# Image Morphology

Lecturer: Sang Hwa Lee

# ❑ Introduction

- Morphology
  - set operation to handle shapes in the image
- Applications
  - Usually binary image processing
  - OCR preprocessing
  - Fingerprint noise reduction
  - Smoothing object boundaries
- Mask: Structuring element
  - Region of interest to process

# ❑ Erosion Operation (1)

- 침식 연산(erosion operator)

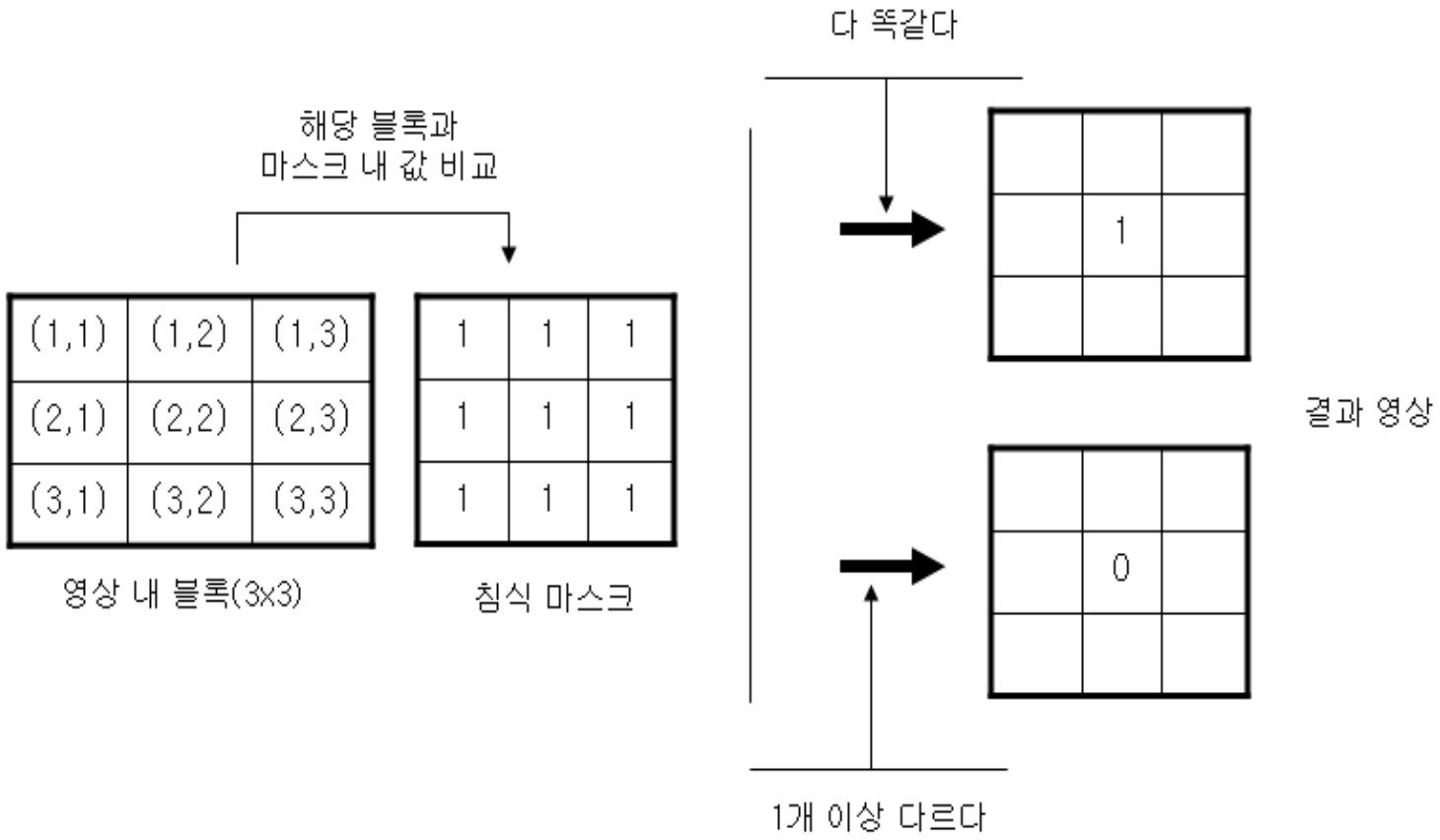
  – extension of background, contraction of object area

