

INDIAN INSTITUTE OF TECHNOLOGY
KHARAGPUR

DIGITAL IMAGE PROCESSING LABORATORY

A REPORT ON
Experiment-5

Morphological Operations

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1 Introduction

Morphological image processing is a collection of non-linear operations related to shape or morphology of features in 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 neighbourhood. Some operations try to find whether the SE fits or matches exactly with the neighbourhood, while other 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. $g(x,y) = 1$ if s fits f and 0 otherwise, repeating for all pixel coordinates (x, y) . Mathematically,

$$A \ominus B = \{x \in Z^2 \mid (B)_x \subseteq A\}$$

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 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,

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

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 .

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

2 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.

3 Results

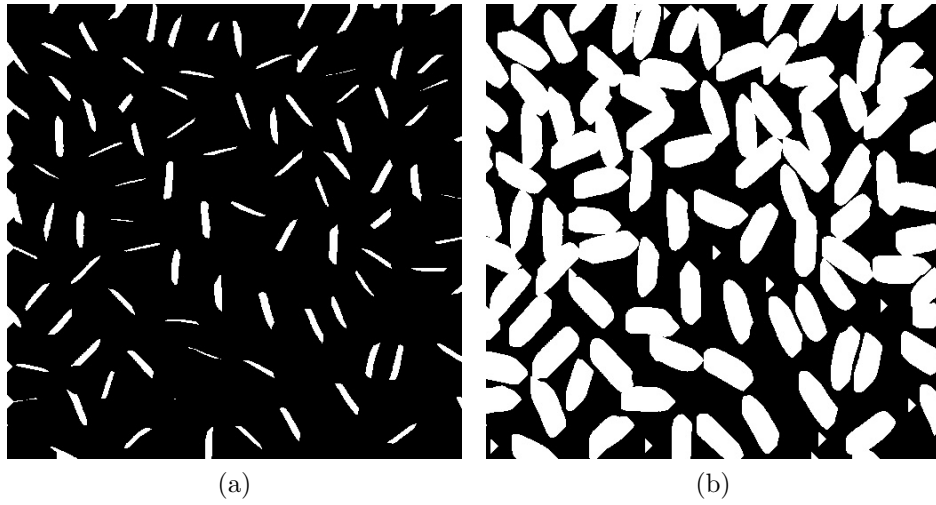


Figure 1: (a) Erosion with 15x15 (b)Dilation with 15x15

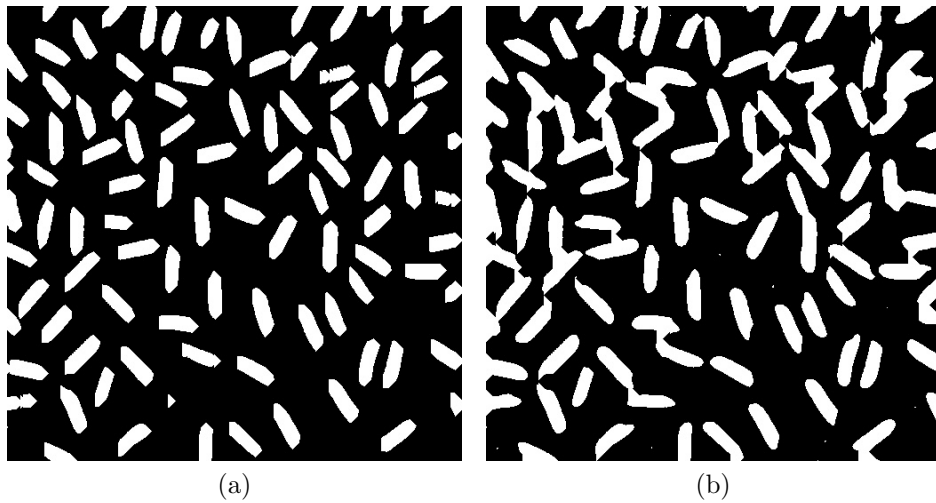


Figure 2: (a) Opening with 15x15 (b)Closing with 15x15

4 Analysis

1. Morphological operators often take a binary image and a structuring element as input. They process objects in the input image based on characteristics of its shape, which are encoded in the structuring element.
2. The effect of Erosion is to remove any foreground pixel that is not completely surrounded by other white pixels. Such pixels lie at the edges of white regions, and the foreground regions shrink and holes inside a region grow.
3. The effect of Dilation is to set to the foreground color any background pixels that have a neighboring foreground pixel. Such pixels lie at the edges of white regions, and the foreground regions grow and holes inside a region shrink.
4. The effect of opening is similar to rounding off things. It smoothens the boundaries of the image by chopping off elements. It happens that because erosion first sharpens the image boundaries by chopping off noisy parts and then dilation smoothens them.
5. Closing uses dilation followed by erosion. Thus it first adds extra parts to the image and then sharpens them. In contrast to opening, here the smoothing process is done by adding elements.
6. Opening and closing showed better results when compared to that of erode and dilate applied individually on the given input Image.