KMITL BEYOND THE LIMIT

Computer Visions

01416500
Course Code

Image Reconstruction

Overview

1. Morphological reconstruction
2. Hough Line Transforms
3. Hough Circle Transforms

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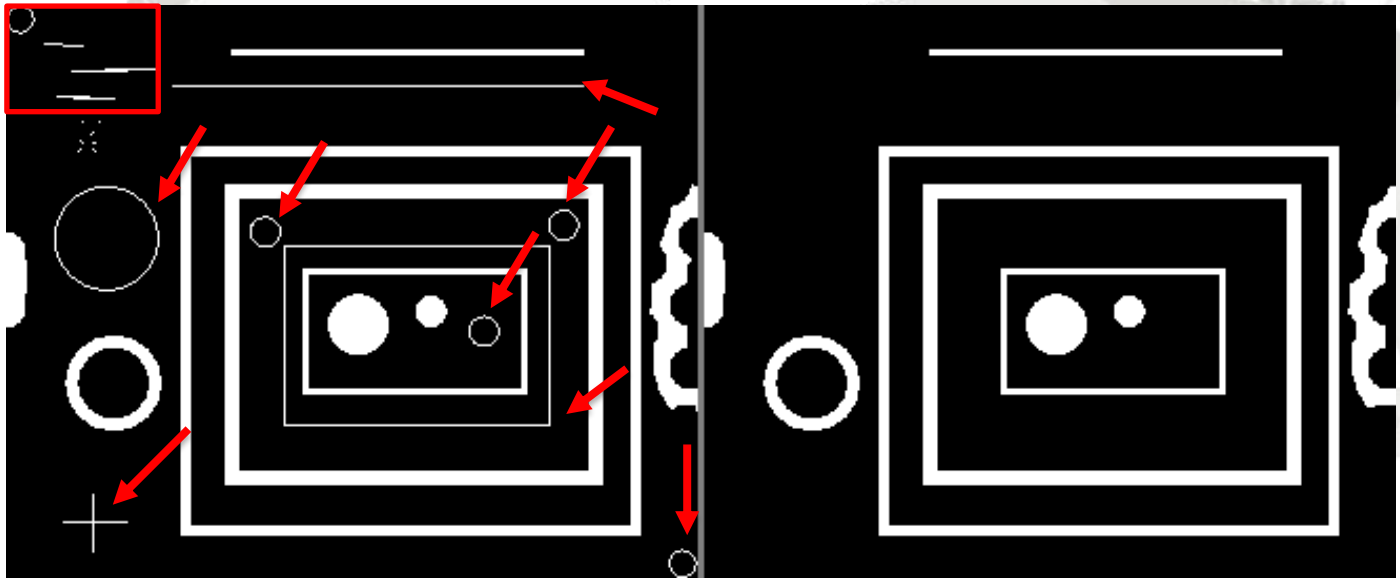
1. Morphological Theory

Morphology is a broad set of image processing operations that process images based on shapes. ***Morphological operations (kernel)*** apply **a structuring element** to an input image (***gray image***), creating an output image of the same size.

Example **Applied the opening operator**

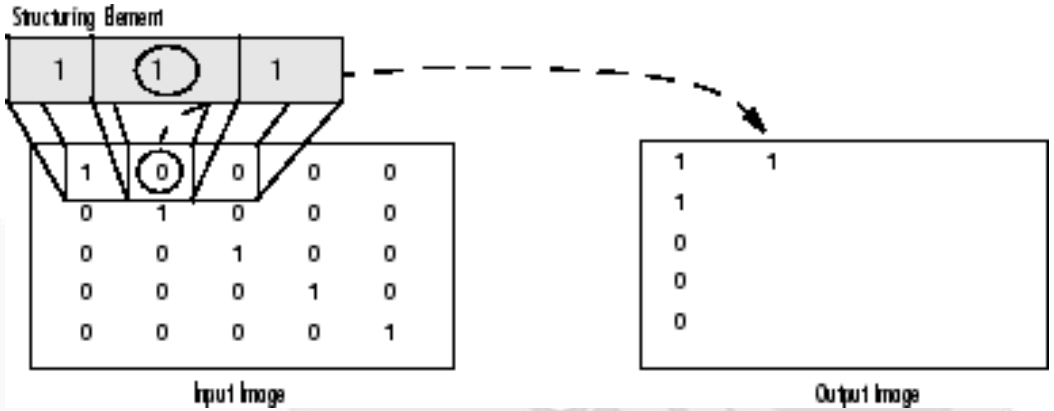


input image **output image**

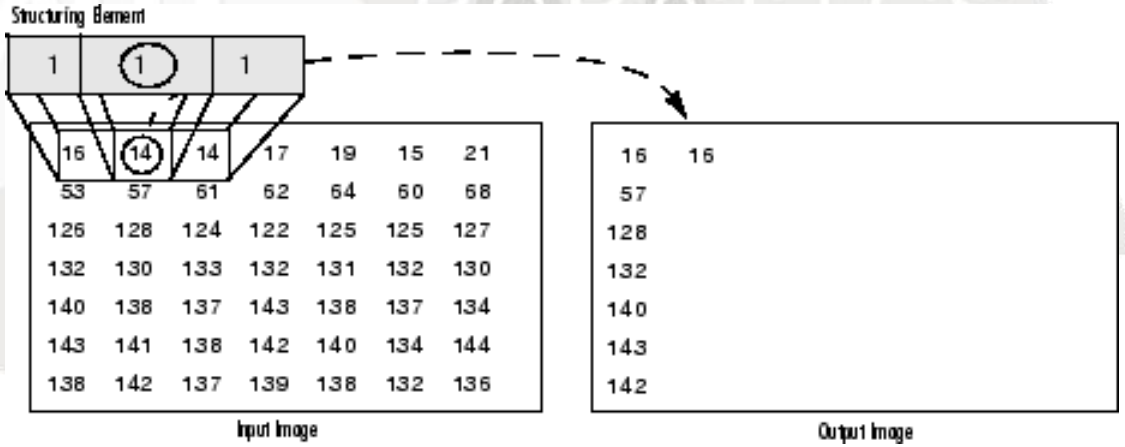
1. Morphological Theory

1. Dilation
2. Erosion
3. Opening
4. Closing
5. Gradient
6. Top Hat
7. Black Hat

Morphological *Dilation* of a Binary Image



Morphological *Dilation* of a Grayscale Image



1. Dilation (increase border)

A pixel element is “1” if **at least one pixel** under **the kernel** is “1”.

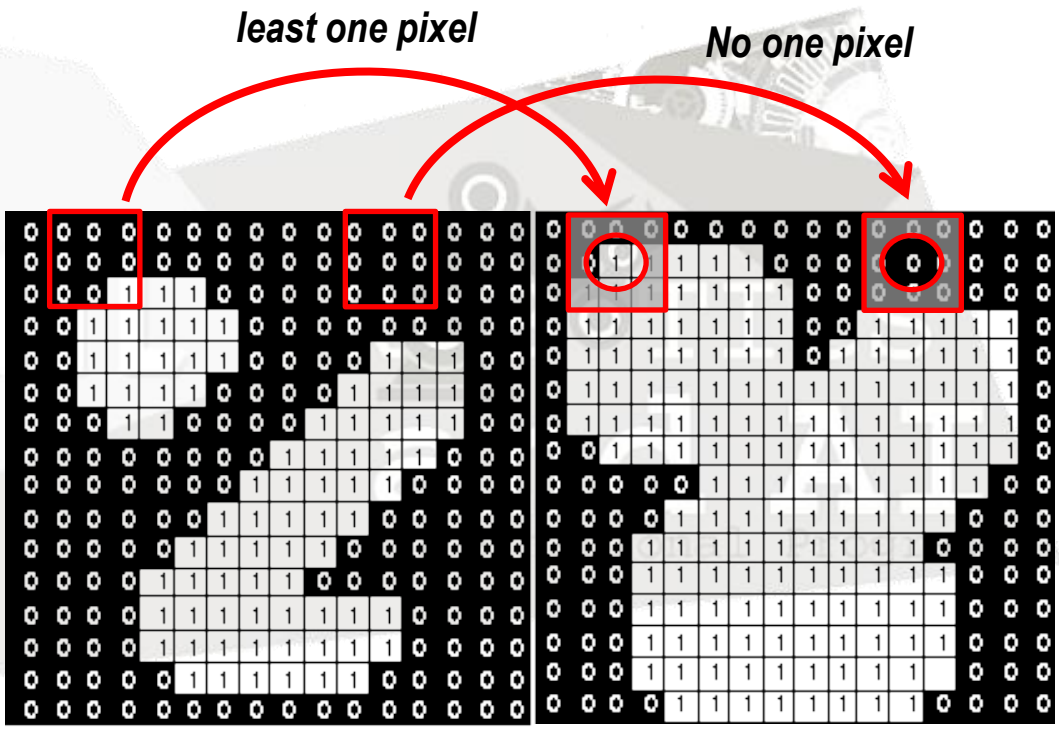
So it ***increases*** the white region in the image or size of foreground object increases.

