Edge Detection Using Morphology

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ABSTRACT

Edge detection is one of the most commonly used operations in image analysis, and there are probably more algorithms in the literature for enhancing and detecting edges than any other single subject. The reason for this is that edges form the outline of an object. An edge is the boundary between an object and the background, and indicates the boundary between overlapping objects. This means that if the edges in an image can be identified accurately, all of the objects can be located and basic properties such as area, perimeter, and shape can be measured. Since computer vision involves the identification and classification of objects in an image, edge detections is an essential tool.

Keyword: - *Image, Edge, Detection, Morphology, Pictures.*

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1. Introduction

Edge detection is a very important area in the field of Computer Vision. Edges define the boundaries between regions in an image, which helps with segmentation and object recognition. They can show where shadows fall in an image or any other distinct change in the intensity of an image. Edge detection is a fundamental of low-level image processing and good edges are necessary for higher level processing.

The problem is that in general edge detectors behave very poorly. While their behavior may fall within tolerances in specific situations, in general edge detectors have difficulty adapting to different situations. The quality of edge detection is highly dependent on lighting conditions, the presence of objects of similar intensities, density of edges in the scene, and noise. While each of these problems can be handled by adjusting certain values in the edge detector and changing the threshold value for what is considered an edge, no good method has been determined for automatically setting these values, so they must be manually changed by an operator each time the detector is run with a different set of data. Since different edge detectors work better under different conditions, it would be ideal to have an algorithm that makes use of multiple edge detectors, applying each one when the scene conditions are most ideal for its method of detection. In order to create this system, you must first know which edge detectors perform better under which conditions. This data could then be used to create a multi-edge-detector system, which analyzes the scene and runs the edge detector best suited for the current set of data [1].

Edge detection is an image processing technique for finding the boundaries of objects within images. It works by detecting discontinuities in brightness. Edge detection is used for image segmentation and data extraction in areas such as image processing, computer vision, and machine vision [2].

1.1 methods: Some of the most commonly used methods in edge detection is:

- Prewitt edge detection
- Sobel edge detection
- Laplacian edge detection
- Canny edge detection

2. Morphology

Morphological edge detection algorithm selects appropriate structuring element of the processed image and makes use of the basic theory of morphology including erosion, dilation, opening and closing operation and the synthesization operations of them to get clear image edge. In the process, the synthesized modes of the operations and the feature of structuring element decide the result of the processed image. Detailedly saying, the synthesized mode of the operation. reflects the relation between the processed image and origin image, and the selection of structuring element decides the effect and precision and the result. Therefore, the keys of morphological operations can be generalized for the design of morphological filter structure and the selection of structuring element. In medical image edge detection, we must select appropriate structuring element by texture features of the image. And the size, shape and direction of structuring element must be considered roundly [3].

2.1 Structuring Elements, Hits & Fits

Fit: All on pixels in the structuring element cover on pixels in the image
Hit: Any on pixel in the structuring element covers an on pixel in the image
Structuring Element (Kernel)

- Structuring Elements can have varying sizes
- Usually, element values are 0,1 and none(!)
- Structural Elements have an origin
- For thinning, other values are possible
- Empty spots in the Structuring Elements are don't care's!

