark them on the original image.

Code

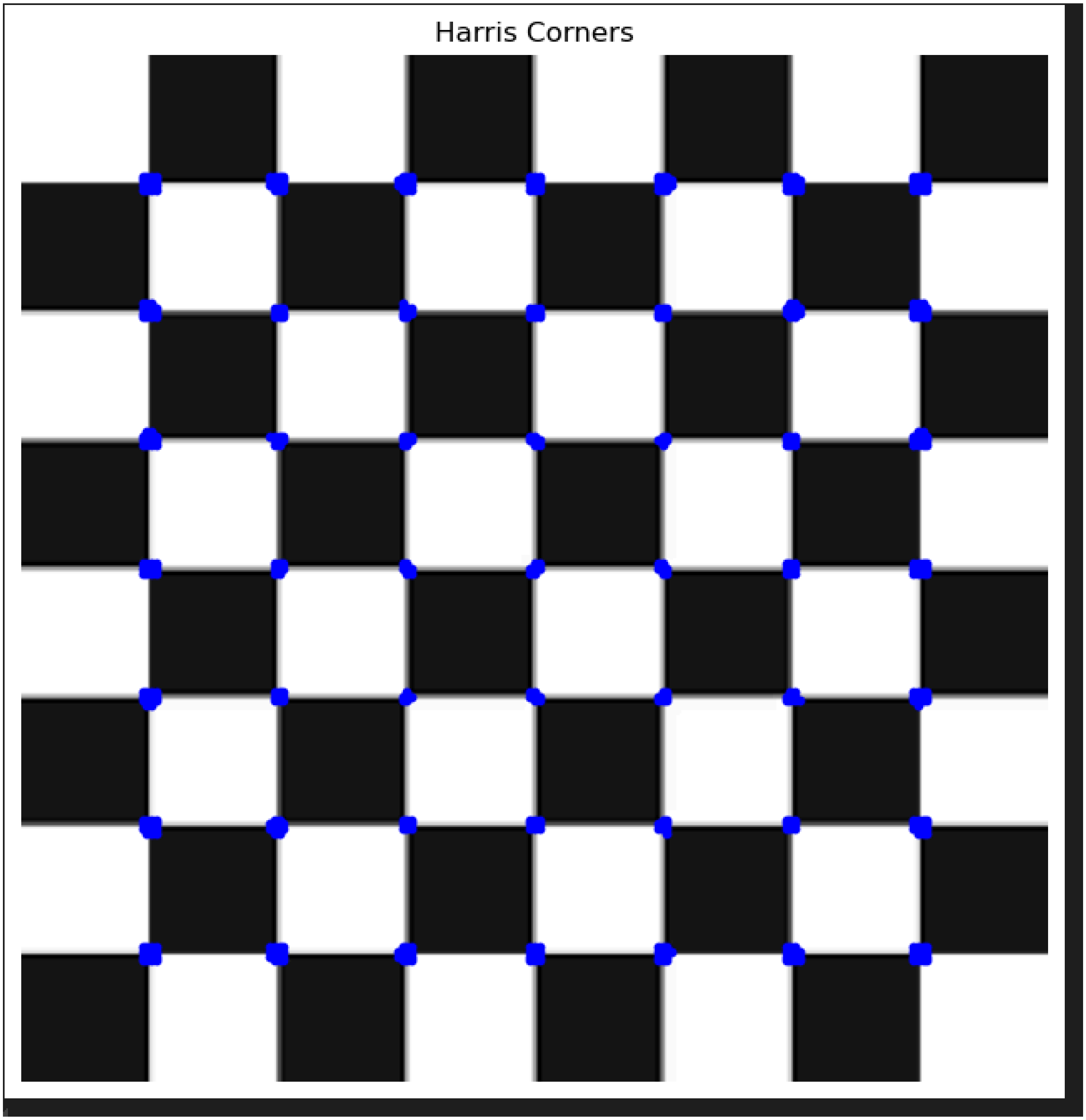
```
def convolution2d(image, kernel):
  image_h, image_w = image.shape
  kernel_h, kernel_w = kernel.shape
  padding_h = (kernel_h - 1) // 2
  padding_w = (kernel_w - 1) // 2
  padded_image = np.pad(image, ((padding_h, padding_h), (padding_w, padding_w)), mode='constant',
constant_values=0)
  output = np.zeros((image_h, image_w))


  for i in range(image_h):
     for j in range(image_w):
```

```
        new = padded_image[i:i+kernel_h, j:j+kernel_w]

        output[i, j] = np.sum(new * kernel)

  return output



image = np.random.rand(8, 4)

image = cv2.imread('chess.png', cv2.IMREAD_GRAYSCALE)

def guassian_filter2d(sigma):

 size = int(2 * (np.pi * sigma))

 if size % 2 == 0:

  size += 1

 kernel = np.zeros((size, size))

 for x in range(size):

    for y in range(size):

       kernel[x, y] = (1/(2 * np.pi * sigma**2)) * np.exp(-((x - size//2)**2 + (y - size//2)**2) / (2 * sigma**2))

 return kernel

def harris_corner_detector(img, k):

  sobel_x = np.array([[-1, 0, 1], [-2, 0, 2], [-1, 0, 1]])
```

```
sobel_y = np.array([[-1, -2, -1], [0, 0, 0], [1, 2, 1]])


a = convolution2d(img, sobel_x)

b = convolution2d(img, sobel_y)


A = a * a

B = b * b

C = a * b


guass_value = guassian_filter2d(1.5)

guass_A = convolution2d(A, guass_value)

guass_B = convolution2d(B, guass_value)

guass_C = convolution2d(C, guass_value)


# Harris response

R = (guass_A * guass_B - guass_C ** 2) - k * (guass_A + guass_B) ** 2
```

```
  # Threshold

  corners = np.zeros_like(R)

  threshold = 0.50 * np.max(R)

  corners[R > threshold] = 1



  return corners, R

import matplotlib.pyplot as plt

corners, R = harris_corner_detector(image, k=0.04)

plt.figure(figsize=(8, 8))

plt.imshow(image, cmap='gray')



y, x = np.where(corners == 1)

plt.scatter(x, y, c='b', s=10)

plt.title('Harris Corners')

plt.axis('off')

plt.show()
```

