Feature extraction using Morphological Operations on finger print images

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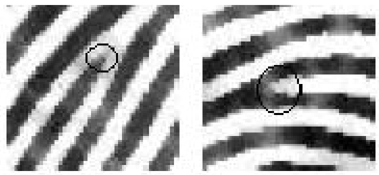
ABSTRACT:
In the world of 6 billion people, biometric system has become indispensable to certain the genuine person. Various methods have been implemented for inducting effective and efficient results. The main emphasis of this paper is on the mathematical morphology developed by J. Serra and G. Matheron. It is a set theory approach to digital image processing based on finger prints. This research paper aims to find the right configuration of morphology tools to obtain accurate results in many images. Our findings in this paper explain that how repeated results obtained from multi images of same object extracts the results of desired accuracy.
KEY WORDS: minutiae, Feature Extraction, minimally connected, skeletonization, parasitic

Introduction:

While point and neighborhood operations are generally designed to alter the look or appearance of an image for visual considerations, morphological operations are used to understand the structure or form of an image. This usually means identifying objects or boundaries within an image. Morphological operations play a key role in applications such as machine vision and automatic object detection.

In an increasingly digital technology world, among the main innovation prospects and framework of future services like authentication that's why the use of biometric based technology get developed. This is new and emerging technology due its high degree of maturity and reliability. Biometric system having two important utility 1) authentication or verification and 2) Identification in which person's identity is verify by biometric sign (fingerprint, face, Pam, iris etc.). In a recently published World Biometric Market Outlook (2005-2008), analysts predict that while the average annual growth rate of the global biometric market is more than 28%, by 2007. The technologies

That would be included are fingerprint technology by 60%, facial & iris by 13%, keystroke by 0.5% and digital signature scans by 2.5% . Fingerprint technology for recognizing fingerprints for identification purposes is proving as regards as reliable but efficient recognition is depending on the quality and the reliability of feature extraction of input fingerprint image. The fingerprint recognition system is basically divided into image acquisition, pre-processing, feature extraction, matching and decision. The reliable feature extraction stage is of great significance as it influences the performance of subsequent recognition algorithm therefore it is an essential step to obtain precise minutiae. Minutiae are local discontinuities in the fingerprint pattern. TheMost important ones are ridge ending and ridge bifurcation illustrated in figure 1.



(a) Ridge ending (b) Ridge bifurcation

Figure 1: Example of minutiae

2. BACKGROUND

The feature extraction stage is concerned with the finding and measuring important similarities of the fingerprint that will be used to match it. And matching is the final goal of recognition system to Find the identity of the persons whose input fingerprint has been submitted i.e. it compares the extracted features or similarities from two fingerprints and determine the possibility that they have been captured from the same finger.

Most of fingerprint recognition system is based on minutiae i.e. ridge ending and ridge bifurcation. Reliable minutiae extraction plays imperative role in recognition system Performance. There are two main approaches used to minutiae extraction. The first approach uses a thinned representation of the binary ridge structure, known as its skeleton. The second approach attempts to extract the minutiae locations from the grey-scale image itself. In view of that, there have been several approaches proposed for features not based on minutiae the cyclic structure of local fingerprint regions, shape signatures of fingerprint ridges and directional micro pattern histograms have been proposed as alternative fingerprint features.

Wavelets, texture features and Gabor filters have also been investigated as tools for feature extraction. Furthermore, experiments based on image verification and optical processing techniques have also been conducted. The most popular method for minutiae extraction is to use a binarized and skeletonised Representation of the fingerprint. The task is to extract the minutiae from the thinned ridge map; Any black pixel that has only one black neighbor is a ridge ending similarly any black pixel with more than two black pixel neighbor is ridge bifurcation as shown in figure 2.