Dilation

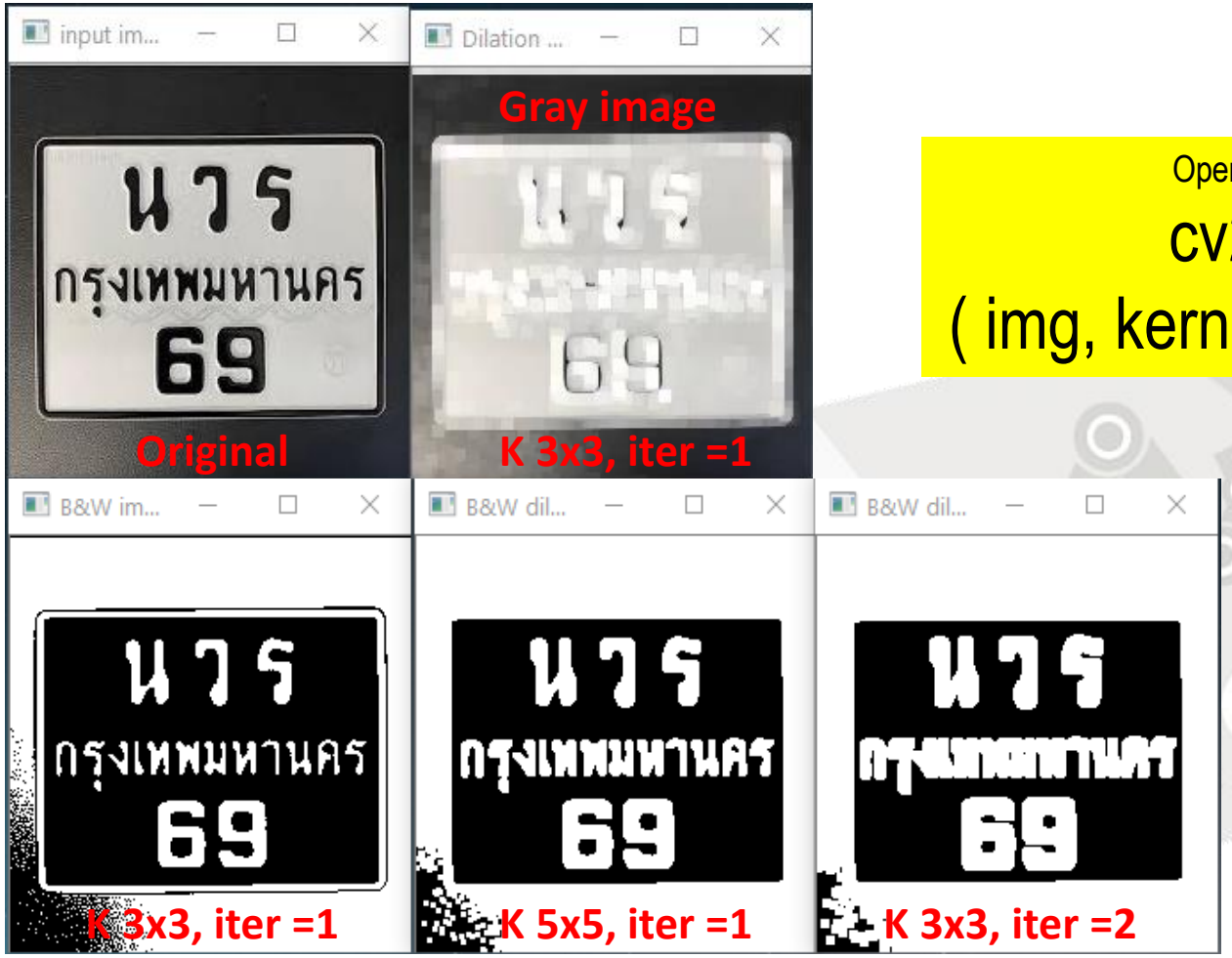
kernel size [3x3]

1	1	1
1	1	1
1	1	1

Example dilation



1. Dilation (increase border)



OpenCV function :

cv2.dilate

(img, kernel, iterations=1)

2. Erosion (decrease border)

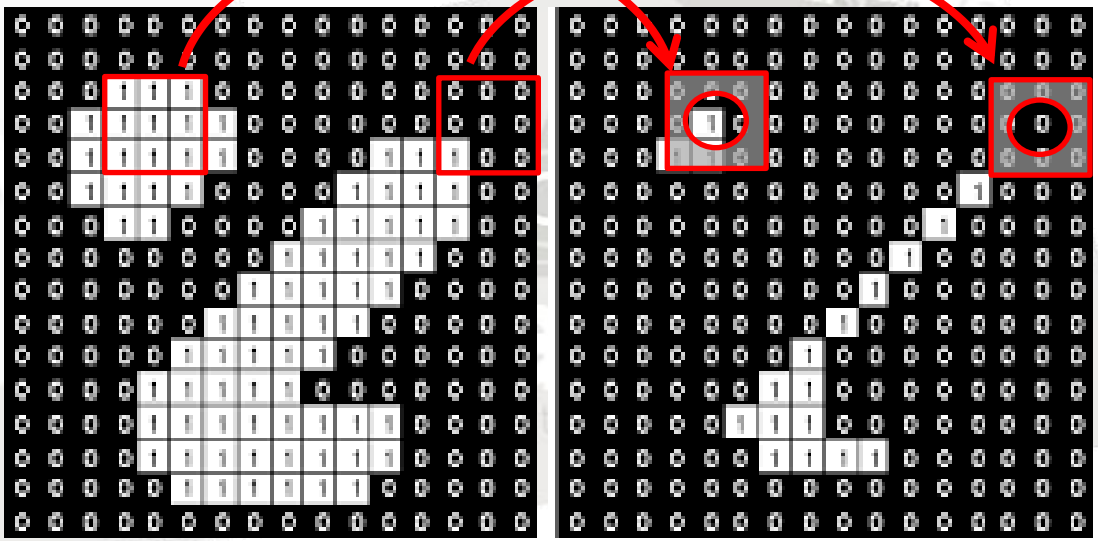
The kernel slides through the image (as in 2D convolution). A pixel in the original image (either 1 or 0) will be considered 1 only **if all the pixels** under the kernel is 1, otherwise it is eroded (made to zero).

