INDIAN INSTITUTE OF TECHNOLOGY

KHARAGPUR

DIGITAL IMAGE PROCESSING LABORATORY

A REPORT ON

EXPERIMENT 05

Morphological Operations

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Group No. 16

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Introduction

Morphological image processing is a collection of non-linear operations related to shape or morphology of features in an image. Morphological operations rely only on the relative ordering of pixel values, not on their numerical values, and therefore are especially suited to the processing of binary images. Binary images may contain numerous imperfections like distortion in binary regions produced by simple thresholding due to noise. Morphological image processing pursues the goals of removing these imperfections by accounting for the form and structure of the image. Morphological techniques explore an image with a small shape or template called a structuring element. The structuring element (SE) used in convolution with the image to compare with the pixels in the neighbourhood. Some operations try to find whether the SE fits or matches exactly with the neighbourhood, while others test if it hits or partially matches to the neighbourhood. Following are four basic operations in morphological techniques:

1. Erosion: The erosion of a binary image f by a structuring element s (denoted $f \ominus s$) produces a new binary image $g = f \ominus s$ with ones in all locations (x, y) of a structuring element's origin at which that structuring element s fits the input image f, i.e. g(x, y) = 1 is s fits f and 0 otherwise, repeating for all pixel coordinates (x, y). Mathematically,

$$A \ominus B = (x \in Z^2 | (B)_x \subseteq A)$$

2. Dilation: The dilation of an image f by a structuring element s (denoted f $\oplus$ s) produces a new binary image g = f $\oplus$ s with ones in all locations (x, y) of a structuring element's origin at which that structuring element s hits the the input image f, i.e. g(x, y) = 1 if s hits f and 0 otherwise, repeating for all pixel coordinates (x, y). Dilation has the opposite effect to erosion; it adds a layer of pixels to both the inner and outer boundaries of regions. Mathematically,

$$A \oplus B = \{c \in Z^2 | c = a + b for some a \in A, b \in B\}$$

3. Opening: The opening of A by B is obtained by the erosion of A by B, followed by dilation of the resulting image by B:

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

4. Closing: The closing of A by B is obtained by the dilation of A by B, followed by erosion of the resulting image by B:

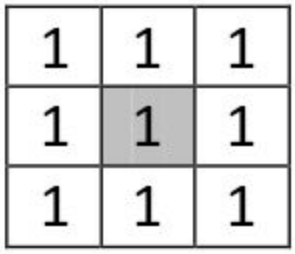
$$A \bullet B = (A \oplus B) \ominus B$$

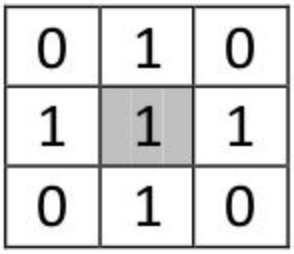
Algorithm

Both Erosion and Dilation require the structuring element to move in a convolution like fashion and check for hit or fit. For opening and closing output of the first operation is fed to another operation.

The structuring elements are:

1) 

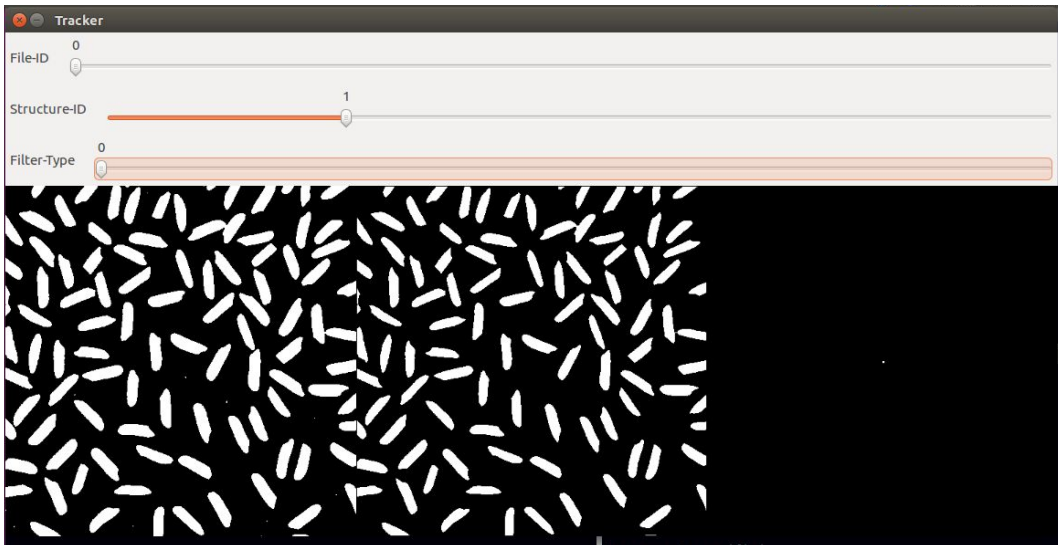
2) 