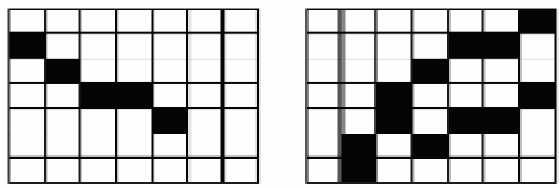


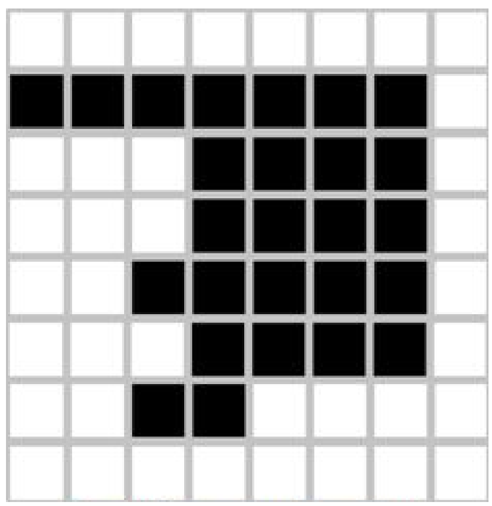
Figure 2: ridge ending and ridge bifurcation in a thinned ridge map

There are three primary morphological functions: **erosion, dilation,** and **hit-or-miss.** Others are special cases of these primary operations or are cascaded applications of them. Morphological operations are usually performed on binary images where the pixel values are either 0 or 1. For simplicity, we will refer to pixels as 0 or 1, and will show a value of zero as black and a value of 1 as white. While most morphological operations focus on binary images, some also can be applied to grayscale images.

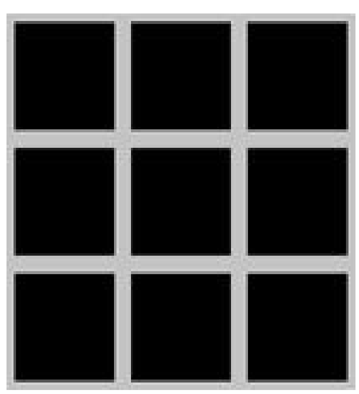
It is important to introduce the concepts of **segmentation and connectivity**. Consider a binary image where the predominant field of white pixels is divided (or segmented) into two parts by a black line. In this image there are three segments: the top group of white pixels, the bottom group of white pixels, and the group of black pixels that form the dividing line. Another three segment image would be one an outer border of white pixels, the black pixels that form square, and a group of white pixels within the square. We see that all pixels of a segment are directly adjacent to at least one other pixel of the same classification, they are all connected.

Most morphological functions operate on 3 x 3 pixel neighborhoods. The pixels in a neighborhood are identified in one of two ways - sometimes interchangeably. The pixel of interest lies at the center of the neighborhood and is labeled X. The surrounding pixels are referred to as either X_0 through X_7, or by their compass coordinates E, NE, N, NW, W, SW, S, and SE. A pixel is four-connected if at least one of its neighbors in positions X_0, X_2, X_4, or X_6 (E, N, W, or S) is the same value. The pixel is eight-connected if all neighbors are the same value. Under eight-connectivity, a set of pixels is said to be minimally connected if the loss of a single pixel causes the remaining pixels to lose connectivity.

- Mathematical Morphological operations are used to extract image components that are useful in the representation and description of region shape, such as
- boundaries extraction
- skeletons
- convex hull
- morphological filtering
- thinning
- pruning
- **Dilation, Erosion**
- For the next operations we consider a specific example. Suppose we have the following binary image and a structural element:



Source Image(B)



Structure Element(S)

Dilation

- Structural element of S is applied to all pixels of binary image. Every time the origin of the structural element is combined with a single binary pixel, the entire structural element is wrapped and subsequent alteration of the corresponding pixels of binary image. The results of logical addition is written into the output binary image, which was originally initialized to zero.

