2.4. Morphological

Example: remove the gray spots from the image

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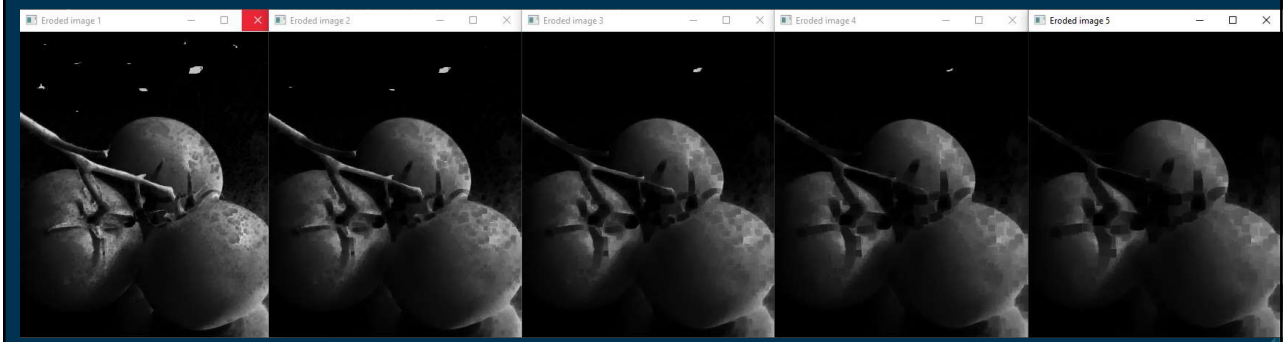
2.4. Morphological

Example: remove the gray spots from the image



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2.4. Morphological

Solution:

```
import cv2
import numpy as np

# Đọc ảnh nhiễu
img = cv2.imread('C:/Users/quang/OneDrive/Desktop/tomato_noise.jpg')

gray_img = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)


# Lặp lại quá trình erosion với số lần lặp khác nhau
for i in range(0, 5):
    eroded_img = cv2.erode(gray_img.copy(), None, iterations=i + 1)
    cv2.imshow("Eroded image {}".format(i + 1), eroded_img)

cv2.waitKey(0)
cv2.destroyAllWindows()
```

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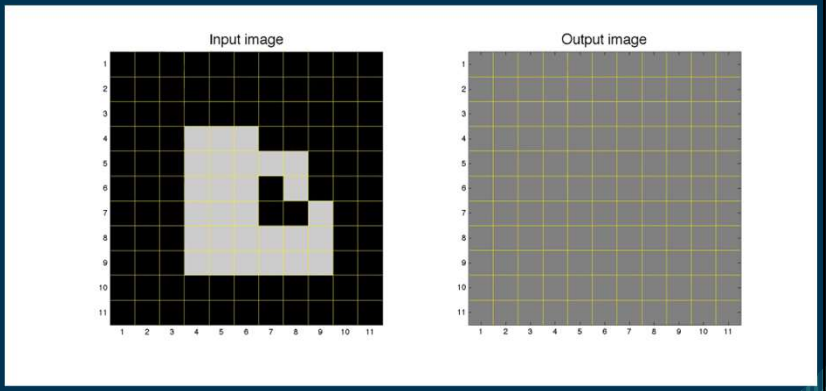
2.4. Morphological

Dilation is a morphological operation used to expand the white regions (foreground) in a binary or grayscale image and to shrink the black regions (background). It is typically used to fill small gaps, connect broken regions, and enhance features in the image.



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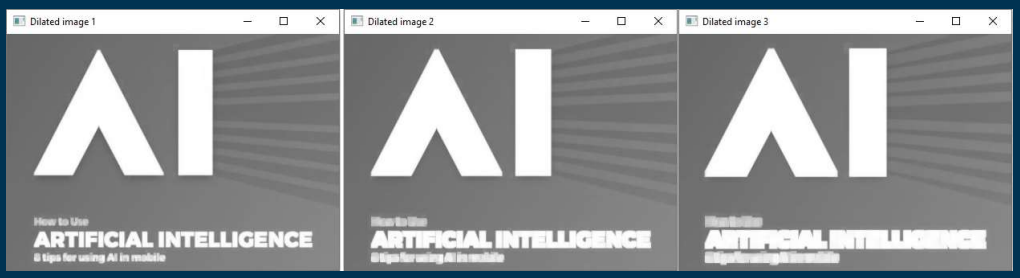
2.4. Morphological