  – Reduction of impulsive noises in the object

  – A(–)B = Erosion of A by B

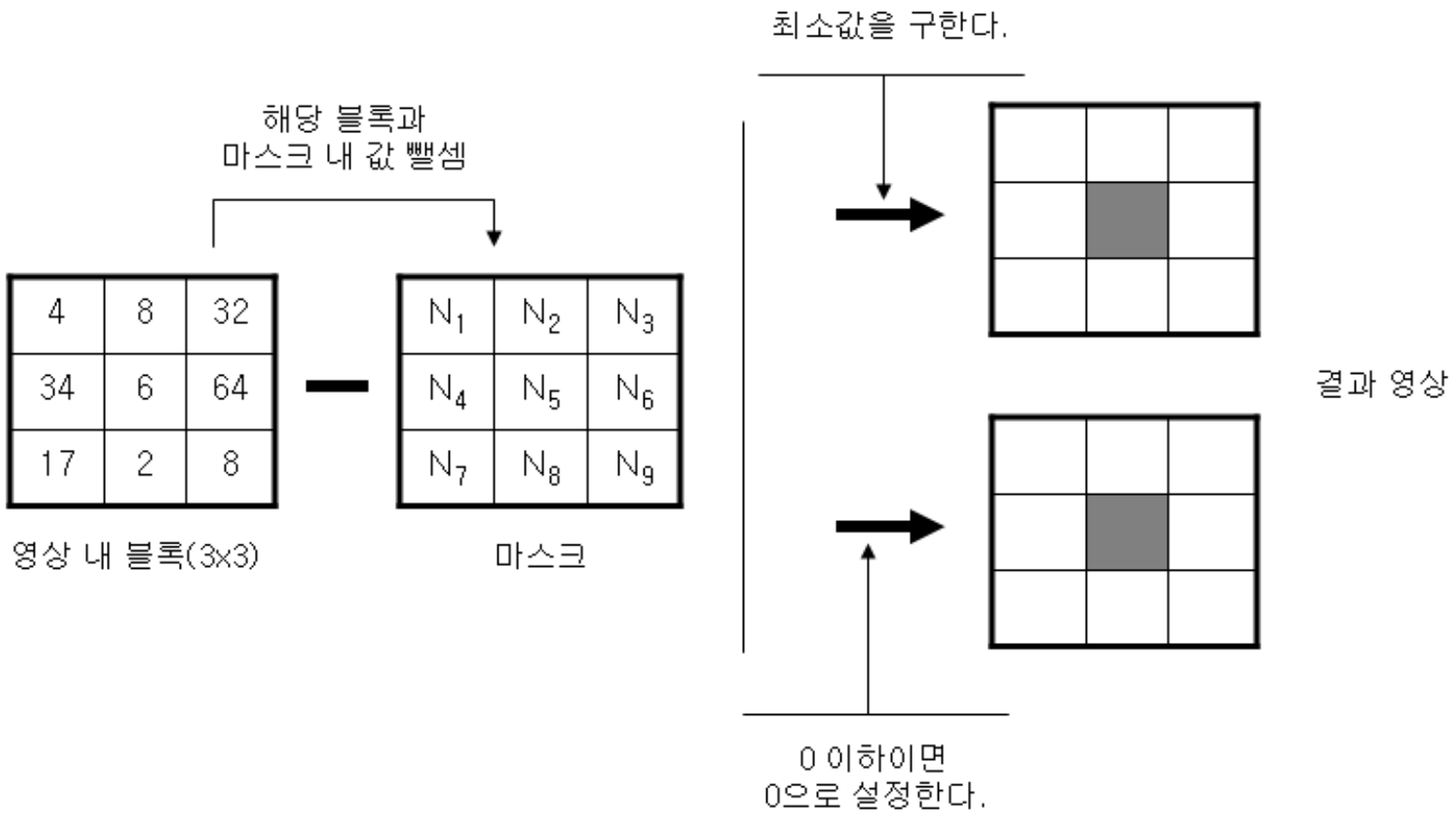
$$A(-)B = \{x \mid (B)_x \subseteq A\}$$