Erosion

kernel size [3x3]

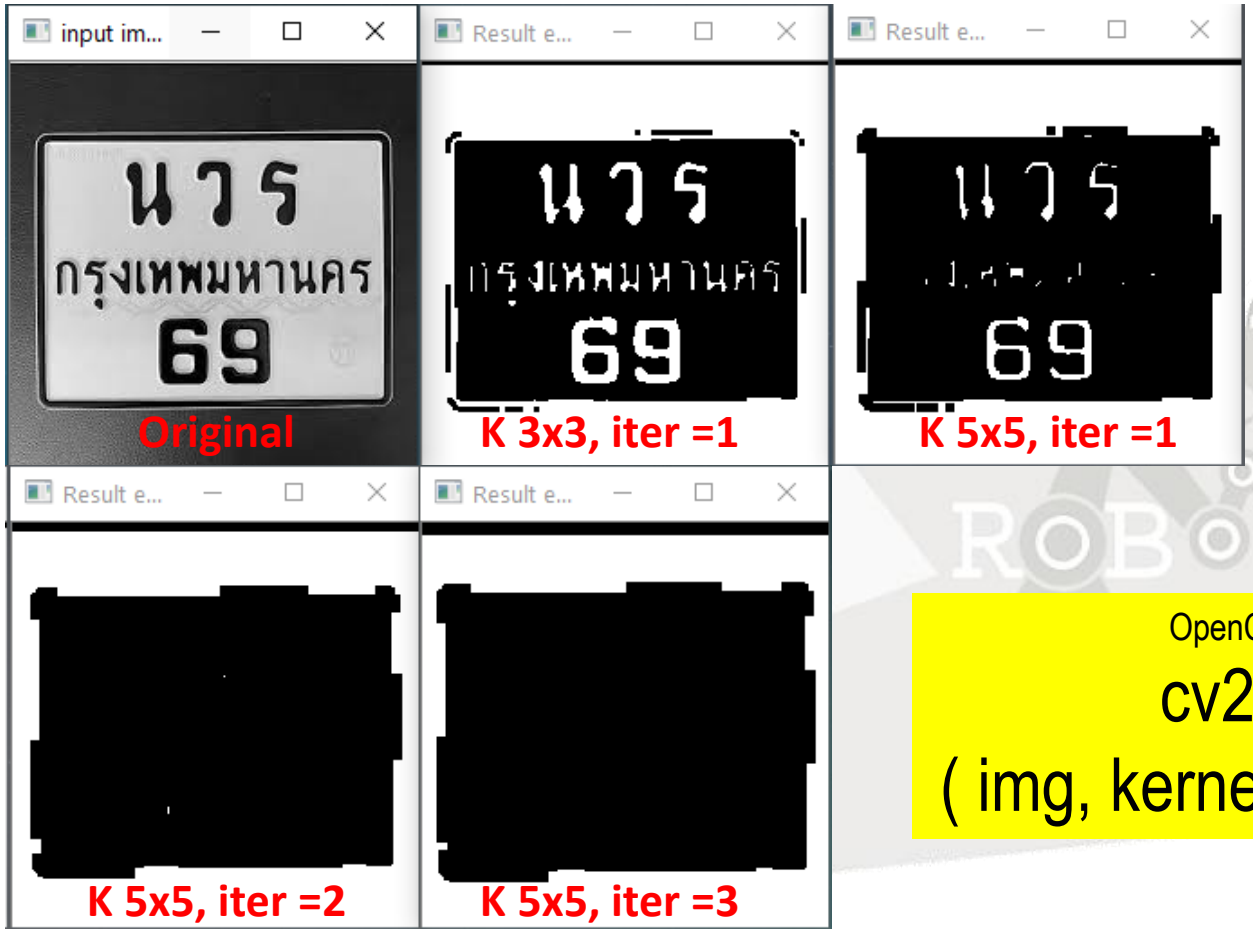
1	1	1
1	1	1
1	1	1

Erosion



Input image output image

2. Erosion (decrease border)



OpenCV function :

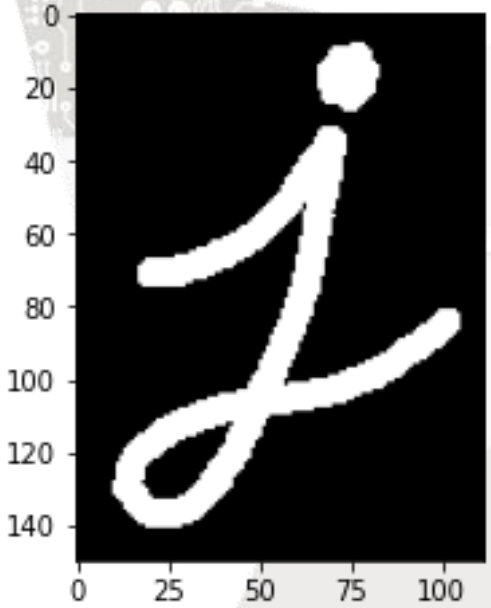
cv2.erode

(img, kernel, iterations=1)

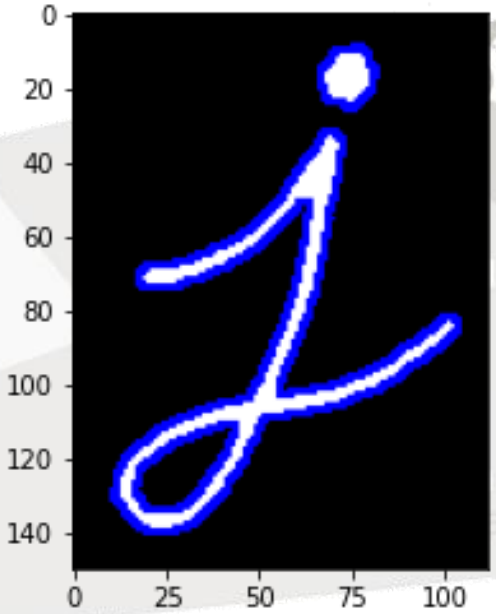
Quiz#1 (15 min)

1. Let's show the blue border inside object.

Original



Output



***** Border size 2 pixels**

3. Opening (reduce noise)

Opening is just another name of ***erosion followed by dilation***

Opening

kernel size [3x3]

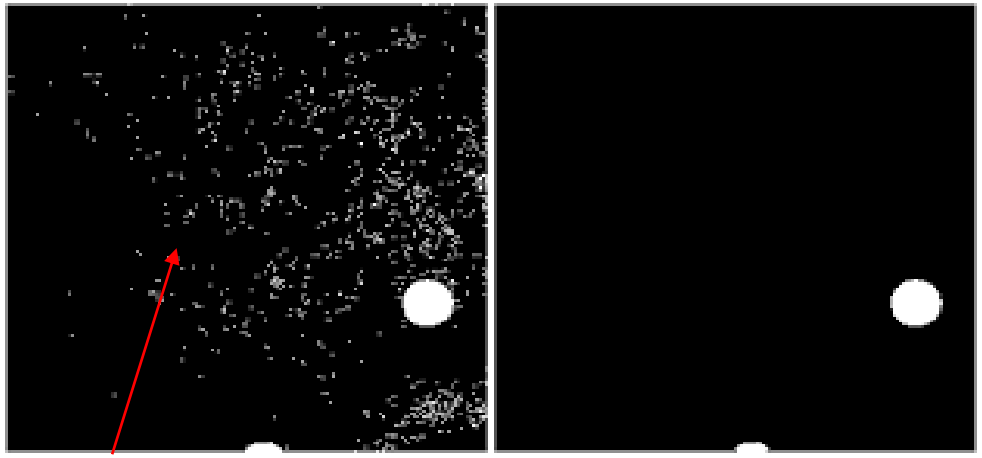
1	1	1
1	1	1
1	1	1

OpenCV function :

cv2.morphologyEx()
cv2.MORPH_OPEN

Example Opening

Input image output image



noise

4. Closing (Fill holes)

Closing is reverse of Opening, **Dilation followed by Erosion**. It is useful in closing small holes inside the foreground objects, or small black points on the object.