- Dilation: cv2.dilate



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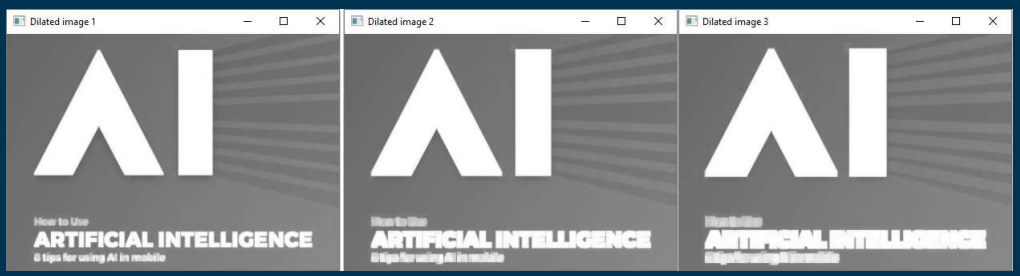
2.4. Morphological

- Dilation: cv2.dilate




```
for i in range(0, 3):
    dilated_img = cv2.dilate(gray_img.copy(), None, iterations=i + 1)
    cv2.imshow("Dilated image {} ".format(i + 1), dilated_img)
    cv2.waitKey(0)
```

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2.4. Morphological

Exercise: Remove cracks/blemishes in the text "Mechatronics".

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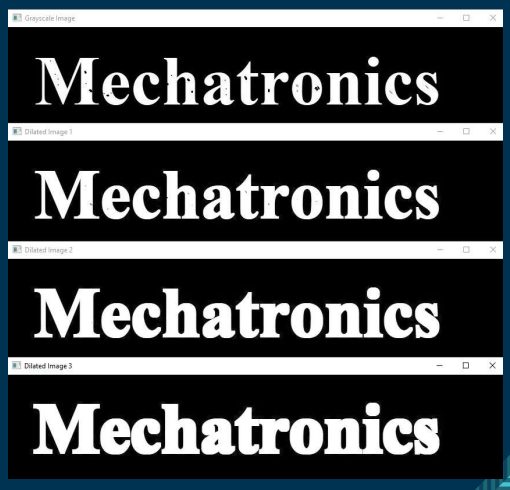
2.4. Morphological

Solution:

```
import cv2

img = cv2.imread("C:/Users/quang/OneDrive/Desktop/dilation.jpg")
gray_img = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
cv2.imshow("Grayscale Image", gray_img)

for i in range(0, 3):
    dilated_img = cv2.dilate(gray_img.copy(), None, iterations = i + 1)
    cv2.imshow("Dilated Image {}".format(i+1), dilated_img)
    cv2.waitKey(0)
```



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2.4. Morphological

Opening - Closing

Opening is a combination of two operations: erosion followed by dilation. Opening is used to remove small objects or minor noise details in an image.

Closing is a combination of two operations: dilation followed by erosion. Closing is used to fill small gaps and connect broken regions in an image.

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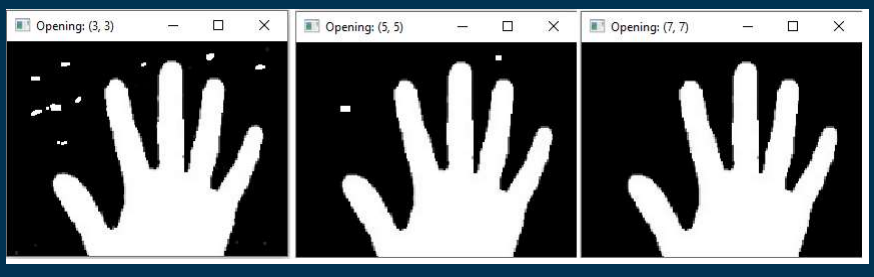
Opening

Syntax: opening = cv2.morphologyEx(gray_img, cv2.MORPH_OPEN, kernel)

Process: Erosion -> Dilation



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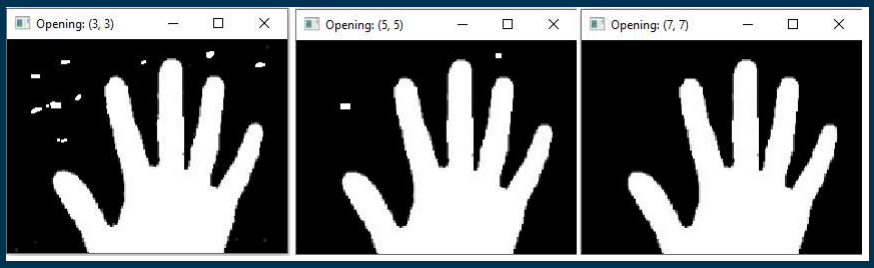
2.4. Morphological

