Lab 4, Morphological Operations

- Morphological operations on binary images.
- Dilation and Erosion.
- Opening and Closing.
- Region segmentation using Flood-Filling.

4.1 Dilation

When applied to binary images, the morphological dilation operation expands the boundaries of foreground regions.
Given the gray-level image wdg2.bmp, create a new program (`Aula_04_exe_01.py`) carrying out the following sequence of operations:

a. Conversion to a binary image, with threshold 120.

b. Inversion of the resulting image (i.e., obtaining the negative image).

c. 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 Edge detection with morphological operations

The morphological dilation can be used to obtain image edges.
Given the gray-level image wdg2.bmp, carry out the following sequence of operations:

a. Conversion to a binary image, with threshold 120.

b. Inversion of the resulting image (i.e., obtaining the negative image: Image A).

c. Dilation of the negative image using a square structuring element of size 3×3.

d. Subtration of Image A form the resulting dilated image.

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

4.3 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:

a. Conversion to a binary image, with threshold 120.

b. Inversion of the resulting image (i.e., obtaining the negative image).

c. 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. A structuring element of size 11×1.

b. A square structuring element of size 3×3; but with its origin ("hotspot") in the center pixel of the first row.

What happens?

4.4 Segmentation with morphological operations

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:

a. Conversion to a binary image, with threshold 90.

b. Inversion of the resulting image (i.e., obtaining the negative image).

c. 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?

4.5 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 using a rectangular structuring element of size 9×3. What happens?

4.6 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 23 pixels.
Use structuring elements of smaller and larger diameter. Analyze the resulting images.

4.7 Region Segmentation using Flood-Filling

Create a new example (`Aula_04_exe_07.py`) that allows segmenting regions of a given image.
Starting from a seed pixel, the floodFill function segments a region by spreading the seed value to neighboring pixels with (approximately) the same intensity value.
Use the function

```
retval, rect = cv2.floodFill(image, mask, seedPoint, newVal[,
    loDiff[, upDiff[, flags]]])
```

Listing 9: floodFill function

Segment the `lena.jpg` image, using as seed the pixel at position (430, 30) and allowing intensity variations of ±5 regarding the intensity value of the seed pixel.

Optional

Allow the user to interactively select the seed pixel for region segmentation.
Test the interactive region segmentation using the `wdg2bmp, tools_2png` and `lenajpg` images.

Report

Write a report following the DETI journal template about the experiences done in this class. It should contain an example of the images displayed in each exercise, as well your comments about them. All the exercises must be repeated with other images of your choice.