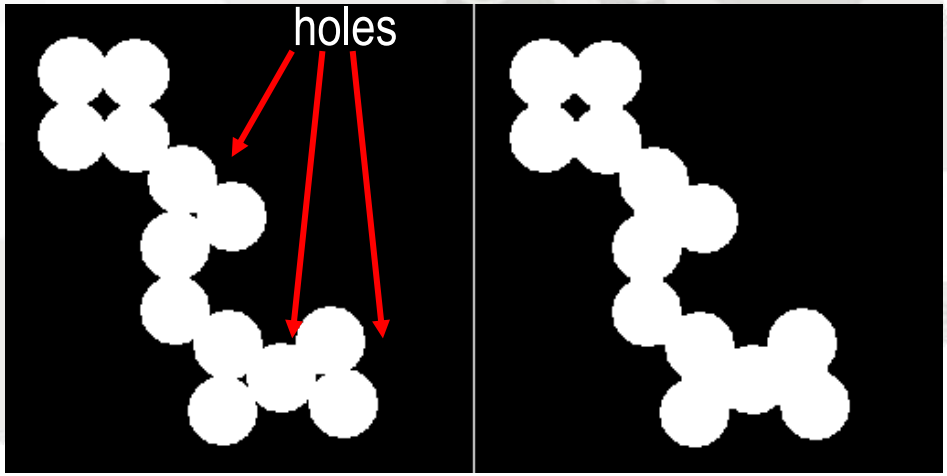
OpenCV function :

cv2.morphologyEx()
cv2.MORPH_CLOSE

Closing

kernel size [3x3]

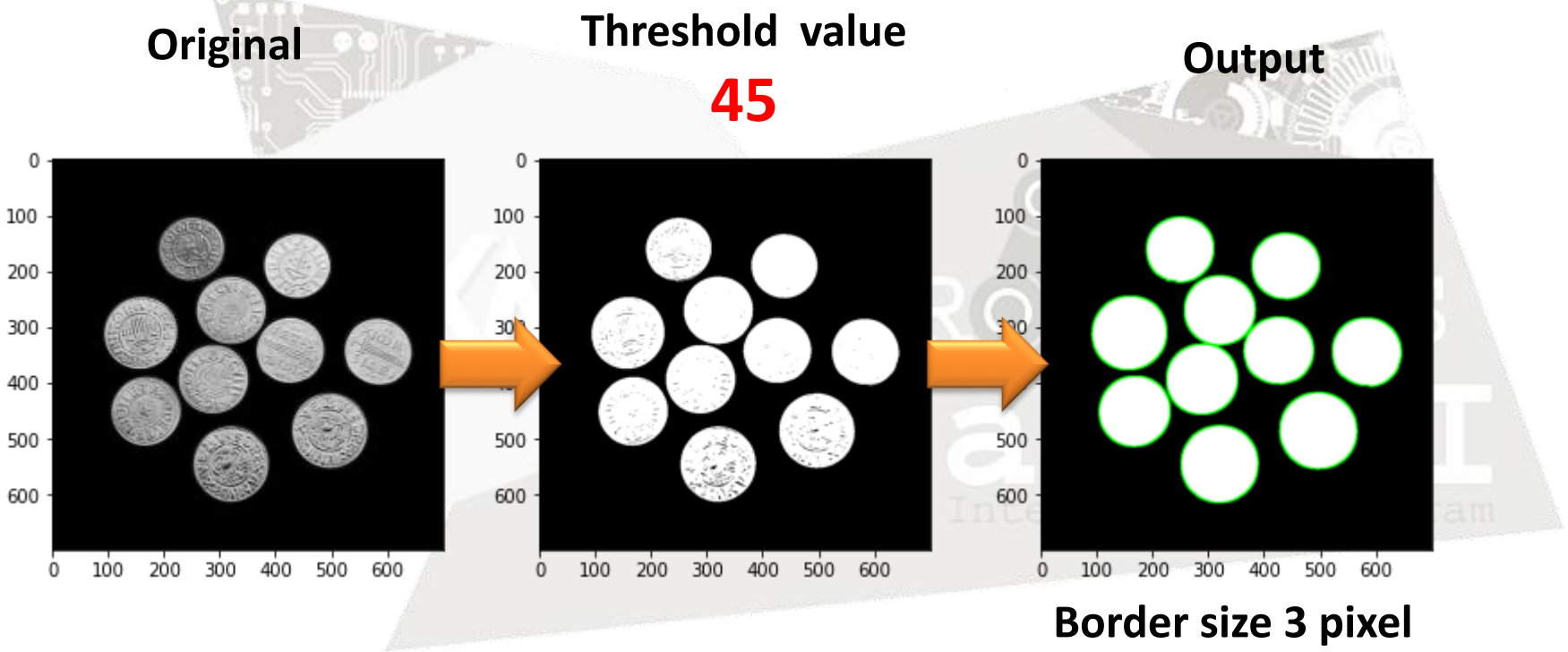
1	1	1
1	1	1
1	1	1



Example Closing

Quiz#2 (15 min)

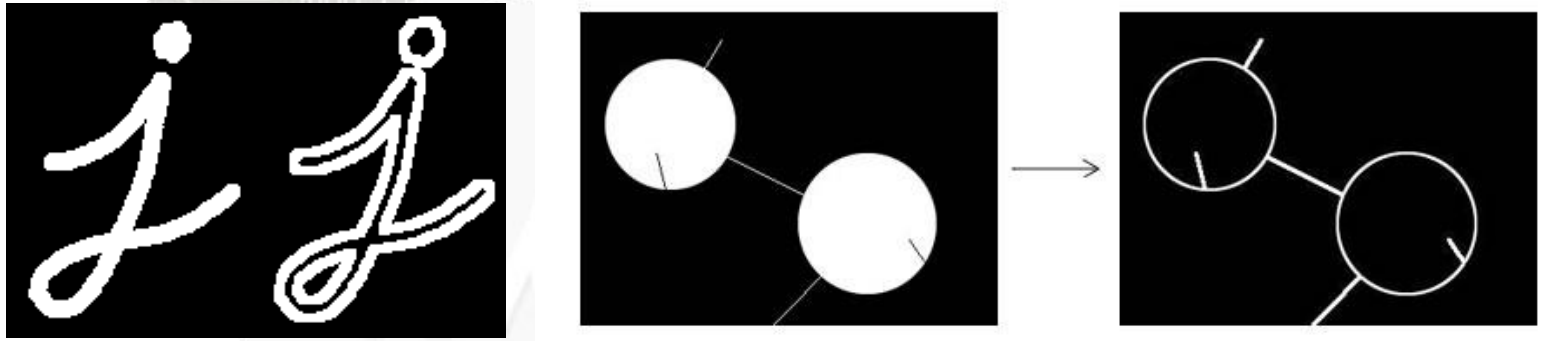
1. Let's show the code for draw the green border outside object.



5. Morphological Gradient

It is the difference between dilation and erosion of an image.

Below example is done for a ***9x9 kernel***



Morphological Gradient

OpenCV function :

cv2.morphologyEx()
cv2.MORPH_CLOSE

5. Morphological Gradient

Example Gradient

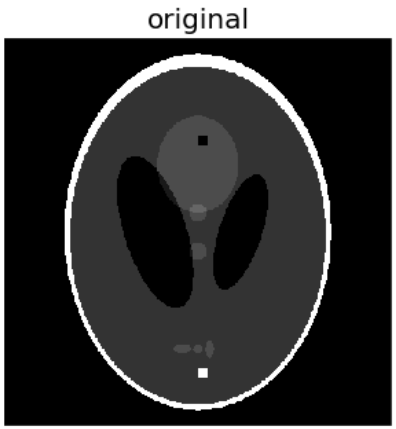
Original | K3x3, iter =1 | K5x5, iter =1 | K3x3, iter=2 | K5x5, iter=2

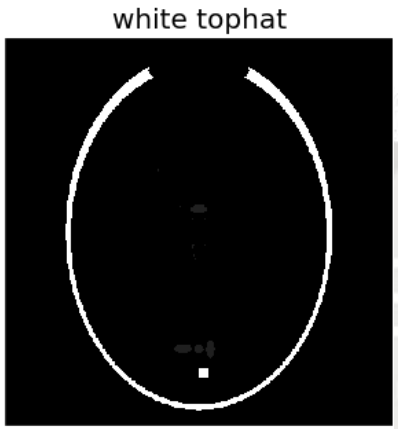
```
img = cv2.imread("dataset/69.jpg",0)
# threshold
_,bw = cv2.threshold(img,180,255,cv2.THRESH_BINARY)
gra1 = cv2.morphologyEx(bw,cv2.MORPH_GRADIENT,np.ones((3,3),np.uint8))
gra2 = cv2.morphologyEx(bw,cv2.MORPH_GRADIENT,np.ones((5,5),np.uint8))
gra3 = cv2.morphologyEx(bw,cv2.MORPH_GRADIENT,np.ones((3,3),np.uint8),iterations=2)
gra4 = cv2.morphologyEx(bw,cv2.MORPH_GRADIENT,np.ones((5,5),np.uint8),iterations=2)
```

6. Top Hat (noise object)

It is the **difference** between **input image** and **Opening** of the image..