- Opening: Erosion -> Dilation




```
kernelSizes = [(3, 3), (5, 5), (7, 7)]
for kernelSize in kernelSizes:
    kernel = cv2.getStructuringElement(cv2.MORPH_RECT, kernelSize)
    opening = cv2.morphologyEx(gray_img, cv2.MORPH_OPEN, kernel)
    cv2.imshow("Opening: ({}, {})".format(kernelSize[0], kernelSize[1]), opening)
    cv2.waitKey(0)
```

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2.4. Morphological

```
kernelSizes = [(3, 3), (5, 5), (7, 7)]
for kernelSize in kernelSizes:
    kernel = cv2.getStructuringElement(cv2.MORPH_RECT, kernelSize)
    opening = cv2.morphologyEx(gray_img, cv2.MORPH_OPEN, kernel)
    cv2.imshow("Opening: ({}, {})".format(kernelSize[0], kernelSize[1]), opening)
    cv2.waitKey(0)
```

kernelSizes: A tuple representing the size of the kernel with dimensions (3, 3), (5, 5), and (7, 7).

kernel = cv2.getStructuringElement(cv2.MORPH_RECT, kernelSize) creates a rectangular kernel with the given size.

opening = cv2.morphologyEx(gray_img, cv2.MORPH_OPEN, kernel) applies the opening operation to the image.

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Opening

Example: remove the gray spots from the image using opening

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Closing

- Syntax: closing = cv2.morphologyEx(gray_img, cv2.MORPH_CLOSE, kernel)
- Process: Dilation -> Erosion

Closing is the combination of two operations: dilation followed by erosion. Closing is used to fill small holes and connect broken areas in an image.

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Closing

- Closing: Dilation -> Erosion


```
for kernelSize in kernelSizes:
    kernel = cv2.getStructuringElement(cv2.MORPH_RECT, kernelSize)
    closing = cv2.morphologyEx(gray_img, cv2.MORPH_CLOSE, kernel)
    cv2.imshow("Closing: ({}, {})".format(kernelSize[0], kernelSize[1]), closing)
    cv2.waitKey(0)
```

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Closing

Example: remove the gray spots from the image using Closing

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Closing

Results:

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Closing

Code:

```
import cv2

img = cv2.imread("C:/Users/quang/OneDrive/Desktop/closing.jpg")
gray_img = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
cv2.imshow("Grayscale Image", gray_img)
kernelSizes = [(3, 3), (5, 5), (7, 7)]
for kernelSize in kernelSizes:
    kernel  = cv2.getStructuringElement(cv2.MORPH_RECT, kernelSize)
    closing = cv2.morphologyEx(gray_img, cv2.MORPH_CLOSE, kernel)
    cv2.imshow("closing: {} {}".format(kernelSize[0], kernelSize[1]), closing)
    cv2.waitKey(0)
```

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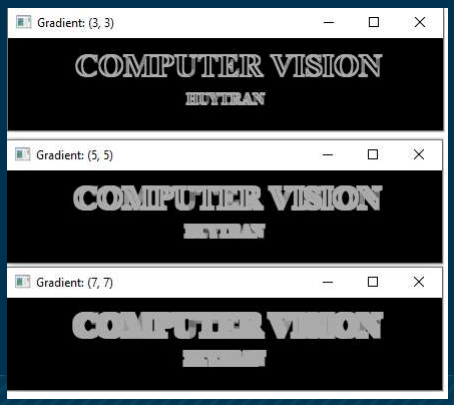
Morphological gradient

- Morphological gradient: gradient = cv2.morphologyEx(gray_img, cv2.MORPH_GRADIENT, kernel)



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Morphological gradient

- Morphological gradient is an image processing technique used to highlight the edges or boundaries in an image.
- This technique is computed by taking the difference between the image after dilation and the image after erosion.
- Syntax: gradient = cv2.morphologyEx(gray_img, cv2.MORPH_GRADIENT, kernel)

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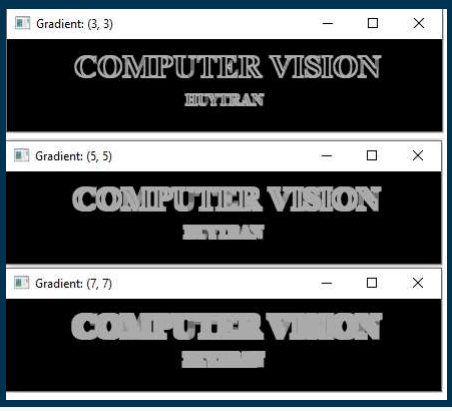
Morphological gradient