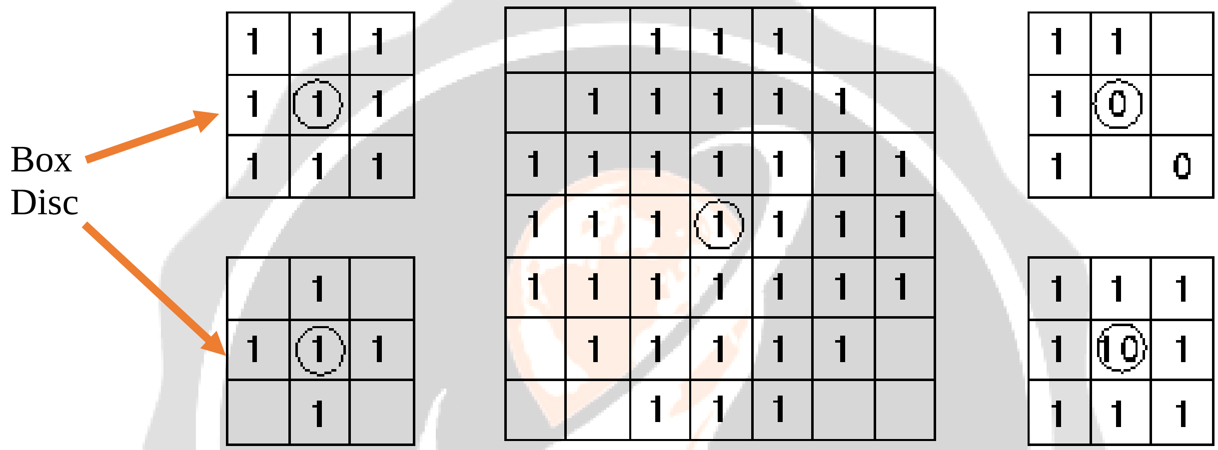


Fig -1: Structuring Element

2.2 Mathematical Morphology (MM)

A. Dilation: enlarges foreground, shrinks background.
B. Erosion: shrinks foreground, enlarges background.

A. Dilation

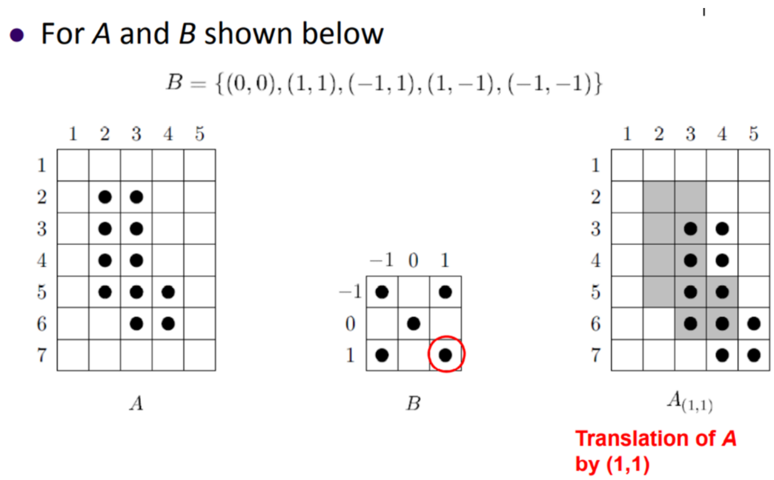
Dilation of image f by structuring element s is given by $f \oplus s$
The structuring element s is positioned with its origin at (x, y) and the new pixel value is determined using the rule:

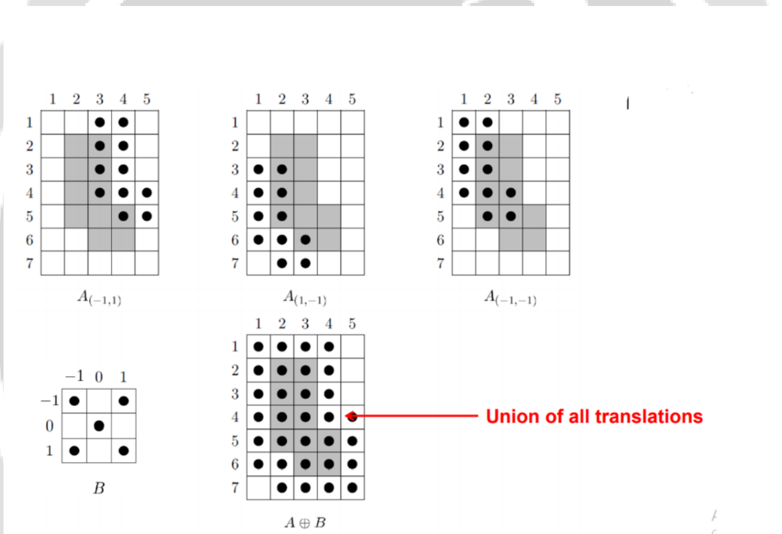
$$g(x,y) = \begin{cases} 1 \text{ if } s \text{ hits } f \\ 0 \text{ otherwise} \end{cases}$$

Dilation is the set of all points in the image, where the structuring element "touches" the foreground.

- Consider each pixel in the input image
- If the structuring element touches the foreground image, write a "1" at the origin of the structuring element!

