Image Processing: Morphological Filters

Shrink and grow

- Shrink by peeling off an output layer.
- Shrinking will removes small structure and remain it by grow back.
- Growing should done in original shape.
- Neighborhood of pixel
  - N4 is 4 neighborhood
  - N8 is 8 neighborhood

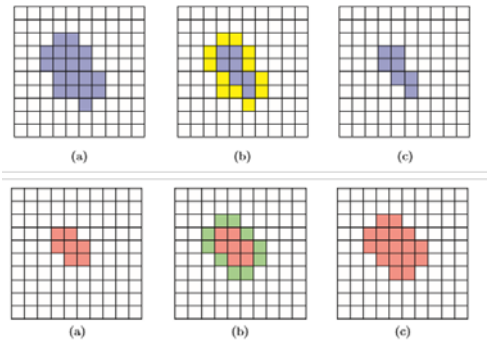

Figure 7.1 Top is shrinking, Bottom is growing

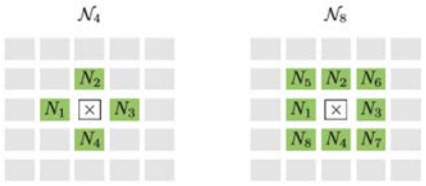

Figure 7.2 Neighborhood pixel

Basic morphological operations

- Structure element
  - H(i,j) $\in$ {0,1}
  - Hot spot is the origin of coordinate system of H.

Figure 7.3 structure element

- Point set
  - For binary image, Q_I consist of coordinate pairs of all foreground pixels
- Dilation
  - Growing up
  - Properties
    - $I \oplus H = H \oplus I$
    - $(I_1 \oplus I_2) \oplus I_3 = I_1 \oplus (I_2 \oplus I_3)$
    - $I \oplus H_{big} = (\ldots((I \oplus H_1) \oplus H_2) \oplus \ldots \oplus H_k)$
- Erosion
  - Inverse of dilation, shrinking

- Properties
  - $I \ominus H \neq H \ominus I$
  - $(I \ominus I_2) \ominus I_3 = I_1 \ominus (I_2 \oplus I_3)$
- Some properties of dilation and erosion
  - Dilation foreground (I) equal erosion background ($\bar{I}$)

$$I \oplus H = \overline{\bar{I} \ominus H^*} \quad , \quad I \ominus H = \overline{\bar{I} \oplus H^*}$$

Composite operation

- Opening
  - $I \circ H = (I \ominus H) \oplus H$
  - All foreground are eliminated, it called growth back.
  - Note* all foreground is smaller than structure element
- Closing
  - $I \cdot H = (I \oplus H) \ominus H$

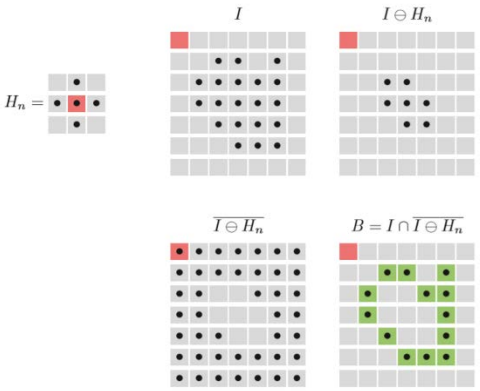

Figure 7.4 outline example using N4

Grayscale morphology

- Generalize of binary morphology
- In case of color image, you should convert each color channel to grayscale before apply grayscale morphology filter.
- Structuring element
  - Structure elements is real value 2D function
  - Note* real value can be negative or zero, and zero unlike empty cell
- Dilation and erosion
  - Dilation
    - $I \oplus H = \max\{I_{(u+i,\ v+j)} + H_{(i,\ j)}\}$
  - Erosion
    - $I \ominus H = \min\{I_{(u+i,\ v+j)} + H_{(i,\ j)}\}$
- Opening and closing
  - The operation consist of dilation and erosion with the same structure element.