Example:




```
for kernelSize in kernelSizes:
    kernel = cv2.getStructuringElement(cv2.MORPH_RECT, kernelSize)
    gradient = cv2.morphologyEx(gray_img, cv2.MORPH_GRADIENT, kernel)
    cv2.imshow("Gradient: ({}, {})".format(kernelSize[0], kernelSize[1]), gradient)
    cv2.waitKey(0)
```

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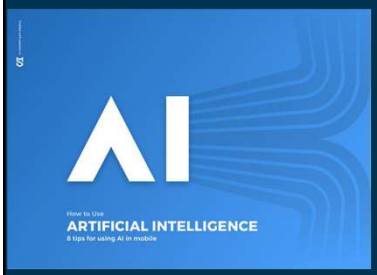
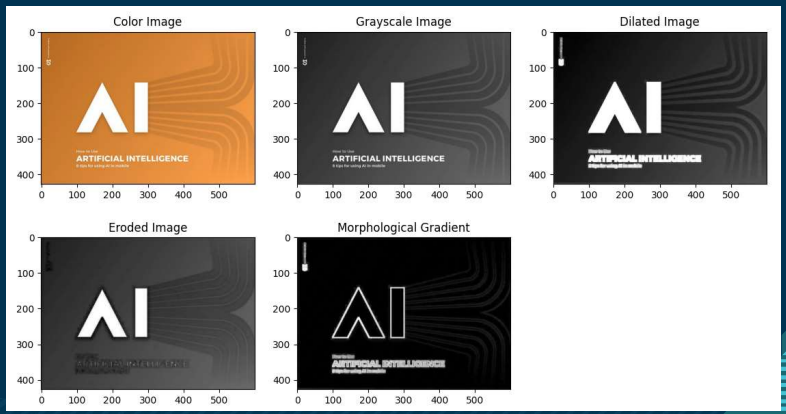
Morphological gradient

Example: apply Morphological gradient and Matplotlib to achieve the following result





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Morphological gradient

- Apply matplotlib:

  import matplotlib.pyplot as plt

- Create new blank figure with dimensions of 20 x 12 inches (width x height)

  plt.figure(figsize=(20, 12))

- Make a frame with 2 rows and 3 columns. The selected image is in the first position.

  plt.subplot(2, 3, 1)

- Set title

  plt.title('Color Image')

- Display images

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

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Morphological gradient

```
import cv2
import matplotlib.pyplot as plt

# Load image
img = cv2.imread("C:/Users/quang/Downloads/AI.png")
image = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
# Create structuring element
kernel = cv2.getStructuringElement(cv2.MORPH_RECT, (5, 5))

# Apply dilation and erosion
dilated = cv2.dilate(image, kernel)
eroded = cv2.erode(image, kernel)

# Apply morphological gradient
gradient = cv2.morphologyEx(image, cv2.MORPH_GRADIENT, kernel)
```

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Morphological gradient

```
# Display images
plt.figure(figsize=(20, 12))

plt.subplot(2, 3, 1)
plt.title('Color Image')
plt.imshow(img, cmap='gray')

plt.subplot(2, 3, 2)
plt.title('Grayscale Image')
plt.imshow(image, cmap='gray')

plt.subplot(2, 3, 3)
plt.title('Dilated Image')
plt.imshow(dilated, cmap='gray')

plt.subplot(2, 3, 4)
plt.title('Eroded Image')
plt.imshow(eroded, cmap='gray')

plt.subplot(2, 3, 5)
plt.title('Morphological Gradient')
plt.imshow(gradient, cmap='gray')

plt.show()
```