Example is done for a ***9x9 kernel***





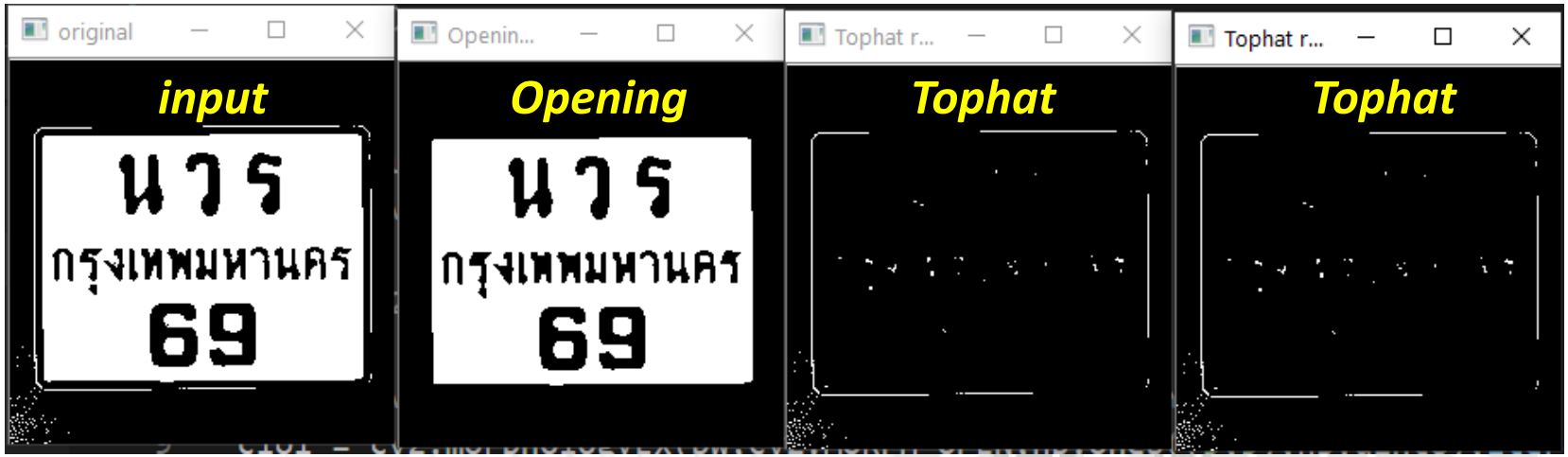
OpenCV function :

cv2.morphologyEx()
cv2.MORPH_TOPHAT

6. Top Hat (noise object)

Example Tophat

Input-opening ***morphologyEx***



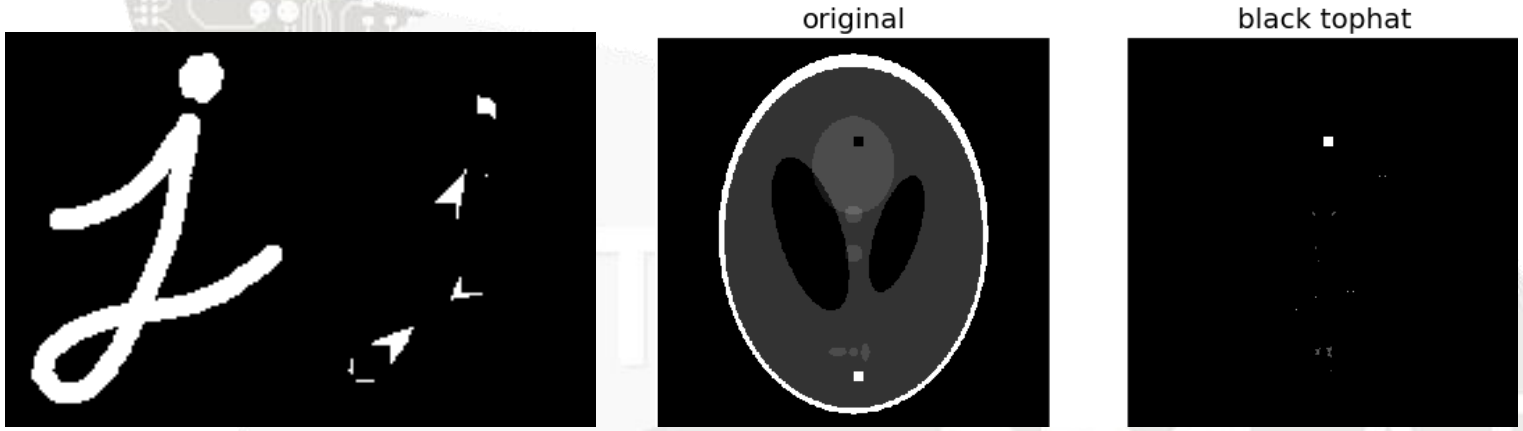

```
img = cv2.imread("dataset/69.jpg",0)
# tophat  = input - closing
_,bw = cv2.threshold(img,150,255,cv2.THRESH_BINARY)
clo1 = cv2.morphologyEx(bw,cv2.MORPH_OPEN,np.ones((3,3),np.uint8),iterations=1)

tophat = cv2.subtract(bw,clo1)
tophat2 = cv2.morphologyEx(bw,cv2.MORPH_TOPHAT,np.ones((3,3),np.uint8),iterations=1)
```

7. Black Hat (Hole object)

It is the **difference** between the **closing** of the input image and **input image**.

Example is done for a ***9x9 kernel***



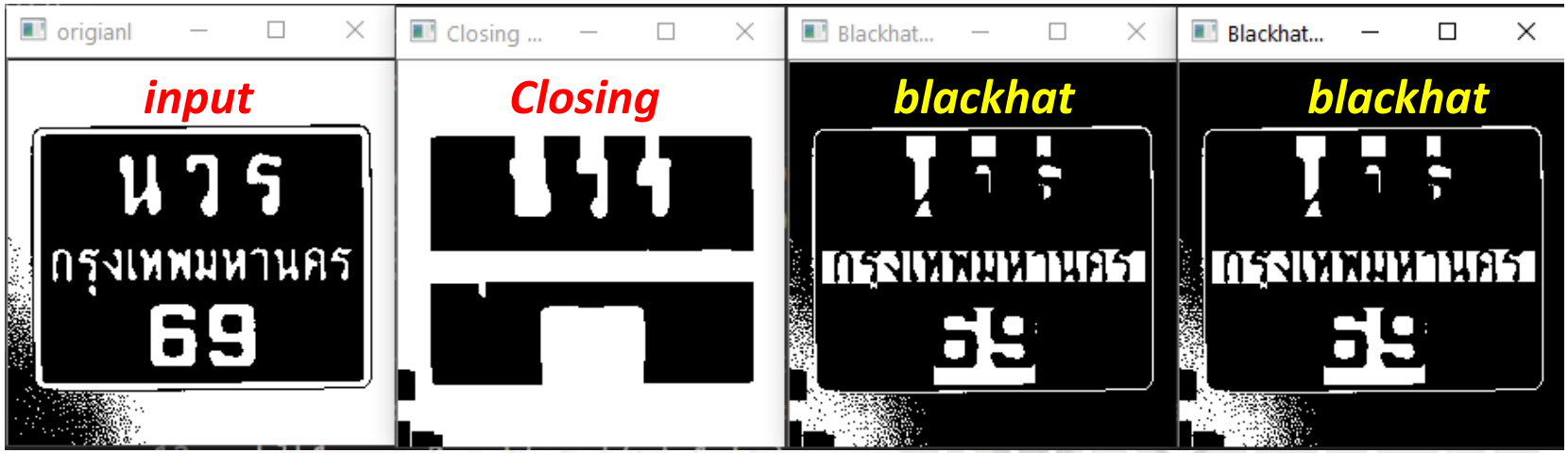
OpenCV function :

cv2.morphologyEx()
cv2.MORPH_BLACKHAT

Example Blackhat

Closing-Input

morphologyEx




```
img = cv2.imread("dataset/69.jpg",0)
_,bw = cv2.threshold(img,100,255,cv2.THRESH_BINARY_INV)

# blackhat = closing - input
cls1 = cv2.morphologyEx(bw,cv2.MORPH_CLOSE,np.ones((5,5),np.uint8),iterations=3)
blk1 = cv2.subtract(cls1,bw)
blk2 = cv2.morphologyEx(bw,cv2.MORPH_BLACKHAT,np.ones((5,5),np.uint8),iterations=3)
```