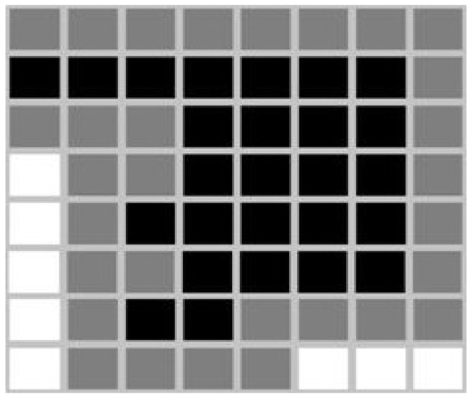


Image (B) expansion using structure element S

Erosion

When using erosion structural element also passes through all pixels of the image. If at a certain position every single pixel structuring element coincides with a single pixel binary image, then the logical disjunction of the central pixel structuring element with the corresponding pixel in the output image.

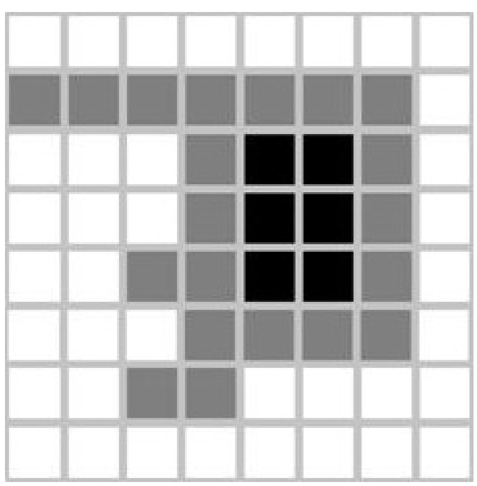


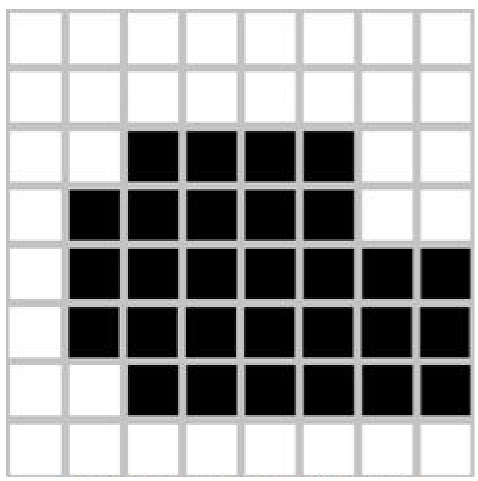
Image (B) erosion using structure element S

As a result of applying the erosion of all the objects smaller than the structural element will be erased, objects, connected by thin lines are disconnected and the sizes of all objects are reduced.

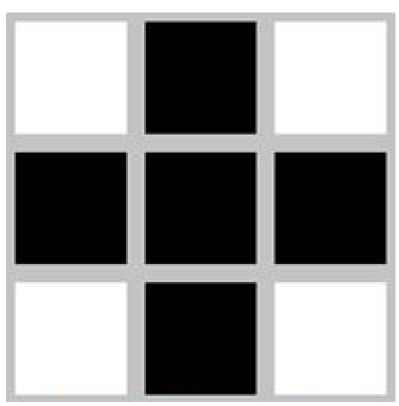
Boundaries extraction:

Morphological operations can also be used to distinguish the boundaries of binary object. This operation is very important, because the border is complete, and at the same time very compact description of the object.

It is easy to see that the boundary points have at least one background pixel in its neighborhood. Thus, applying the operator of erosion with a structural element that contains all possible neighboring elements, we will remove all the boundary points. Then the boundary obtained by the operation of the difference between the sets of the original image and obtained as a result of erosion.