Example of Dilation





B. Erosion

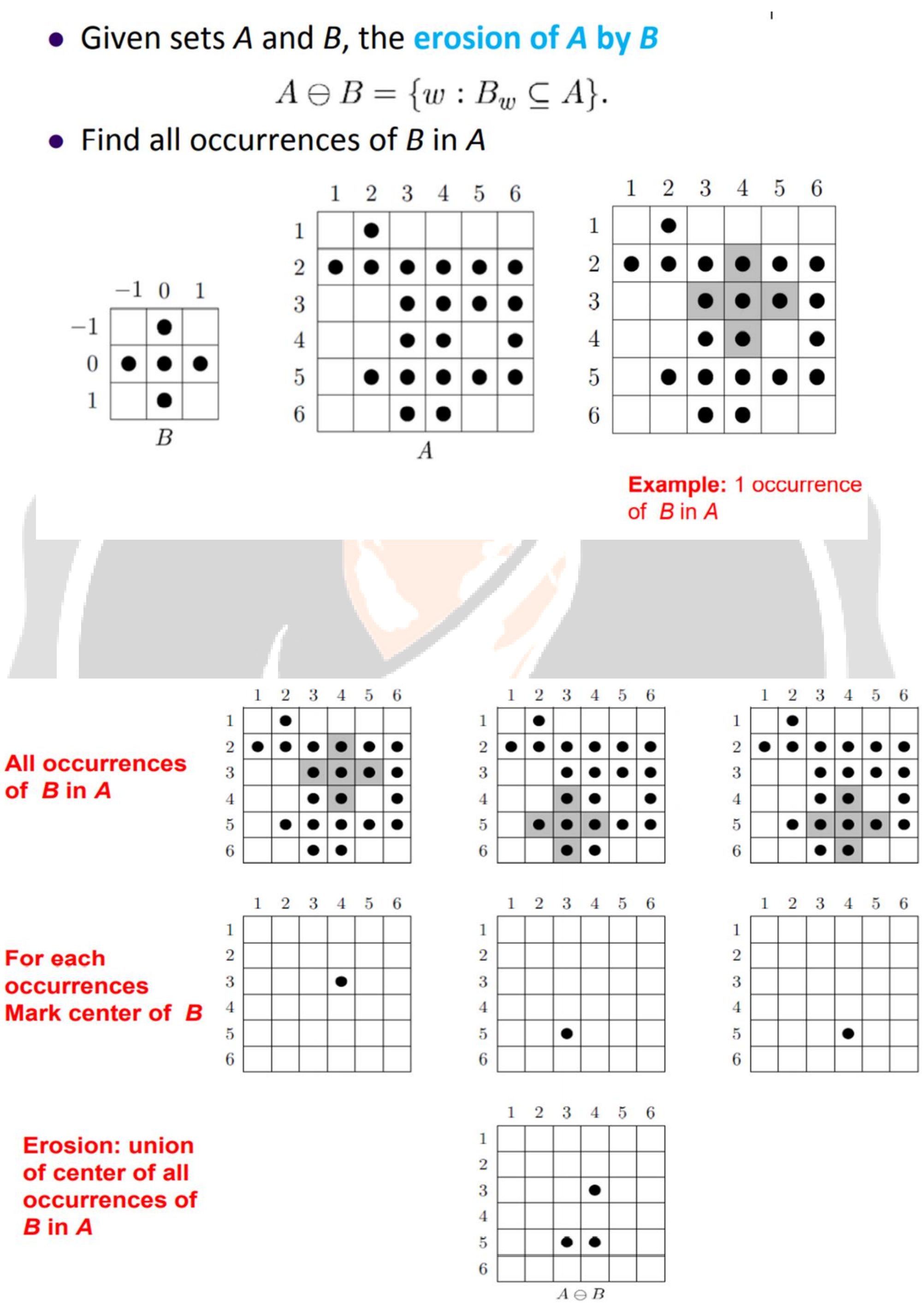
Erosion of image f by structuring element s is given by f ⊖ s
The structuring element s is positioned with its origin at (x, y) and the new pixel value is determined using the rule:

$$g(x,y)=\begin{cases}1 \text{ if } s \text{ fits } f\\ 0 \text{ otherwise}\end{cases}$$

Erosion is the set of all points in the image, where the structuring element "fits into".

- Consider each foreground pixel in the input image
- If the structuring element fits in, write a "1" at the origin of the structuring element!
- Simple application of pattern matching