II. Structuring Element

```
# Rectangular Kernel
>>> cv2.getStructuringElement(cv2.MORPH_RECT,(5,5))
array([[1, 1, 1, 1, 1],
       [1, 1, 1, 1, 1],
       [1, 1, 1, 1, 1],
       [1, 1, 1, 1, 1],
       [1, 1, 1, 1, 1]], dtype=uint8)

# Elliptical Kernel
>>> cv2.getStructuringElement(cv2.MORPH_ELLIPSE,(5,5))
array([[0, 0, 1, 0, 0],
       [1, 1, 1, 1, 1],
       [1, 1, 1, 1, 1],
       [1, 1, 1, 1, 1],
       [0, 0, 1, 0, 0]], dtype=uint8)

# Cross-shaped Kernel
>>> cv2.getStructuringElement(cv2.MORPH_CROSS,(5,5))
array([[0, 0, 1, 0, 0],
       [0, 0, 1, 0, 0],
       [1, 1, 1, 1, 1],
       [0, 0, 1, 0, 0],
       [0, 0, 1, 0, 0]], dtype=uint8)
```

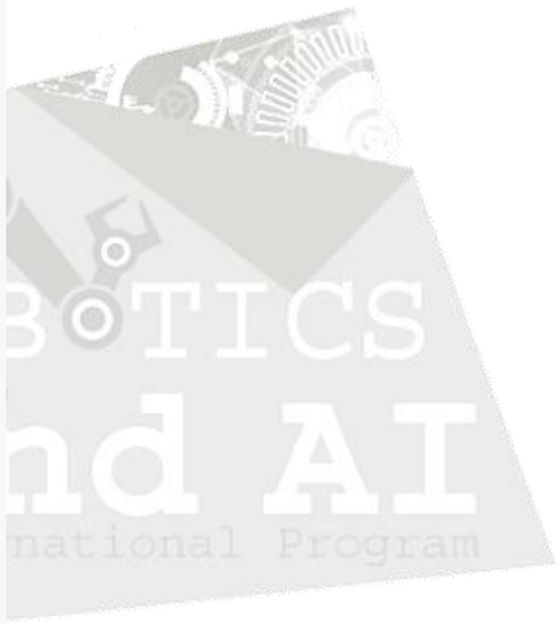


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Image Reconstruction

2. Hough Line Transforms

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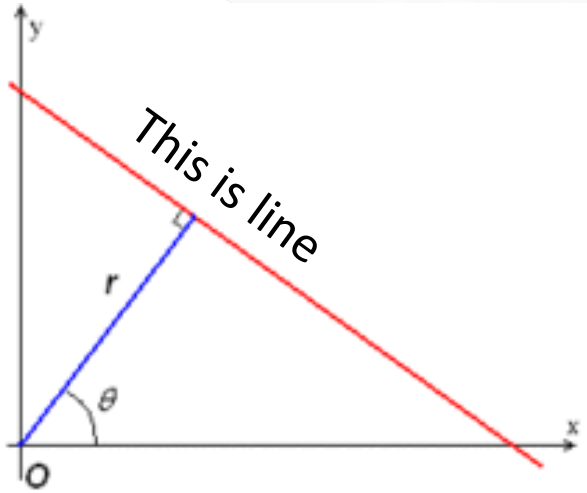
Hough Line Transforms

The **Hough transform** is a feature extraction technique used in image analysis, computer vision, and digital image processing. he purpose of the technique is to find imperfect instances of objects within a certain class of shapes by a voting procedure.

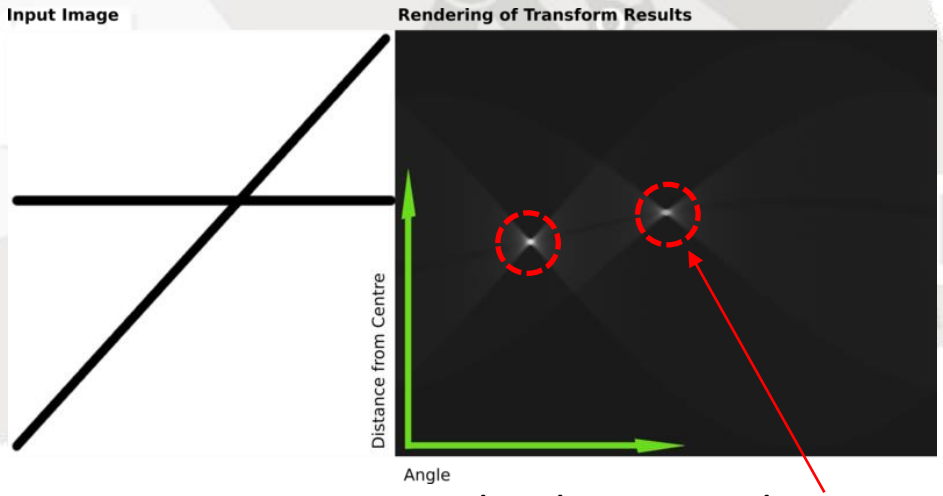
Pixel
Coordinate (x,y)