Source Image



Structure Element

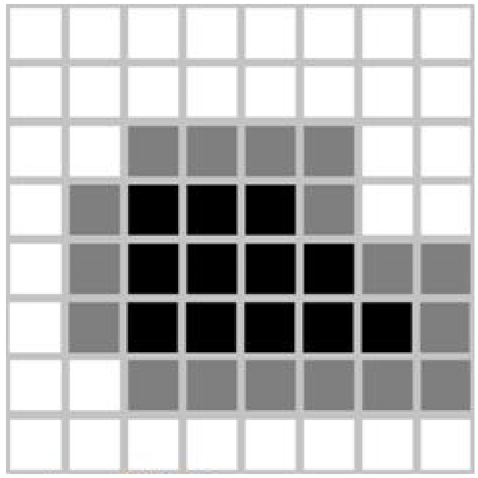
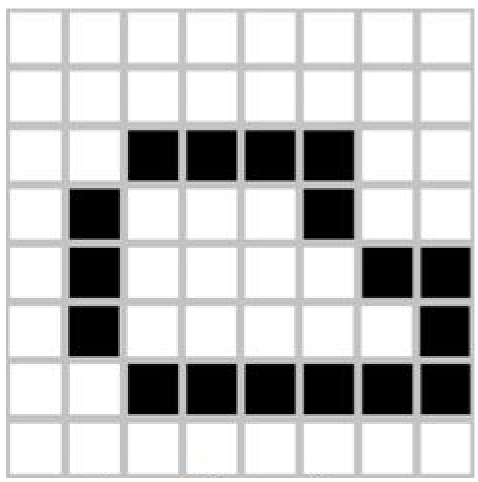


Image after erosion



Final Result

Thus, we are considered the basic operations of mathematical morphology, and several methods of their application. Hopefully, this material become useful to you in future endeavors.

Skeletons

The aim of the skeletonization is to extract a region-based shape feature representing the general form of an object.

Region filling:

After extracting boundary of images regions has to be identified for medical purposes.then to focus on particular area like tumors regions has to be filled to highlight that particular area.

$$X_k = (X_{k-1} \oplus B) \cap A^c \quad k = 1,2,3,...$$

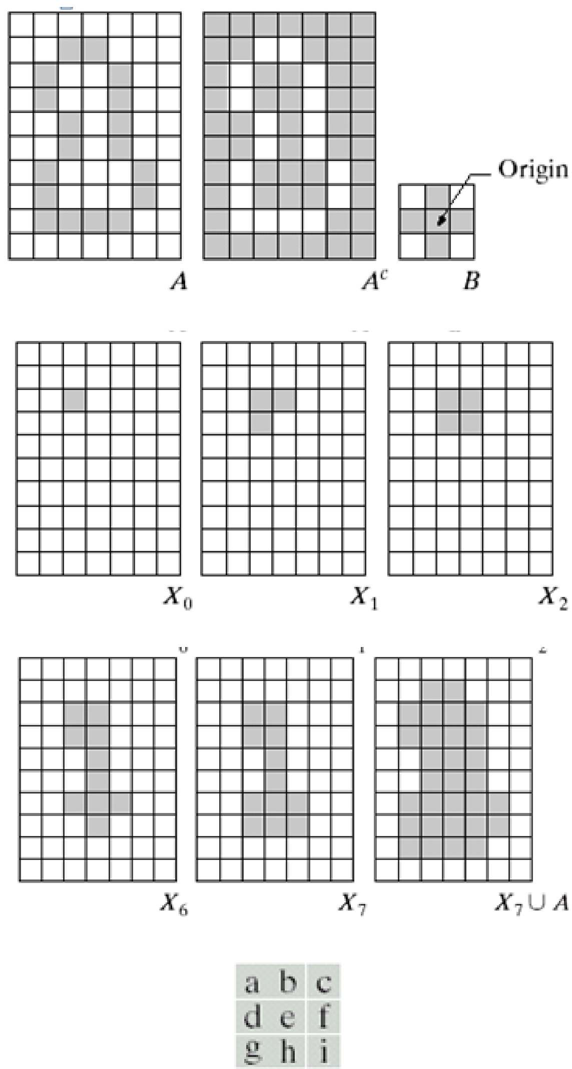
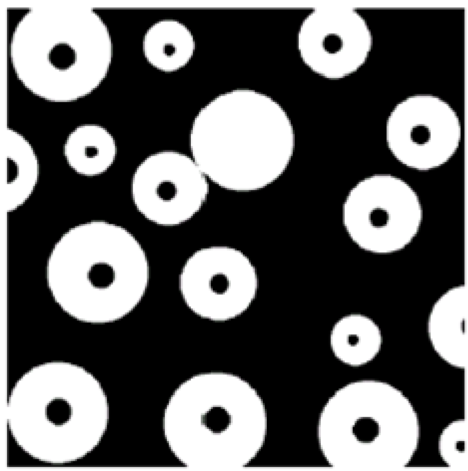