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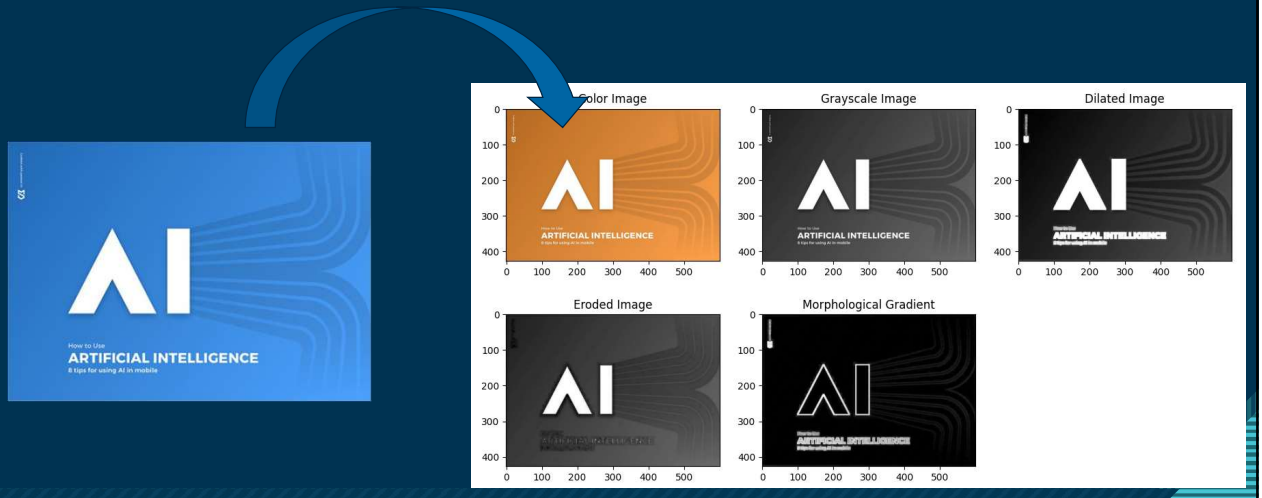
Morphological gradient

Question: why does the original image change its color?



Đáp án: ***img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)***

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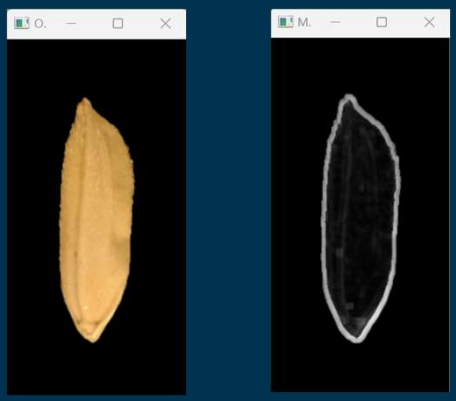
Morphological gradient

Example 1:



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Morphological gradient

Example: apply Morphological gradient

```
import cv2
import numpy as np
# Read the image
img = cv2.imread("C:/Users/quang/OneDrive/Desktop/photo/leaf.PNG")
# Convert the image to grayscale
gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
# Create a kernel for morphological operations
kernel = np.ones( shape: (5,5), np.uint8)
# Apply the Morphological Gradient operation (calculating the object's edges)
gradient = cv2.morphologyEx(gray, cv2.MORPH_GRADIENT, kernel)
# Display the result
cv2.imshow( winname: 'Original Image', img)
cv2.imshow( winname: 'Morphological Gradient', gradient)
cv2.waitKey(0)
cv2.destroyAllWindows()
```

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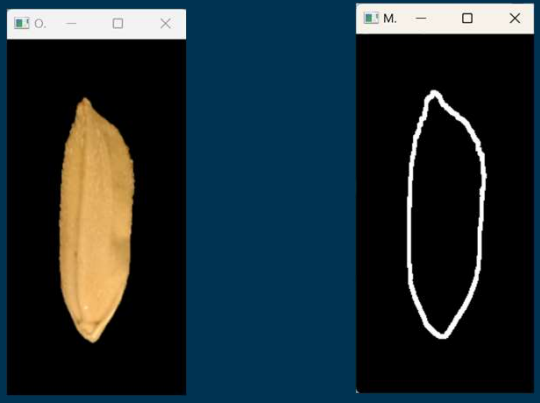
Morphological gradient

Example 2:



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Morphological gradient

Solution: apply Morphological gradient and thresholding

```
import cv2
import numpy as np
# Read the image
img = cv2.imread("C:/Users/quang/OneDrive/Desktop/photo/leaf.PNG")
# Convert the image to grayscale
gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
# Apply binary thresholding to highlight the leaf
_, thresh = cv2.threshold(gray, thresh: 128, maxval: 255, cv2.THRESH_BINARY_INV + cv2.THRESH_OTSU)
# Create a kernel for morphological operations
kernel = np.ones( shape: (5,5), np.uint8)
# Apply the Morphological Gradient operation (calculating the object's edges)
gradient = cv2.morphologyEx(thresh, cv2.MORPH_GRADIENT, kernel)
# Display the result
cv2.imshow( winname: 'Original Image', img)
cv2.imshow( winname: 'Morphological Gradient', gradient)
cv2.waitKey(0)
cv2.destroyAllWindows()
```

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