# ❑ Erosion Operation (2)



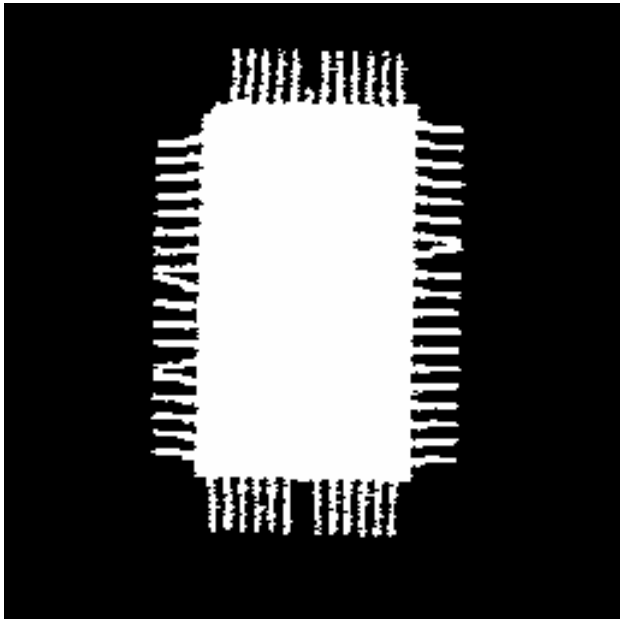

Binary image: Erosion processing

# ❑ Erosion Operation (3)

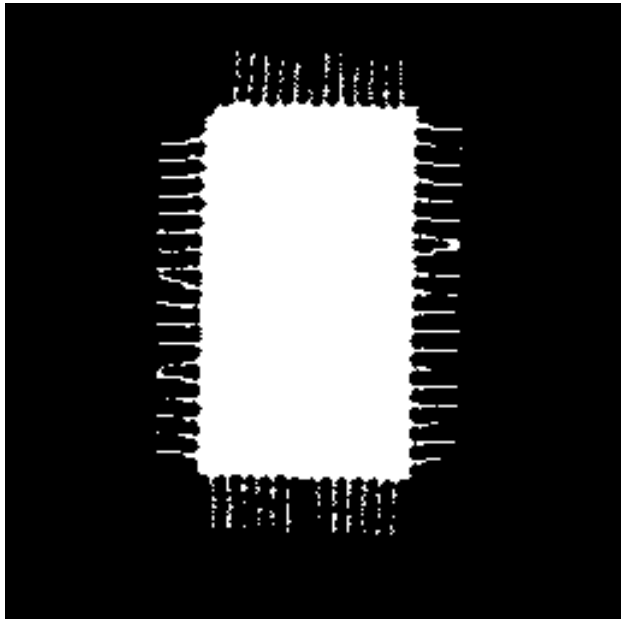



Gray-scale erosion processing

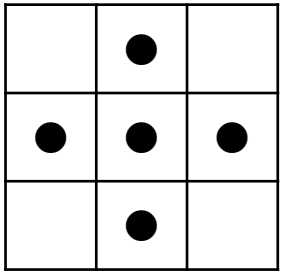
# ❑ Result of Erosion

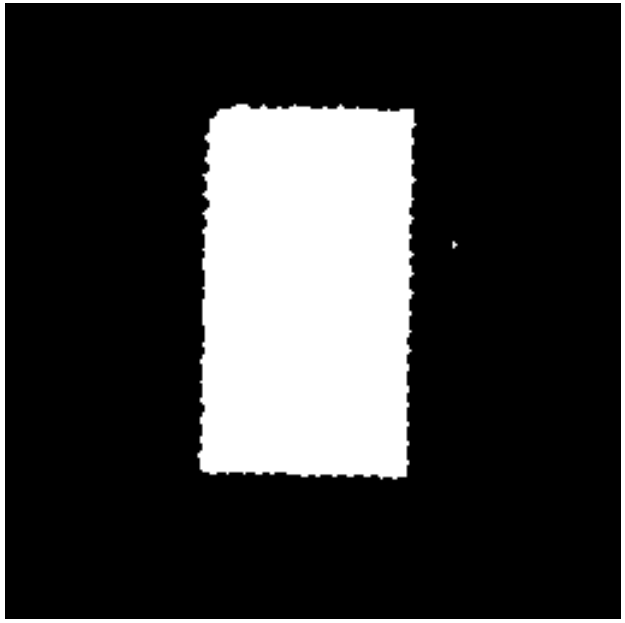


Original binary image

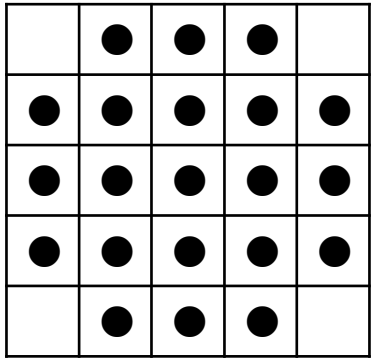


3x3 mask erosion result





5x5 mask erosion result

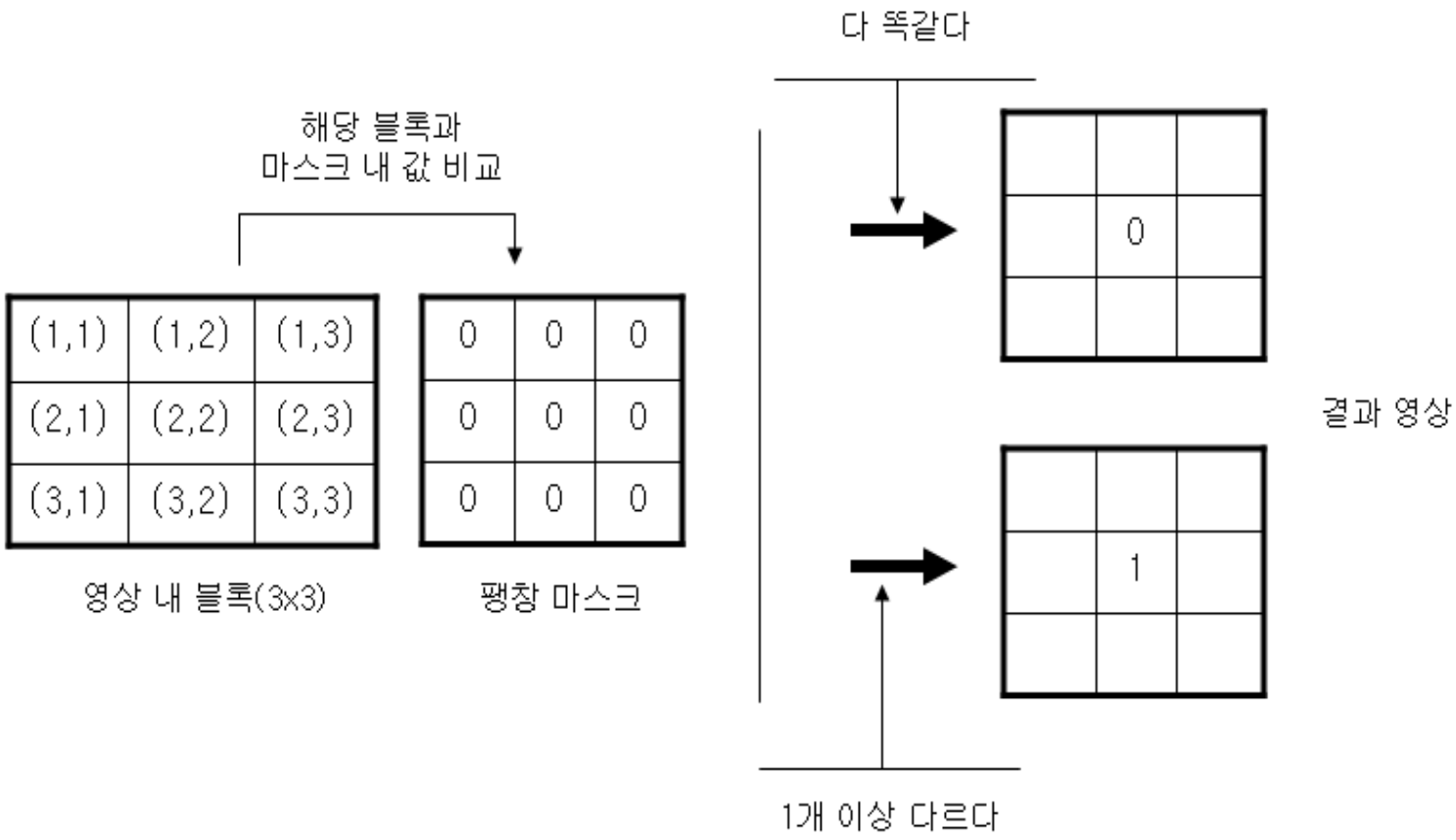


# ❑ Dilation Operation (1)

- 팽창 연산(dilation operator)
  - Contraction of background, extension of object regions
  - Filling the holes in the object
  - Dilation of A by B