Figure3: Region Filling

(a) Set A (b)Complement of A(c) Structuring Element of B(d)Initial point inside the Boundry(e)-(h) Various Steps(i)Final Result union of (a) and (h)s

Example: (a)



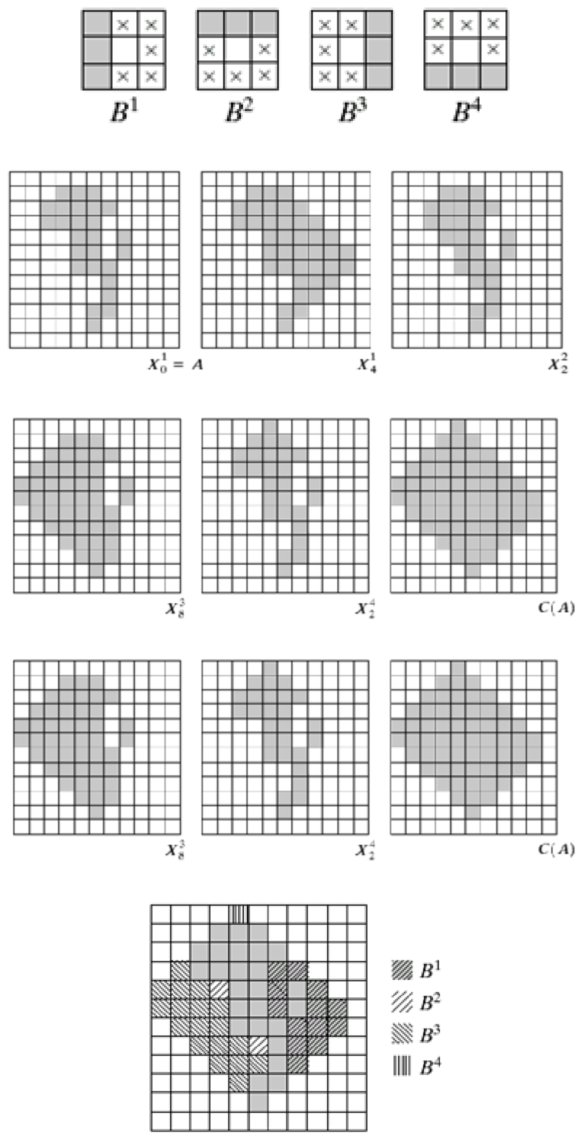
(b)

(c)

Figure4: (a) Binary image(the white dot inside one of the regions is the starting point for the region-filling algorithm) (b) Result of filling that region (c) result of filling all regions.

Convex hull:

- **A set A is said to be convex if the straight line segment joining any two points in A lies entirely within A.**



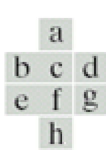


Figure5: (a) Structuring Elements(b)Set A (c)-(f) Results of convergence with the structuring elements shown in (a). (g)Convex Hull (h) Convex Hull showing the contribution of each structuring Element