3) 

4) 9 X 9 kernels of grey value = 1
5) 15 X 15 kernel of grey value = 1

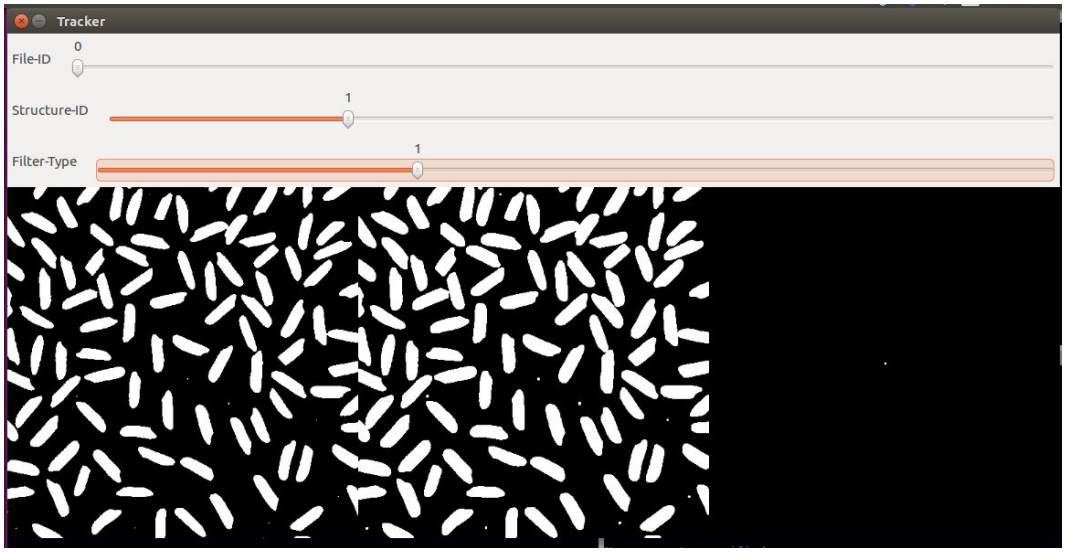
Results

1. Erosion
    a. With 2nd Structuring element

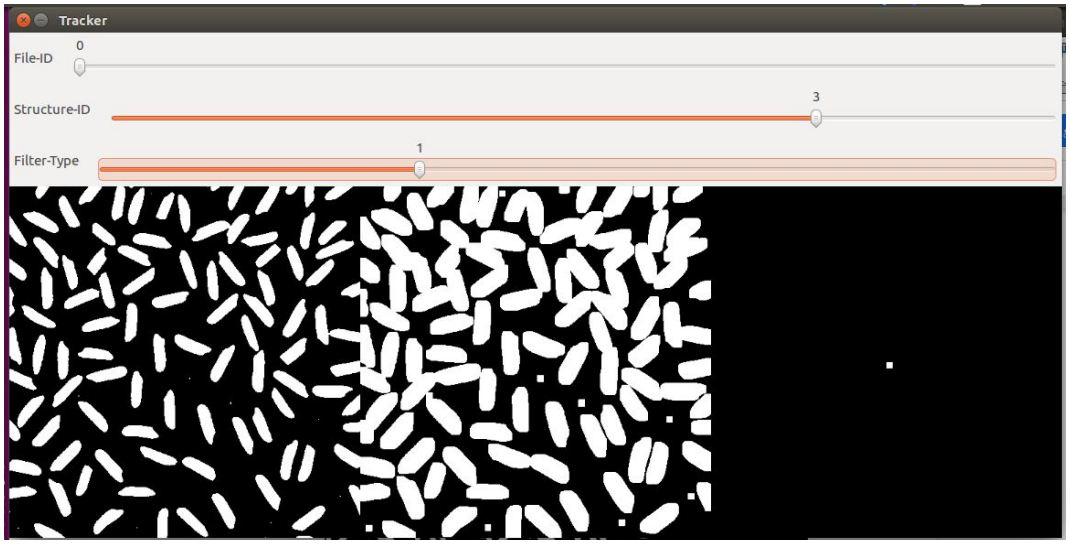


    b. With 4th Structuring element

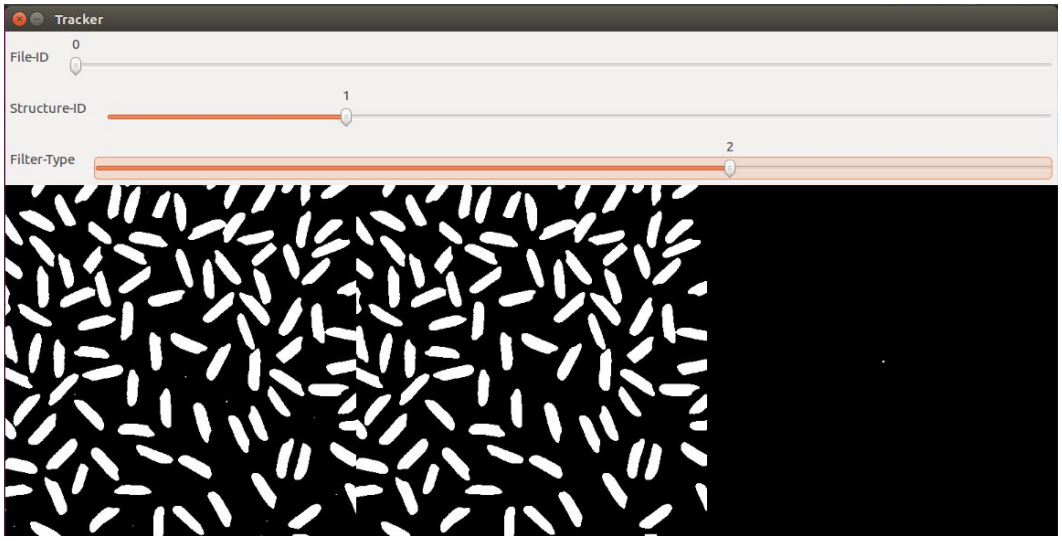
2. Dilation
    a. With 2nd Structuring element



    b. With 4th Structuring element

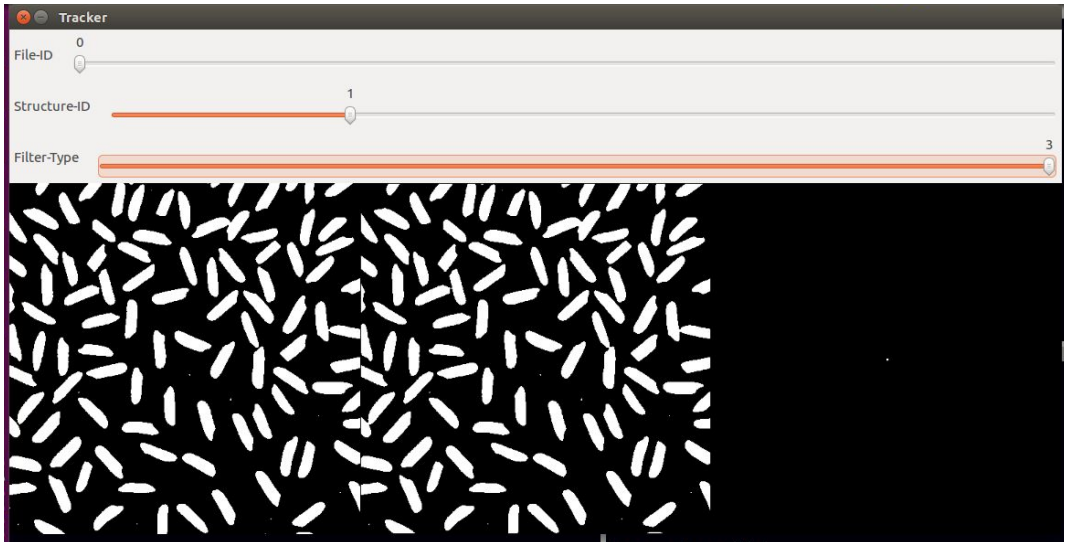


3. Opening
    a. With 2nd Structuring element



    b. With 4th Structuring element

4. Closing
    a. With 2nd Structuring element



    b. With 4th Structuring element

Analysis

1. The erosion and opening operators help in removing the noise in the images using suitable structuring elements.
2. The dilation operator fills the gaps left out in the images and the closing operator helps in connecting parts without changing the noise values.
3. These operators are used in text recognition where the letters are connected with some noise values.

Contributions:

Shubham - Erosion, Opening

Sirish - Dilation, Closing

References

1. R. C. Gonzalez and R. Woods, Digital Image Processing, Reading, MA: Addison-Wesley, 1992.