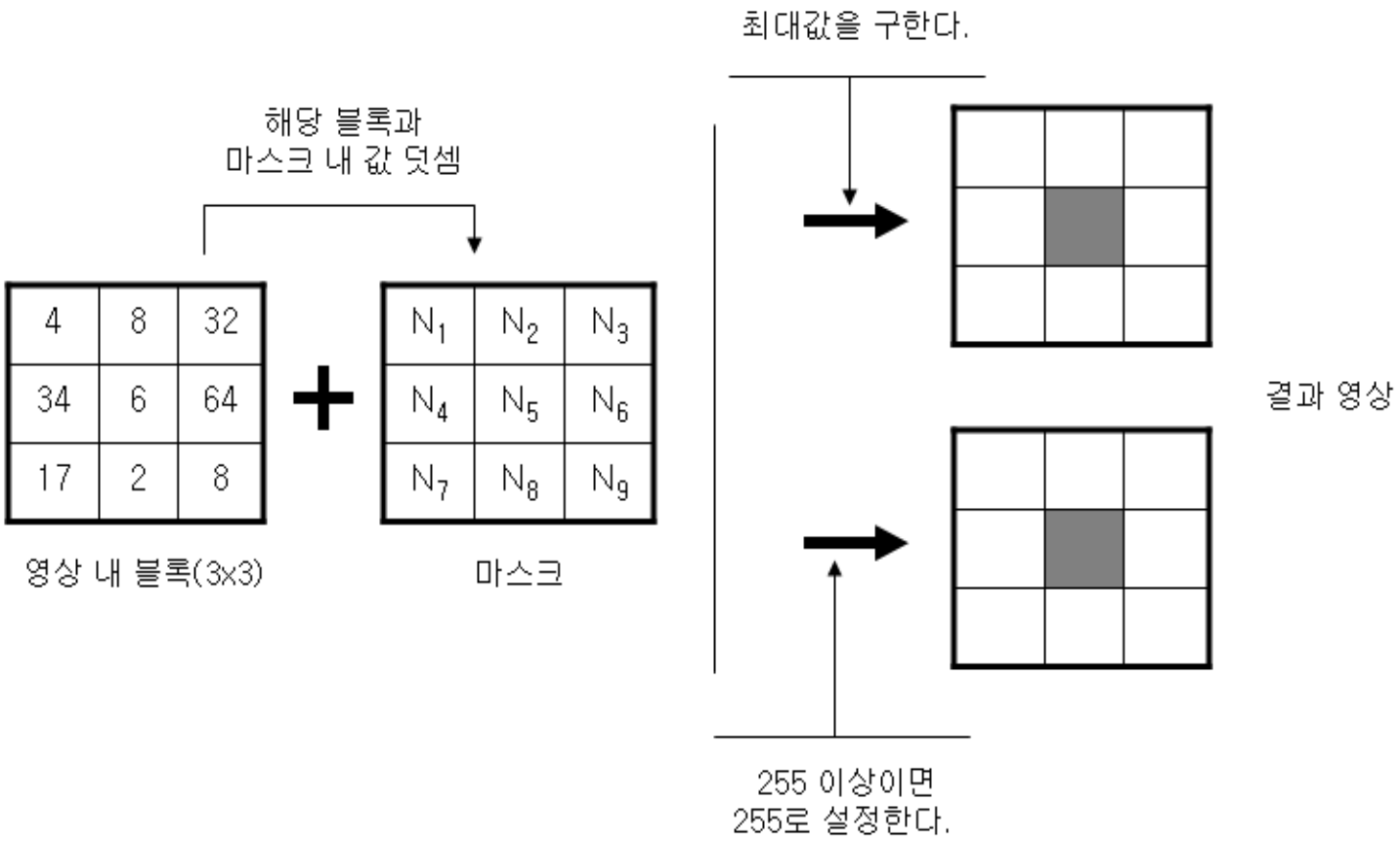
$$A \oplus B = \{x \mid (\hat{B})_x \bigcap \mathrm{A} \neq \varnothing\}$$