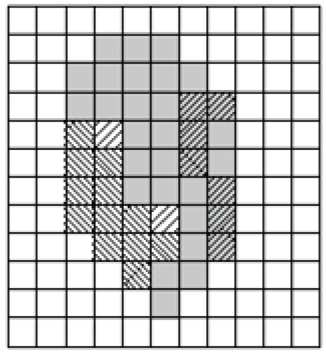
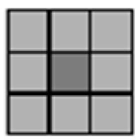
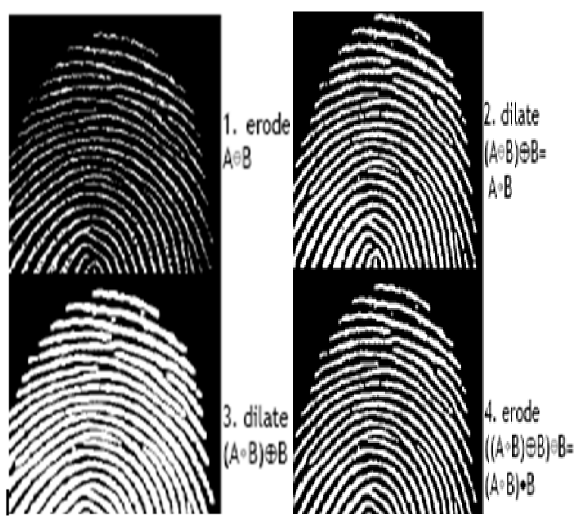


Figure6:Result of limiting growth of convex hull algorithm to the maximum dimensions of the **original set of** points along the vertical and horizontal directions

Morphological Filtering:-



Structure Element **Source Image**



Thinning:

The thinning function is similar to shrinking, except that thinning generates a minimally connected line that is equidistant from the boundaries. Some of the structure of the object is maintained. Thinning also is useful when the binary sense of the image is reversed, creating black objects on a white background. If the thinning function is used on this revered image, the results, are minimally connected lines that form equidistant boundaries between the objects.

After binarization we have done the skeleton of binary image by using morphological thinning operation.

(a)

(b)

(c)

Figure **7:** a) Original Image b) Binary Image c) Thinned Image

Pruning:

The **pruning** algorithm is a technique used in digital image processing based on mathematical morphology. It is used as a complement to the skeleton and thinning algorithms to remove unwanted parasitic components. In this case 'parasitic' components refer to branches of a line which are not key to the overall shape of the line and should be removed. These components can often be created by edge detection algorithms or digitization.

The standard pruning algorithm will remove all branches shorter than a given number of points. The algorithm starts at the end points and recursively removes a given number (n) of points from each branch. After this step it will apply dilatation on the new end points with a (2N+1) (2N+1) structuring element of 1's and will intersect the result with the original image. If a parasitic branch is shorter than four points and we run the algorithm with n = 4 the branch will be removed. The second step ensures that the main trunks of each line are not shortened by the procedure.

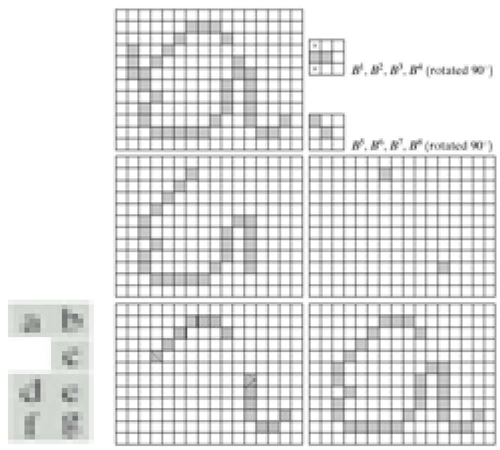


Figure 8: (a) Original image (b)and (c) Structuring elements used for deleting and points (d)Result of three cycles of thinning (e) End points of (d), (f) Dilation of end points conditioned on (a), (g) Pruned image.

Conclusion: The exact features of the finger prints and other images of the objects can be extracted with Morphological operations that include Erosion, dilation, boundary Extraction, skeletons, convex hull, morphological filtering, Thinning, pruning operations.

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