→ Hough transform →

Polar coordinate system
rho, theta



All pixel have same rho,theta



A peak value mean distance of line

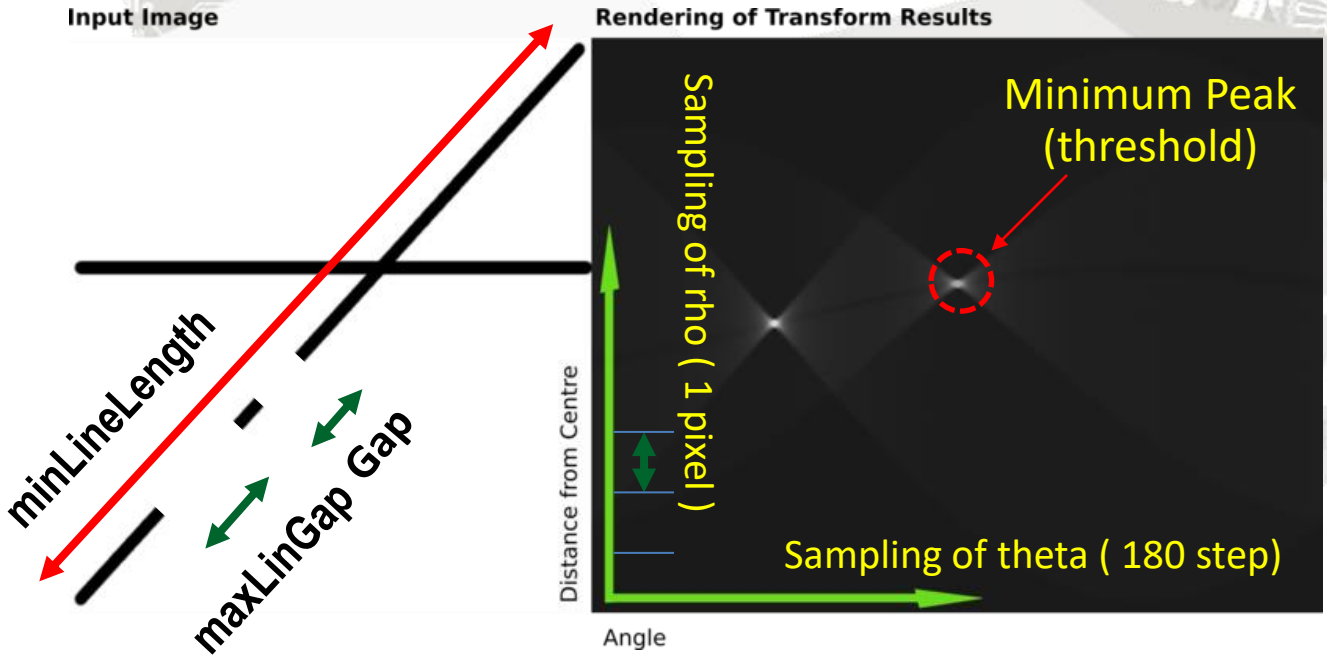
Hough Line Transforms

Hough line Parameters

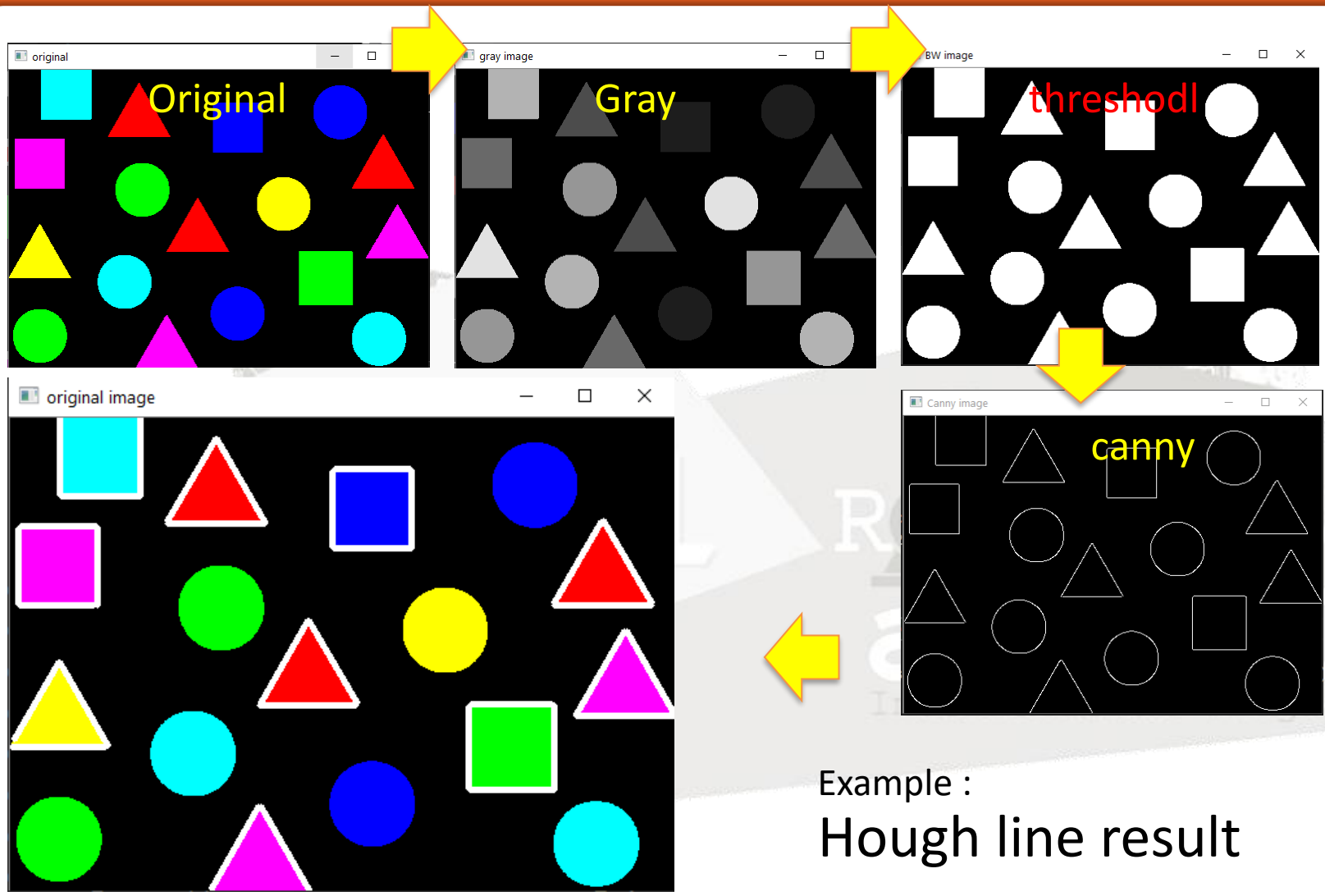
OpenCV function :

cv2.HoughLinesP

(dst, rho, theta, threshold, minLineLength, maxLineGap)



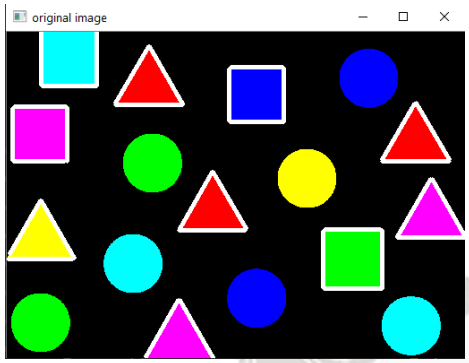
Hough Line Transforms



Example :

Hough line result

Hough Line Transforms



OpenCV function :

cv2.HoughLinesP()

```
img = cv2.imread("dataset/colorobject.png")
gray = cv2.cvtColor(img,cv2.COLOR_BGR2GRAY)
# threshold
_,thr = cv2.threshold(gray,10,255,cv2.THRESH_BINARY)
# Canny edge detection
res = cv2.Canny(thr,10,200)
# hough line
lines = cv2.HoughLinesP(res,1,np.pi/360,50,minLineLength=20,maxLineGap=10)
print(len(lines))

for i in range(len(lines)):
    for x1,y1,x2,y2 in lines[i]:
        cv2.line(img,(x1,y1),(x2,y2),(255,255,255),thickness=3) # change color to white
```

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KMITL ROBOTICS and AI International Program

3. Hough Circle Transforms

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Hough Circle Transforms

In a two-dimensional space, a circle can be described by:

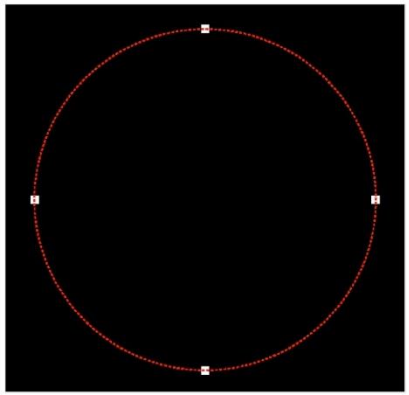
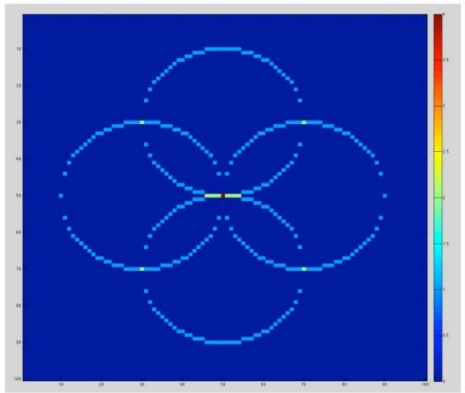
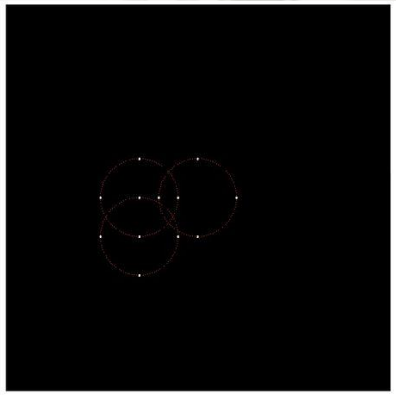
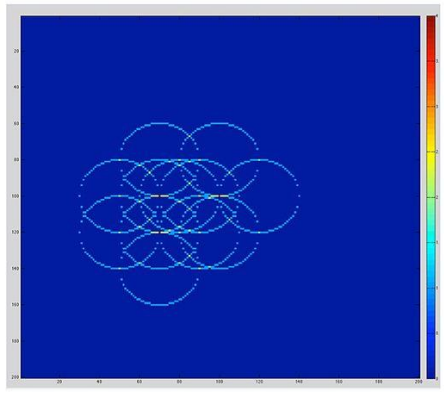
$$(x-a)^2 + (y-b)^2 = r^2$$