Example of Erosion



3. Composite relations:

A. Closing and Opening

B. Hit-and-miss Transform

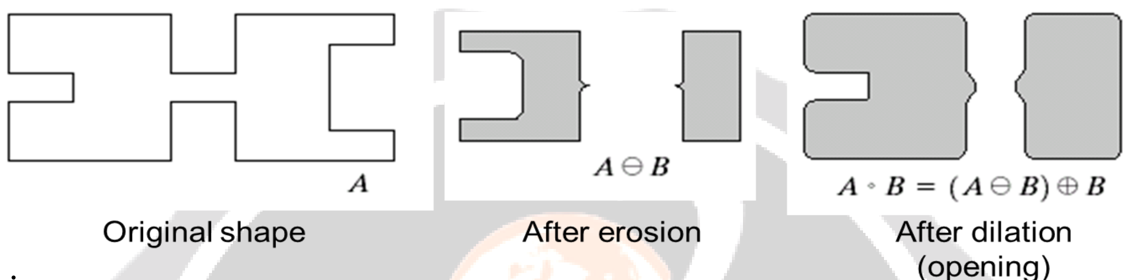
3.1 Opening & Closing

- Important operation
- Derived from the fundamental operations
  - Dilation
  - Erosion
- Usually applied to binary images, but gray value images are also possible.
- Opening and closing are dual operations.

A. Opening

The opening of image f by structuring element s, denoted f ○ s is simply an erosion followed by a dilation.

$$f \bigcirc s = (f \ominus s) \oplus s$$

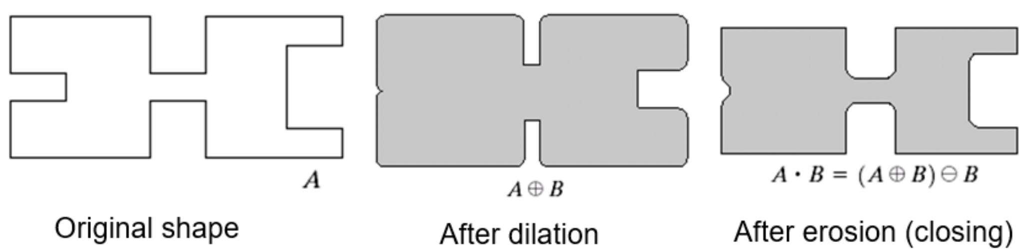


B. Closing

Removal of holes and Tends to enlarge regions, shrink background

The closing of image f by structuring element s, denoted f • s is simply a dilation followed by an erosion

$$f \bullet s = (f \oplus s) \ominus s$$



3.2 Hit and Miss

The hit-or-miss transformation may be defined as morphological operator, which is used for making one-pixel thick image from two or more-pixel thick image. A small odd size mask typically, 3 × 3 , can be scanned over a b inary image. The hit-and-miss transformation operates as a binary matching between the image and the structuring element. If the foreground and background pixels in the structuring element exactly match the foreground and background pixels in the image, then the pixel underneath the origin of the structuring element is set to the foreground color. If it does not, that pixel is set to background color. The Hit-or-Miss transform may also be expressed in terms of erosion as:

$$A\ B = (A\ \Theta\ B1) \cap (Ac\ \Theta\ B2) \ldots (2.3)$$

In this process, at first we make the Erosion Operation on the image A with the structure element B1. Then calculate the complement of image A. Then, again we make the Erosion Operation on the image which is the complement of A with the structure element B2. At last we make the Intersection Operation between the two eroted image and we find the result of the Hit-or Miss Transformation [5].

4. Edge Detection

4.1 Edge

is a part of an image that contains significant variation. The edges provide importantvisual information since they correspond to major physical, photometrical or geometricalvariations in scene object. Physical edges are produced by variation in the reflectance, illumination, orientation, and depth of scene surfaces. Since image intensity is oftenproportional to scene radiance, physical edges are represented by changes in the intensity function of an image.

The most common edge types are steps, lines and junctions. The step edges are mainly produced by a physical edge, an object hiding another or a shadow on a surface. It generally occurs between two regions having almost constant, but different, grey levels. The step edges are the points at which the grey level discontinuity occurs, and localized at the inflection points. They can be detected by using the gradient of intensity function of the image. Step edges are localized as positive maxima or negative minima of the first-order derivative or as zero-crossings of the second-order derivative (Figure 3). It is more realistic to consider a step edge as a combination of several inflection points. The most commonly used edge model is the double step edge. There are two types of double edges: the pulse and the staircase (Figure 4) [6].

