

Lab 4

- Morphological operations on binary images and on gray-level images.
- Dilation and Erosion.
- Opening and Closing.
- Noise removal.
- Edge detection.
- Segmentation.

4.1 Binary images — Dilation

When applied to binary images, the morphological dilation operation expands the boundaries of foreground regions.

Given the gray-level image **wdg2.bmp**, carry out the following sequence of operations:

- Conversion to a binary image, with threshold 120.
- Inversion of the resulting image (i.e., obtaining the negative image).
- Dilation of the negative image using a circular structuring element, with a diameter of 11 *pixels*.

What happens if you repeatedly apply the dilation operation using the same structuring element?

Now, use a square structuring element, of size 11×11 . Repeatedly apply the dilation operation. What differences do you notice?

4.2 Binary images — Edge detection

The morphological dilation can be used to obtain image edges.

Given the gray-level image **wdg2.bmp**, carry out the following sequence of operations:

- Conversion to a binary image, with threshold 120.
- Inversion of the resulting image (i.e., obtaining the negative image: Image A).
- Dilation of the negative image using a square structuring element of size 3×3 .
- Subtraction of Image A from the resulting dilated image.

Carry out the same sequence of operations using a larger structuring element. What differences do you notice?

4.3 Gray-level images — Noise removal

Another application of the morphological dilation is the removal of “*pepper noise*”.

Given the gray-level image **fce5noi2.bmp**, carry out its dilation using a square structuring element of size 3×3 . Analyze what happens.

Use structuring elements of larger dimensions. Analyze the resulting images.

4.4 Binary images — Erosion

When applied to binary images, the morphological erosion operation essentially shrinks the boundaries of foreground regions.

Given the gray-level image **wdg2.bmp**, carry out the following sequence of operations:

- Conversion to a binary image, with threshold 120.
- Inversion of the resulting image (i.e., obtaining the negative image).
- Erosion of the negative image using a circular structuring element, with a diameter of 11 *pixels*.

What happens if you repeatedly apply the erosion operation using the same structuring element?

Now, use a square structuring element, of size 11×11 . Repeatedly apply the erosion operation. What differences do you notice?

The morphological erosion has directional effects, when using non-symmetrical structuring elements.

Try using:

- A structuring element of size 11×1 .
- A square structuring element of size 3×3 ; but with its origin (“*hotspot*”) in the center pixel of the first row.

What happens?

4.5 Binary images — Segmentation

A morphological erosion might be a first step before segmenting contiguous image regions.

Given the gray-level image **mon1.bmp**, carry out the following sequence of operations:

- Conversion to a binary image, with threshold 90.
- Inversion of the resulting image (i.e., obtaining the negative image).
- Repeated erosion (twice) of the resulting image using a circular structuring element, with a diameter of 11 *pixels*.

What happens if you use a square structuring element of size 9×9 ?

4.6 Gray-level images — Noise removal

Another application of the morphological erosion is the removal of “*salt noise*”.

Given the gray-level image **fce5noi1.bmp**, carry out its erosion using a square structuring element of size 3×3 . Analyze what happens.

Use structuring elements of larger dimensions. Analyze the resulting images.

4.7 Binary images — Opening

The morphological opening operation corresponds to applying an **erosion** operation followed by a **dilation** operation, using the same structuring element.

Given the binary image **art3.bmp**, we want to count the circular regions. Carry out a morphological opening using a circular structuring element, with a diameter of 11 *pixels*.

Given the binary image **art2.bmp**, we want to separately segment the vertical and the horizontal line segments. Carry out a morphological opening using a rectangular

structuring element of size 3×9 , and also using a rectangular structuring element of size 9×3 . What happens?

4.8 Gray-level images — Opening

For gray-level images, a morphological opening allows to select and preserve particular intensity patterns.

Given the gray-level image **ape1.bmp**, carry out a morphological opening using a square structuring element of size 5×5 . What happens?

4.9 Gray-level images — Noise removal

Another application of the morphological opening is the removal of “*salt noise*”.

Given the gray-level image **fce5noi1.bmp**, carry out a morphological opening using a square structuring element of size 3×3 . Analyze what happens.

Compare with the results of removing “*salt noise*” using the morphological erosion.

Use structuring elements of larger dimensions. Analyze the resulting images.

What happens if you try to remove “*pepper noise*” using a morphological opening?

4.10 Binary images — Closing

The morphological closing operation corresponds to applying a **dilation** operation followed by an **erosion** operation, using the same structuring element.

Given the binary image **art4.bmp**, we want to remove the circular regions of smaller size. Carry out a morphological closing using a circular structuring element, with a diameter of 22 *pixels*.

Use structuring elements of smaller and larger diameter. Analyze the resulting images.

4.11 Gray-level images — Closing

For gray-level images, a morphological closing allows to select and preserve particular intensity patterns, while attenuating others.

Given the gray-level image **ape1.bmp**, carry out a morphological closing using a square structuring element of size 5×5 . What happens?

4.12 Gray-level images — Noise removal

Another application of the morphological closing is the removal of “*pepper noise*”.

Given the gray-level image **fce5noi2.bmp**, carry out a morphological closing using a square structuring element of size 3×3 . Analyze what happens.

Compare with the results of removing “*pepper noise*” using the morphological dilation.

Use structuring elements of larger dimensions. Analyze the resulting images.

What happens if you try to remove “**salt noise**” using a morphological closing?

Given the gray-level image **fce5noi3.bmp**, try to remove the “*salt and pepper noise*”.