Pixel
Coordinate (x,y)

→ Hough Circle transform →

a,b,r

In practice, an accumulator matrix is introduced to find the intersection point in the parameter space

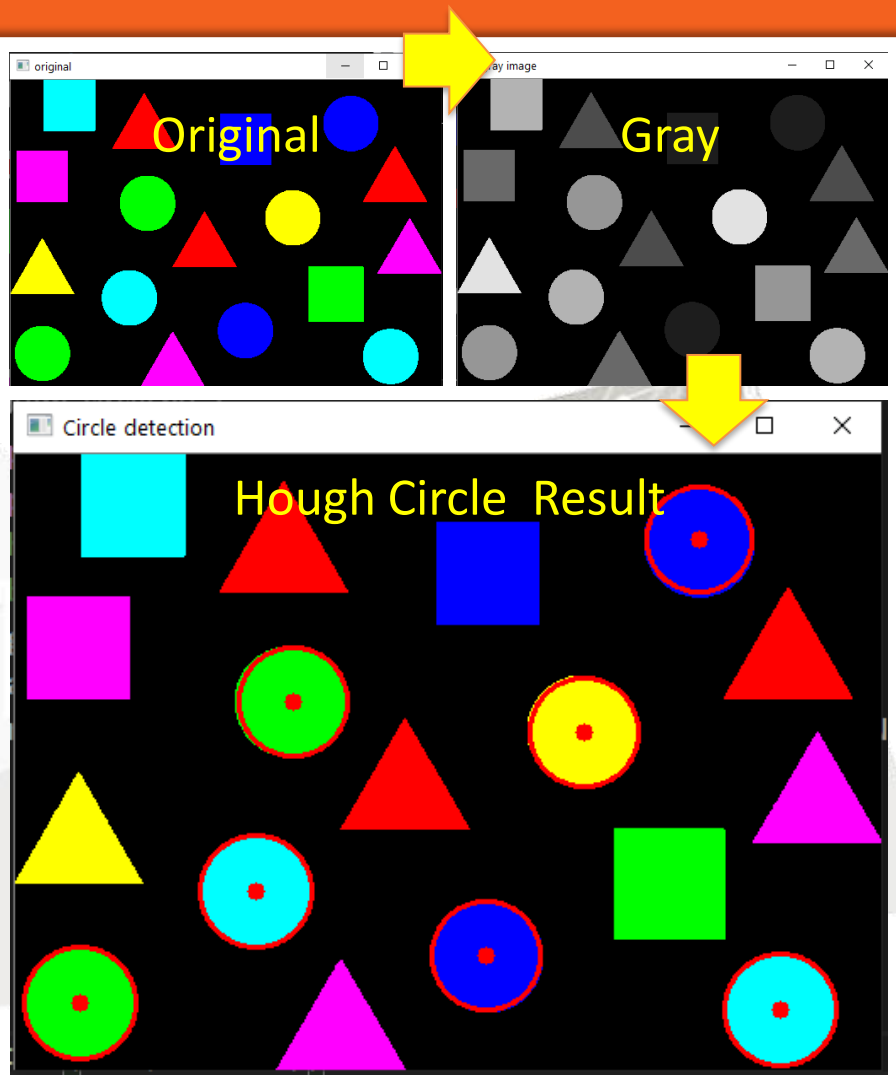





Hough Circle Transforms

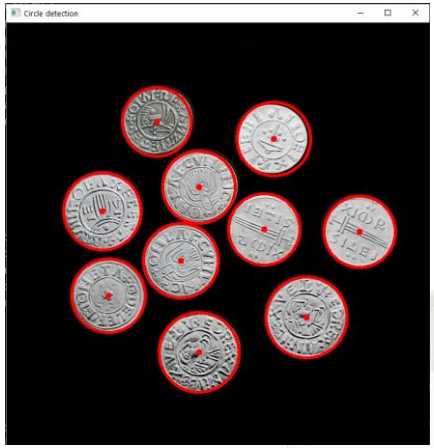
Example

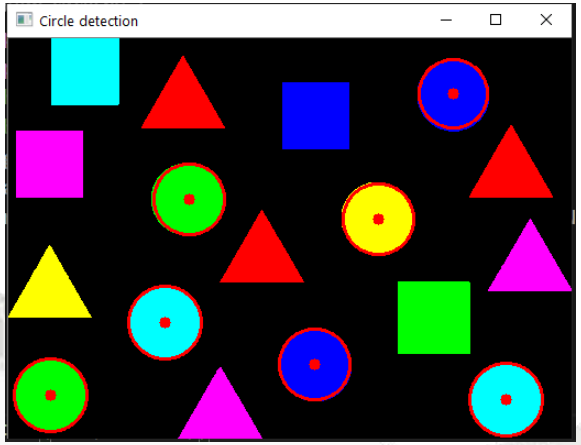
Circle detection 3 step :

1. BGR
2. Convert to Gray
3. HoughCircles()



Hough Circle Transforms





OpenCV function :

cv2.HoughCircles()

```
circles = cv2.HoughCircles(gray,cv2.HOUGH_GRADIENT,
                           dp=1.0,minDist=20,
                           param1=10,param2=10,
                           minRadius=30,maxRadius=40)
print(len(circles))
print("Befor around : ",circles[0])
circles = np.uint16(np.around(circles))
print("After around : ",circles[0])
for i in circles[0]:
    # index 0 : x-center , index 1 : y-center, index 2 : radius
    cv2.circle(img,(i[0],i[1]),i[2],(0,0,255),thickness=2)
    cv2.circle(img,(i[0],i[1]),5,(0,0,255),thickness=-1) # thickness -1 mean fill color
```

Hough Circle Transforms

OpenCV function :

```
cv2. cv2.HoughCircles(
gray, cv2.HOUGH_GRADIENT,
dp, minDist, param1, param2, minRadius, maxRadius)
```

$$dp = \frac{Major}{Minor}$$

param_1 = 200: Upper threshold for the internal Canny edge detector.
param_2 = 100*: Threshold for center detection.

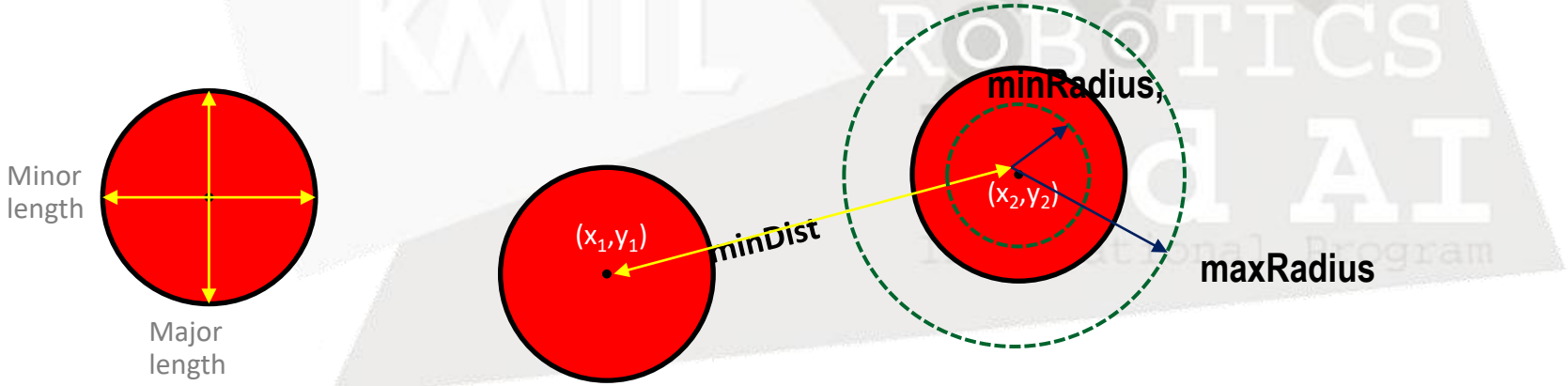


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Image Reconstruction

Q & A

Next : Segmentation

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