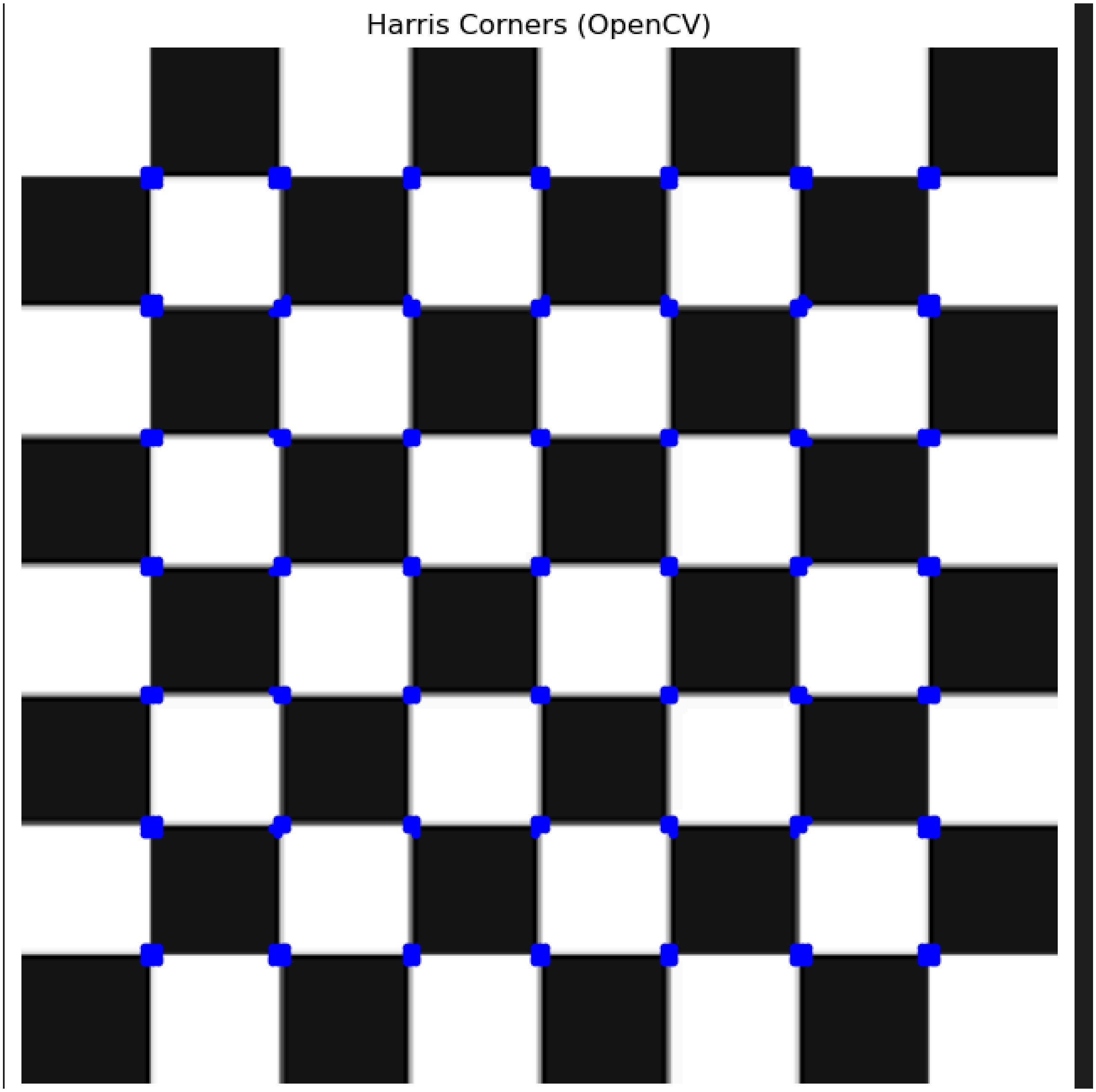
Output :