# ❑ Dilation Operation (2)



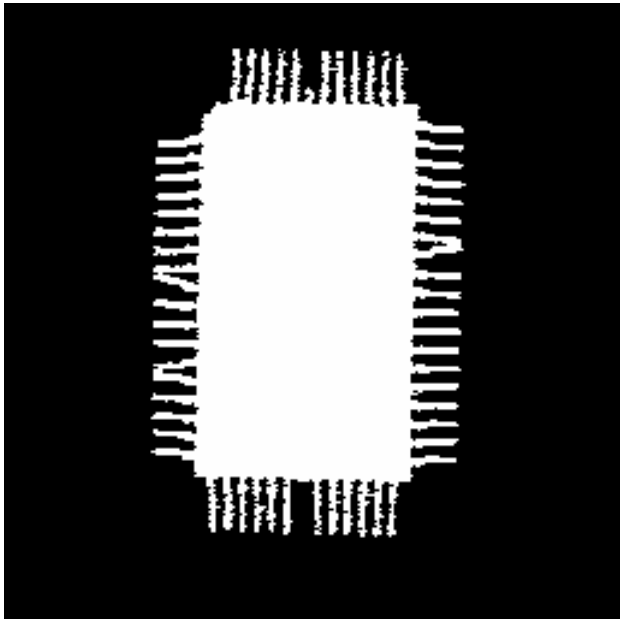

Binary Dilation processing

# ❑ Dilation Operation (3)

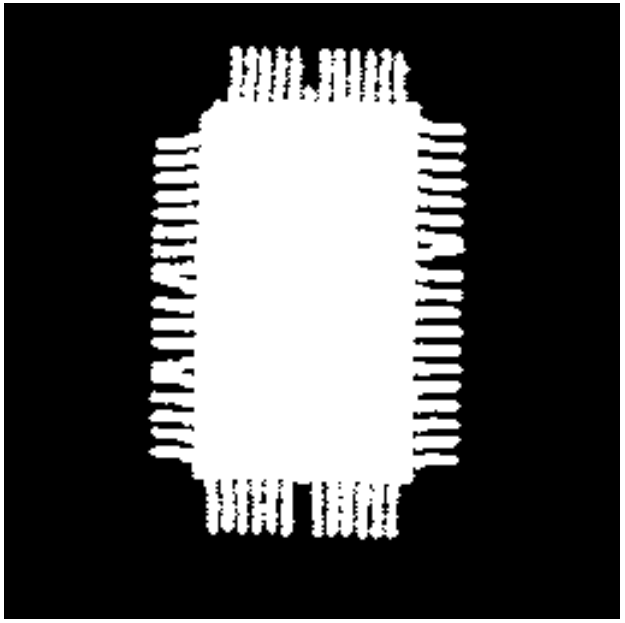



Grey-scale Dilation processing

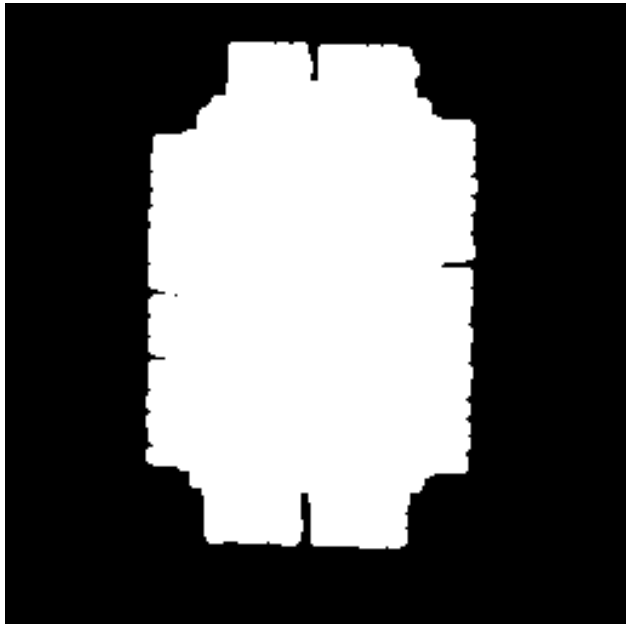
# ❑ Result of Dilation



Original binary image



3x3 mask dilation result



7x7 mask dilation result

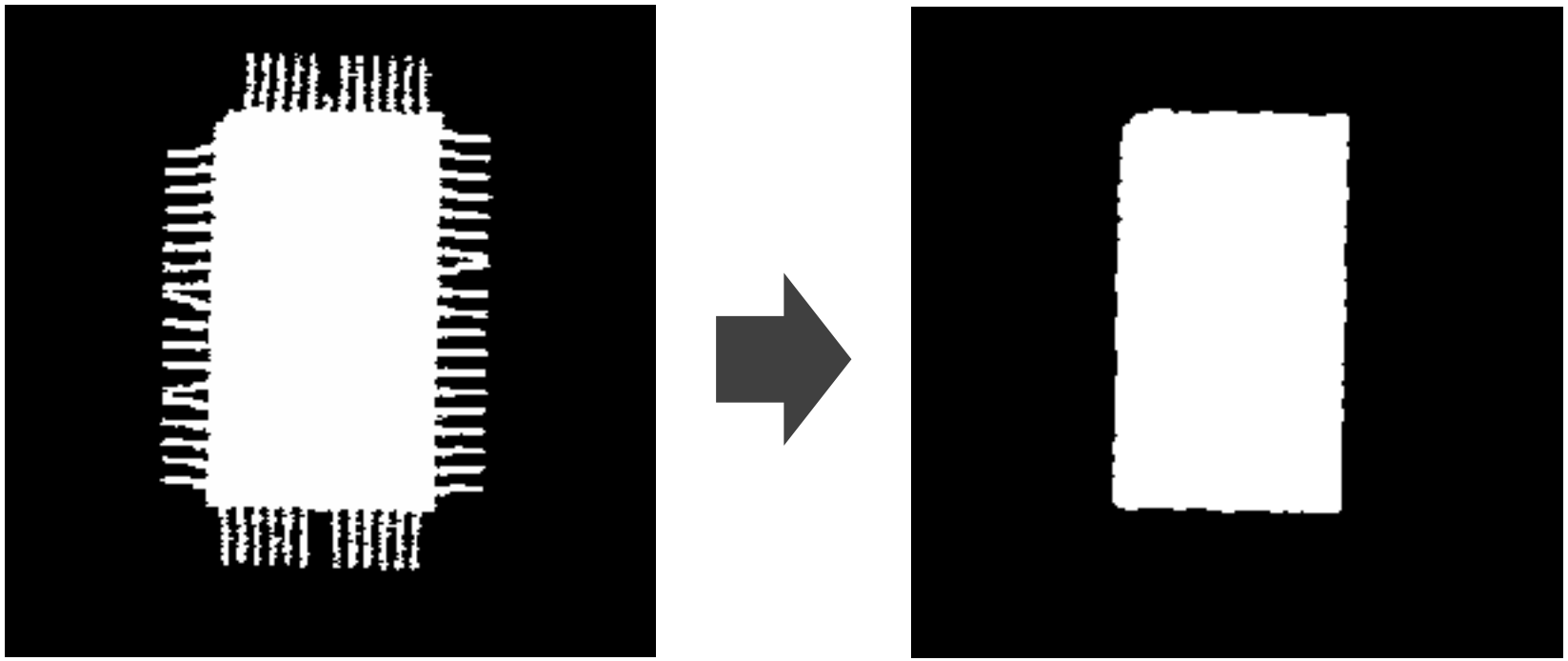
# ❑ Opening Operation

- 열림 연산(opening operator)
  - Erosion followed by dilation

$$A \circ B = (A(-)B) \oplus B$$

- Smoothing object boundaries
- Eliminating pin-like regions

# ❑ Result of Opening



# ❑ Closing Operation

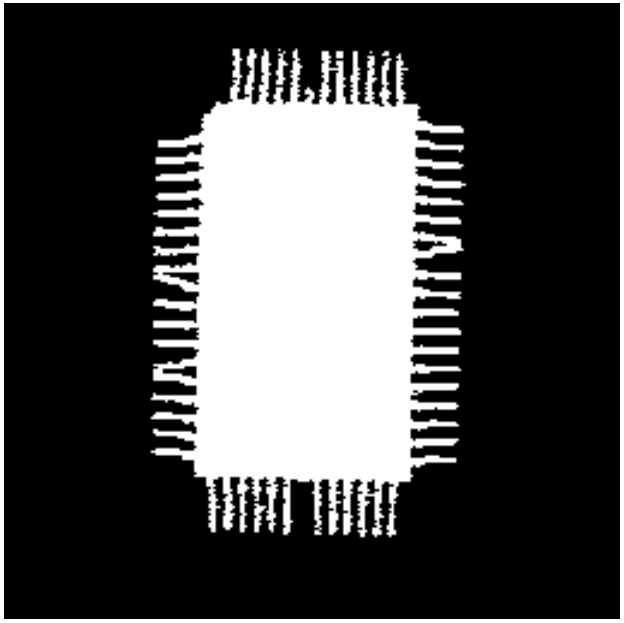
- 닫힘 연산(closing operator)

