German University in Cairo
Faculty of Media Engineering and Technology
Spring 2019

DMET 1002 – Advanced Media Lab

Lab 5 Preparation

Morphological Operators

1. Objective

This experiment aims at implementing different morphological operators for binary images.

2. Pre-requisites

- MATLAB programming knowledge

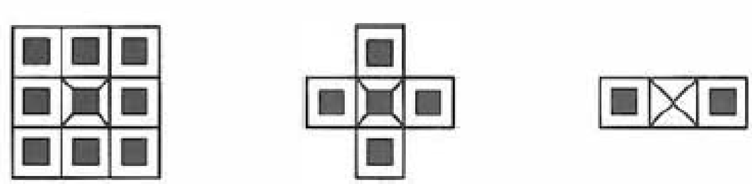
3. References

- Computer Vision lectures of Winter 2018

- Image Processing lectures of Spring 2019

4. Theoretical Background

- Morphology is a branch of biology dealing with the form and structure of creatures
- Mathematical morphology is based on the algebra of non-linear operators
- In mathematical morphology, binary images are treated as 2D point sets
- Points belonging to an object in a binary image represent a set X
- Points belonging to the background are represented by the complement set X^c
- A morphological transformation is given by the relation of the image (point set X) with another small point set B called **structuring element**
- B is expressed with respect to a local origin called the **representative point**
- Examples of structuring elements:



Morphological Operators

4.1 Dilation

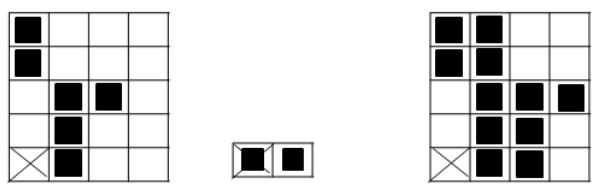
- Dilation combines two sets using vector addition

$$X \oplus B = \{p \in \xi^2 : p = x + b, x \in X \ \ and \ \ b \in B\}$$

- Example:

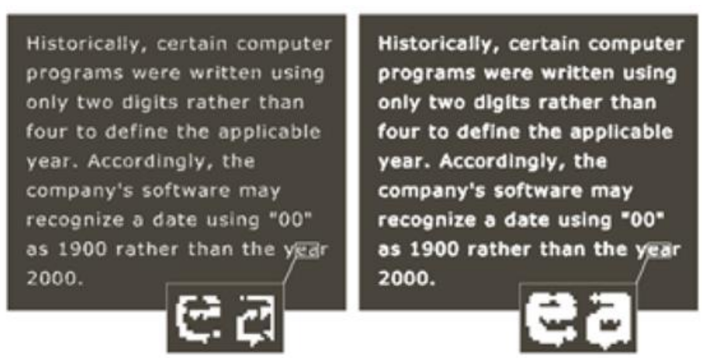
  X = {(1, 0), (1, 1), (1, 2), (2, 2), (0, 3), (0, 4)}
  B = {(0, 0), (1, 0)}
  $X \oplus B$ = {(1, 0), (1, 1), (1, 2), (2, 2), (0, 3), (0, 4), (2, 0), (2, 1), (2, 2), (3, 2), (1, 3), (1, 4)}

  We add every element in X to every element in B.



X $\qquad$ B $\qquad$ $X \oplus B$

- Example:



4.2 Erosion

- Erosion combines two sets using vector subtraction

$$X \ominus B = \{x \in \xi^2 : p = x + b \in X \ \ for \ \ every \ b \in B\}$$

- Example:

  X = {(1, 0), (1, 1), (1, 2), (0, 3), (1, 3), (2, 3), (3, 3), (1, 4)}
  B = {(0, 0), (1, 0)}
  $X \ominus B$ = {(0, 3), (1, 3), (2, 3)}

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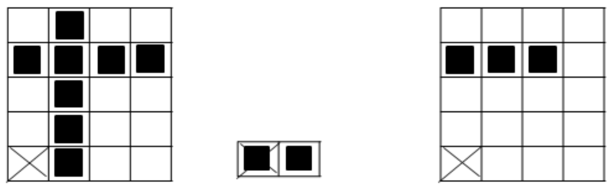
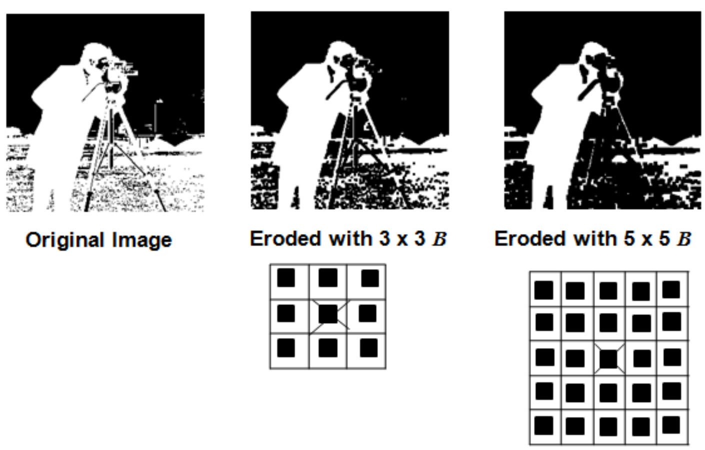
For every element in X, add it to every element in B. If ***all*** the resulting points belong to X, then this point belongs to the eroded output.



X $\quad$ B $\quad$ $X \ominus B$

- Erosion can be used to find the contours of images by subtracting the eroded image from the original one
- Example:



4.3 Opening and Closing

- Opening is defined as

$$X \circ B = (X \ominus B) \oplus B$$

Erosion of X by B followed by dilation of the result with B

- Closing is defined as

$$X \bullet B = (X \oplus B) \ominus B$$

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Dilation of *X* by *B* followed by erosion of the result with *B*

- Example:

  Opening followed by closing can be used to eliminate noise and keep distortion of the original image minimum

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