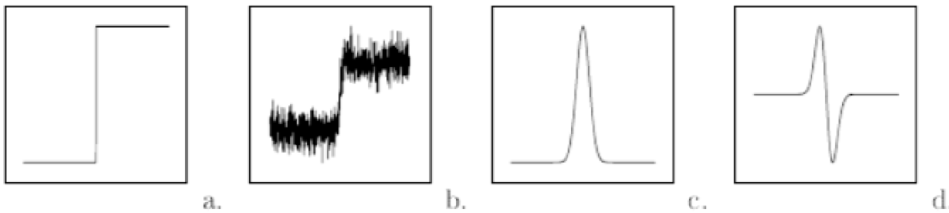


Fig 3 - profile of (a) ideal step edge (b) smoothed step edge corrupted by noise (d) first order derivative (d) second-order derivative of the smoothed step edge corrupted by noise

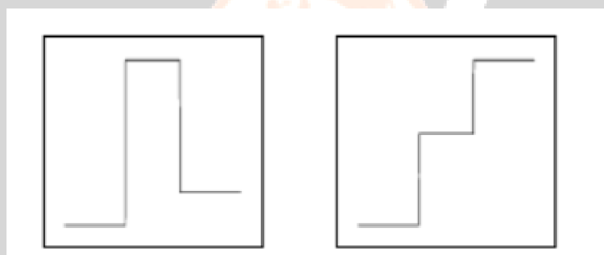


Fig 4 - profile of pulse (left) and staircase (right) step edges

4.2 Edge Detection Methods [6]:

1. Classical Methods
2. Gaussian Based Methods
3. Multi-Resolution Methods
4. Nonlinear Methods
5. Wavelet Based Methods
6. Statistical Methods
7. Machine Learning Based Methods
8. Contextual Methods

5. Proposed System

- The steps of proposed Edge Detection:
    1. Dilate input image.
    2. Subtract input image from dilated image.
    3. Edges remain.
- The main interface of program have five radio putton (**Erosion, Dilation, Closing, Opening and Edge Detection**) shown in figure below:

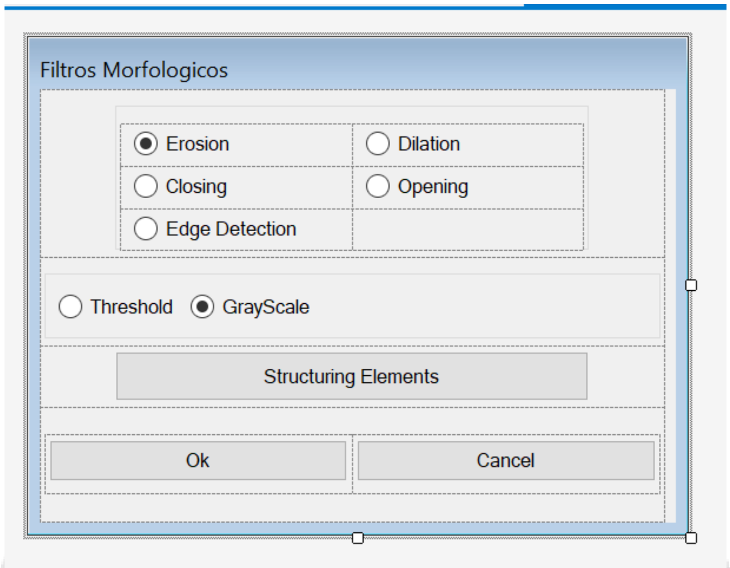
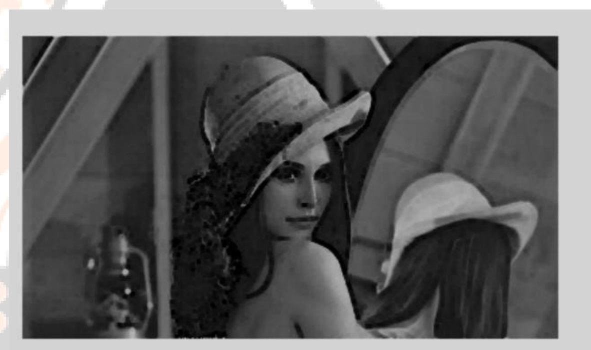


Fig 5: The main interface

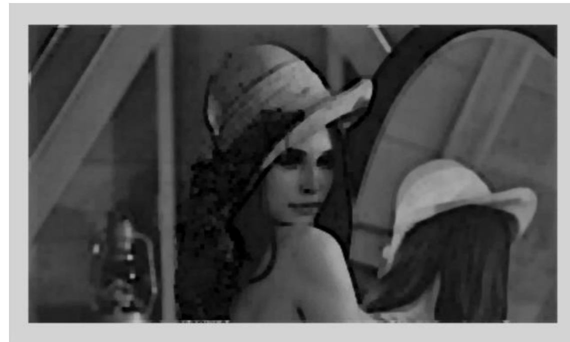
Original Picture



Dilation

Erosion

Opening



Closing

Edge Detection – Grayscale

Edge Detection - Threshold

6. REFERENCES

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