  - Dilationfollowed by Erosion

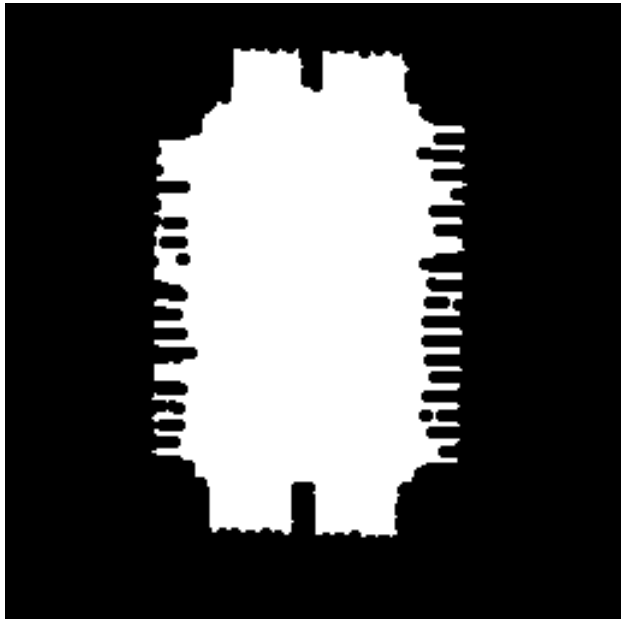
$$A \bullet B = (A \oplus B)(-)B$$

- Connecting small (gulf), and holes
- Smoothing object boundaries

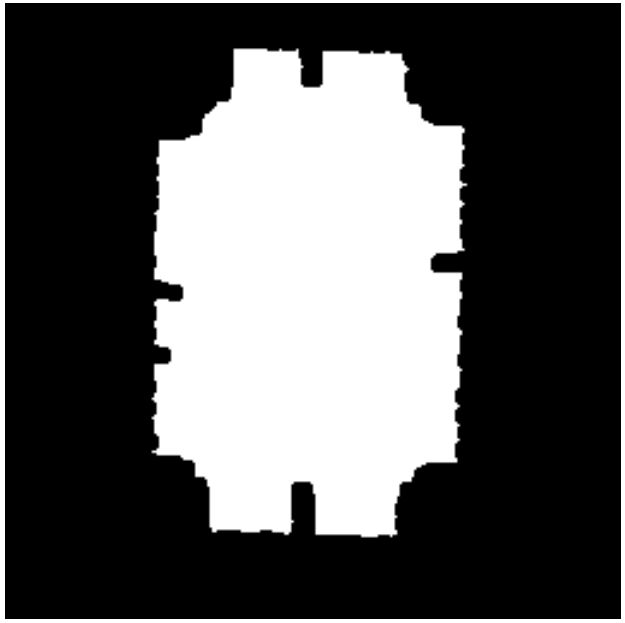
# ❑ Result of Closing



Original binary image



3x3 mask closing result