Built-In Harris

```
b_corners = cv2.cornerHarris(image,3,3,0.04)
threshold = 0.30 * b_corners.max()
y, x = np.where(b_corners > threshold)
plt.figure(figsize=(8, 8))
plt.imshow(image, cmap='gray')
plt.scatter(x, y, c='b', s=10)
plt.title('Harris Corners (OpenCV)')
plt.axis('off')
plt.show()
```

Output:



Lab Task 2 –Shi Tomasi

Implement the **Shi–Tomasi corner detector** (also known as *Good Features to Track*) and compare the detected corners with those obtained using the Harris method. Explain why Shi–Tomasi often provides more stable corner points.

Code:

```
def shiTomashi(img):
    sobel_x = np.array([[-1, 0, 1], [-2, 0, 2], [-1, 0, 1]])
    sobel_y = np.array([[-1, -2, -1], [0, 0, 0], [1, 2, 1]])
    a = convolution2d(img, sobel_x)
    b = convolution2d(img, sobel_y)
    A = a * a
    B = b * b
    C = a * b
    guass_value = guassian_filter2d(1.5)
    guass_A = convolution2d(A, guass_value)
    guass_B = convolution2d(B, guass_value)
    guass_C = convolution2d(C, guass_value)

    # Shi-Tomasi (minimum eigenvalue)
    R = 0.5 * ((guass_A + guass_B) - np.sqrt((guass_A + guass_B) ** 2 - 4 *
(guass_A * guass_B - guass_C ** 2) + 1e-10))
    # Threshold
    corners = np.zeros_like(R)
    threshold = 0.60 * np.max(R)
    corners[R > threshold] = 1
    return corners, R
corners, R = shiTomashi(image)

y, x = np.where(corners == 1)
plt.figure(figsize=(8, 8))
plt.imshow(image, cmap='gray')
plt.scatter(x, y, c='b', s=10)
plt.title('Shi-Tomasi Corner Detection')
plt.axis('off')
plt.show()
```

Output: