LAB-9: Morphological Operations

Objective:

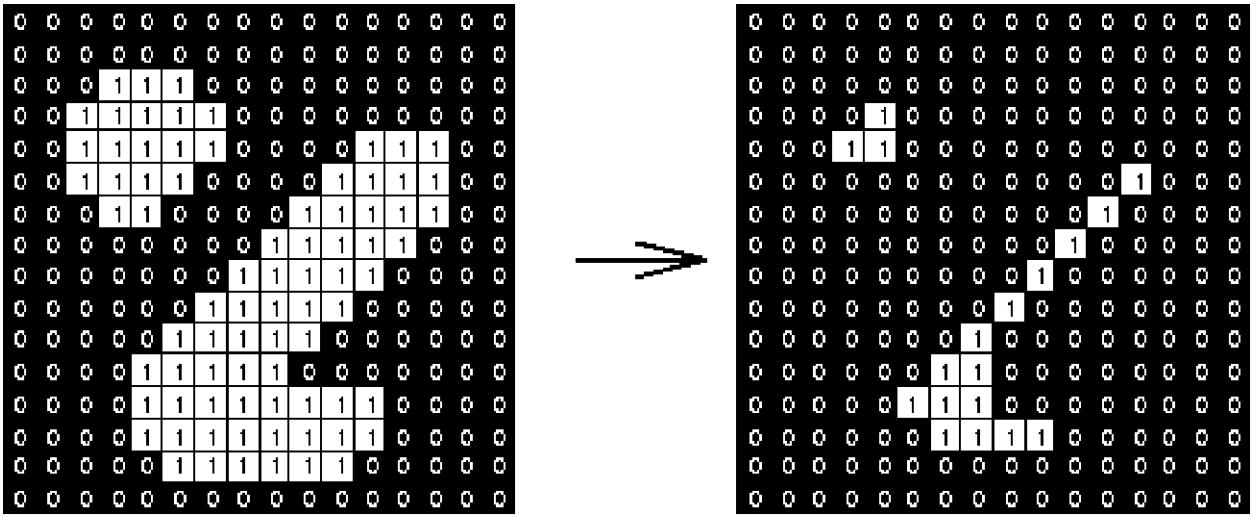
The objective of this lab is to apply morphological operations on binary images.

Theory:

Morphological image processing is quite like spatial filtering. The structuring element just like a spatial mask is moved across every pixel in the original image to produce an output pixel. The value of this new pixel depends on the operation performed. Two basic morphological operations are erosion and dilation.

Erosion shrinks the size of foreground (1-valued) objects; smooths object boundaries and removes small objects. In erosion, for each foreground pixel (also called input pixel):

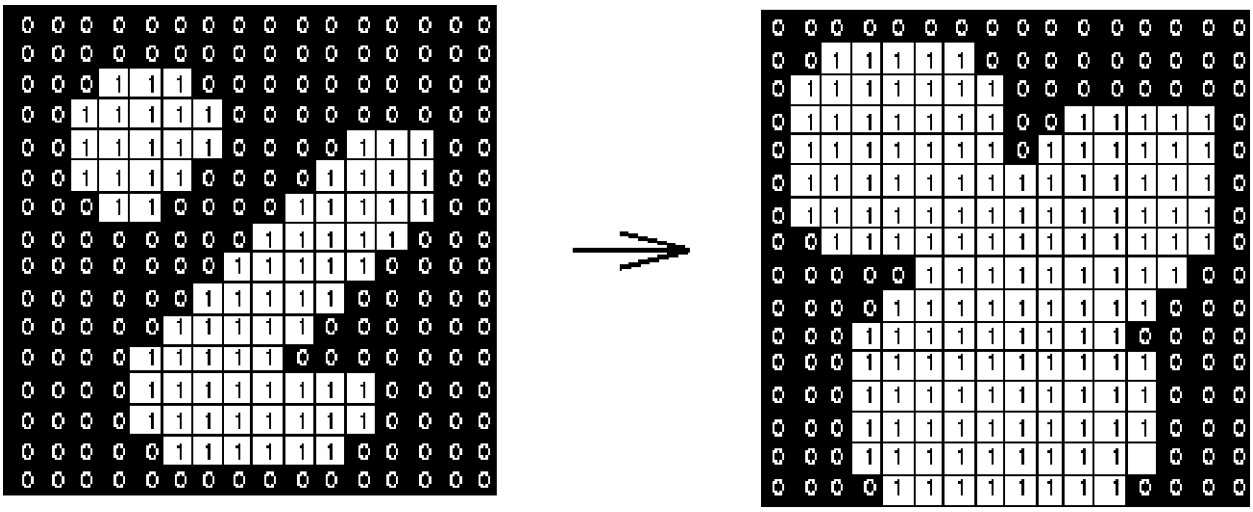
- Superimpose the structuring element on top of the input image so that the origin of the structuring element coincides with the input pixel position.
- If **for every** pixel in the structuring element, the corresponding pixel in the image underneath is a foreground pixel, then the input pixel is left as it is.
- If any of the corresponding pixels in the image are background, however, the input pixel is also set to background value



On the other hand, **dilation** expands the size of foreground (1-valued) objects; smooths object boundaries and closes holes and gaps. In dilation, for each foreground pixel (also called input pixel)

- Superimpose the structuring element on top of the input image so that the origin of the structuring element coincides with the input pixel position
- If **at least one** pixel in the structuring element coincides with a foreground pixel in the image underneath, then the input pixel is set to the foreground value

- If all the corresponding pixels in the image are background, however, the input pixel is left at the background value

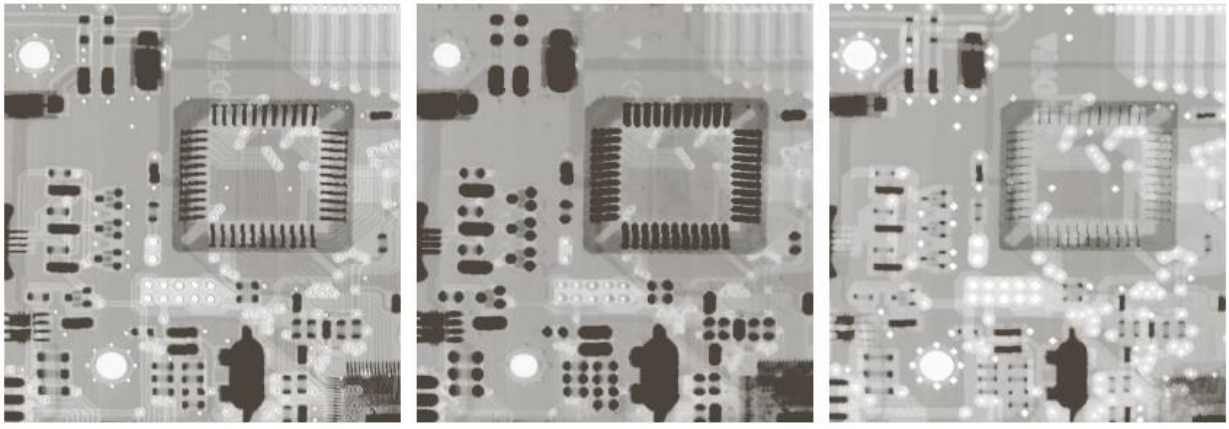


More interesting morphological operations can be performed by performing combinations of erosions and dilations. The most widely used of these compound operations are **opening** and **closing**.

In **opening, erosion** is followed by **dilation.** On the other hand, in **closing, dilation** is followed by **erosion.**

All these operations can be applied on grayscale images as well. Following image shows the application of morphological operation on a grayscale image. **Grayscale Erosion** is to select the minimum of the pixel values under the mask while **Grayscale Dilation** is the maximum of the pixel values.

A **morphological gradient** is the difference between the dilation and the erosion of a given image



1. **The top-hat transform** is defined as the difference between the original image and its opening.
2. **The bottom-hat transform** is defined as the difference between the closing of the original image and the original image

Lab Task 1:

Perform Erosion on Fig 1 such that all balls get separated from each other. Optional (you can further apply your connected component analysis algorithm to count total number of balls present in this image)

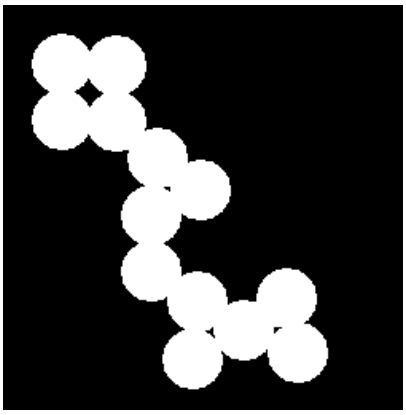


Fig 1

Lab Task 2:

Remove the noise from Fig 2 and then fill the holes or gap between thumb impression. You can apply morphological closing and opening.

Fig 2

Lab Task 3:

We have 512 *512 image of a head CT scan. Perform Gray scale 3x3 dilation and erosion on Fig 3. Also find Morphological gradient. Use following expression to compute gradient

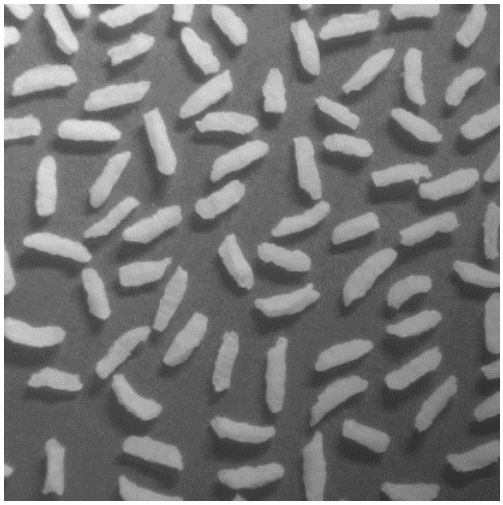
$$g = (f \oplus b) - (f \ominus b)$$

Fig 3

Lab Task 4:

Apply top-hat transformation on the following imag using given expression

$$g_{top} = f - (f \circ b)$$



Conclusion:

This lab has given an introduction to morphological operations and has shown how an image can be preprocessed using morphological operations.