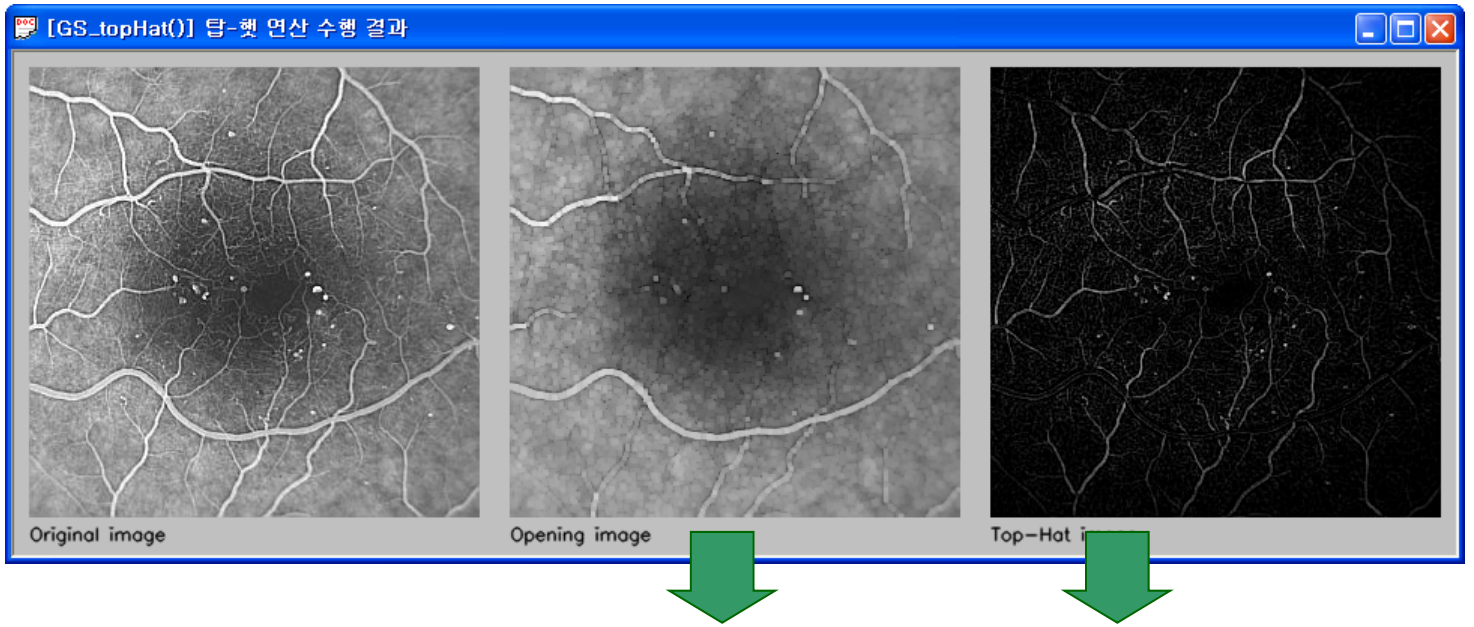


5x5 mask closing result

# ❑ Top-Hat Operation

- grayscale

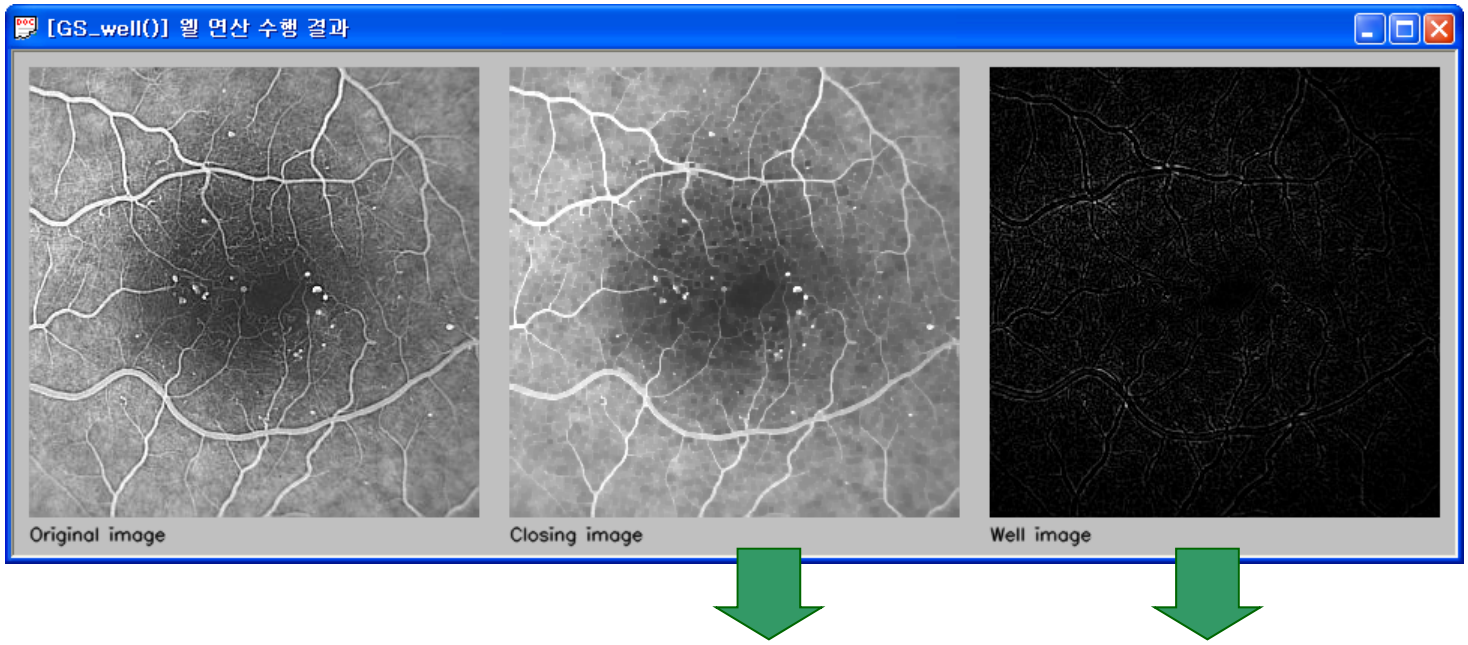
$$F = A - (A \circ B)$$



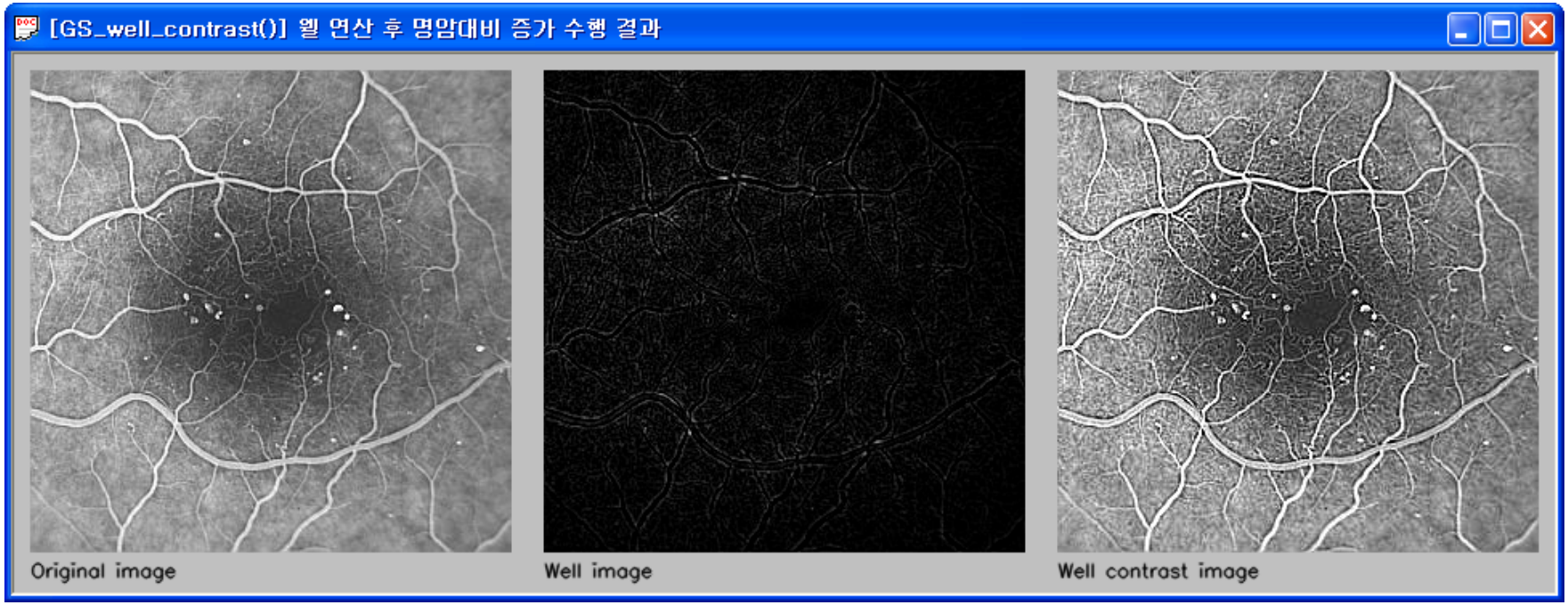
# ❑ Well Operation (1)

- Gray-scale

$$F = A - (A \bullet B)$$



# ❑ Well Operation (2)




Histogram equalization of well result

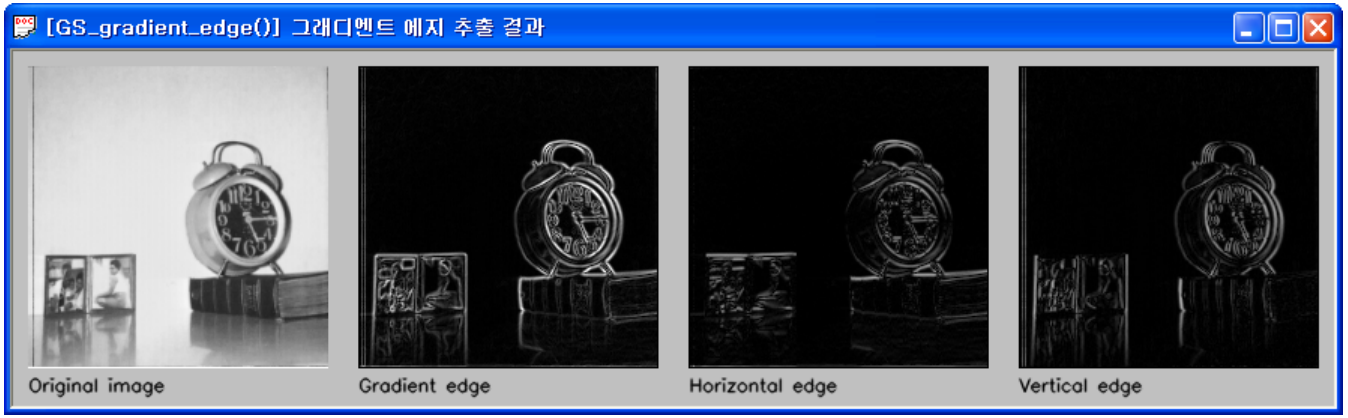
# ❑ Morphological Gradient (1)

- Gray-scale

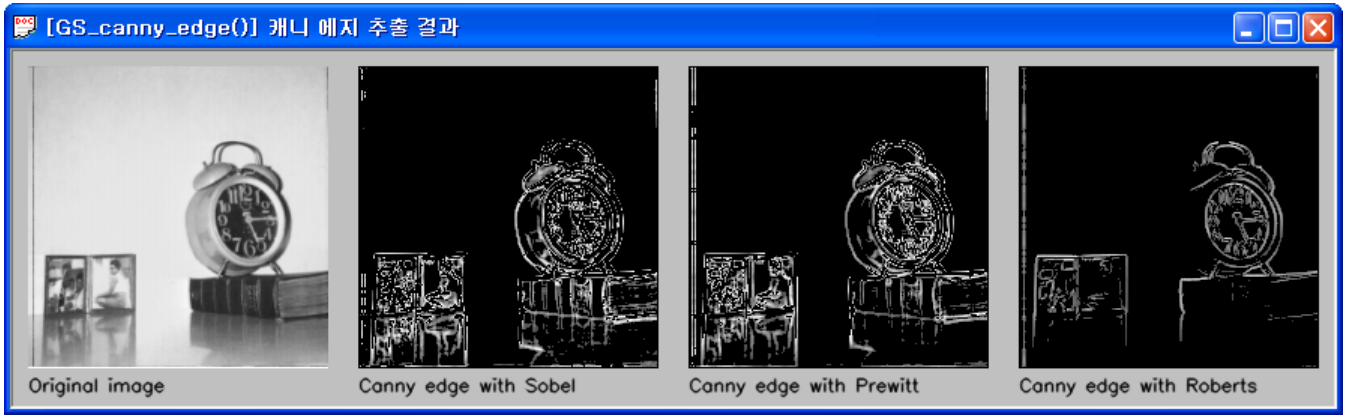
$$F = (A \oplus B) - (A(-)B)$$


Result of morphological gradient

# ❑ Morphological Gradient (2)




Result of morphological gradient edges




Result of Canny