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New Method on 4*4 Mask Skeletonization using Finger Points Extraction and Verification

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Abstract: ***The goal of this research is to develop a complete system for fingerprint verification through extracting and matching finger points. To achieve good finger point's extraction in fingerprints with varying quality, pre-processing in form of binarization and 4×4 Mask skeletonization is first applied on fingerprints before they are evaluated by the neural network.***

I. INTRODUCTION

Authentication and security become much popular because of the arrival of new upcoming technologies like electronic banking, e-commerce, and smartcards and an increased emphasis on the privacy and security of information stored in various databases. Biometric recognition is one of the most important techniques for the security privacy due to its distinctive nature of biometric traits such as fingerprints, iris, faces, palm, etc.

II. REVIEW OF LITERATURE

The fingerprint of an individual is unique and remains unchanged over a lifetime. No two persons have the same set of fingerprints. This property makes fingerprints an excellent biometric identifier. A fingerprint is formed from an impression of the pattern of ridges on a finger. A ridge is defined as a single curved segment and a valley is the region between two adjacent ridges. Typically, there are two prominent types of finger points (ridge ending and ridge bifurcation) that constitute a fingerprint pattern. Finally this research reviews the literature of fingerprint recognition, extraction and verification using neural networks.

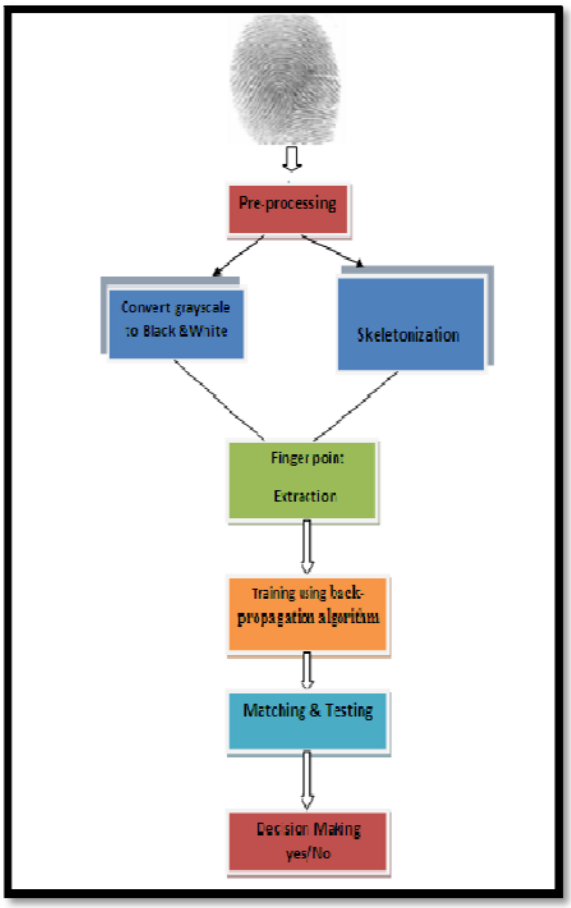
III. RESEARCH METHODOLOGY

Research methodology is a systematic way to solve a problem. It is a science of studying how research is to be carried out. Essentially, the procedures by which researchers go about their work of describing, explaining and predicting phenomena are called research methodology. Its aim is to give the work plan of research.

- ✓ Pre-Processing
- ✓ Finger point Extraction
- ✓ Training using BP
- ✓ Matching & Testing Finger point
- ✓ Decision Making

The first step is removing noise from the image may be corrupted during the fingerprint image capture, convert gray-scale to black and white image, after that skeletonization on an image.

The second step extract finger point and determine the direction of the finger point then the features stored in a database as a template. In the last step the extracted feature, fed forward back propagation neural network and training the neural network, the adjusted weight is used to identify finger print image.



RESEARCH METHODOLOGY

Pre-Processing

Image processing for fingerprint image can be considered as a classical approach and this approach has an advantage of extracting many types of minutiae from a fingerprint image. With the use of certain image processing techniques, the number of extracted minutiae for ridge ending and bifurcation, distances between bifurcation minutiae and the boundary of detected minutiae image are then used for fingerprint identification. Generally, the image pre-processing steps consist of image resizing, enhancement, binarization, filtering, and thinning process.

Image Binarization

A binary image is a digital image that has only two possible values for each pixel. The values in the two-dimensional (2D) image is converted into 0's and 1's values. The binary images are also called as bi-level or two-level image. In this research, the bitmap fingerprint image is converted into a binary image before applying for image filtering and this conversion is called as image binarization. The objective of this conversion is to minimize the computation time during filtering, thinning and extraction of the image. Binary images often arise in a digital image processing as masks or as the result of certain operations such as segmentation, threshold, and dithering.

Image Skeletonization

Skeletonization is a process mostly used on binarized images by thinning a certain pattern shape until it is represented by 1-pixel wide lines, the so called skeleton of that pattern. The skeletonization algorithm while deleting unwanted edge points should not:

- Remove end points.
- Break connectedness.
- Cause excessive erosion of the region.

Finger Point Extractions

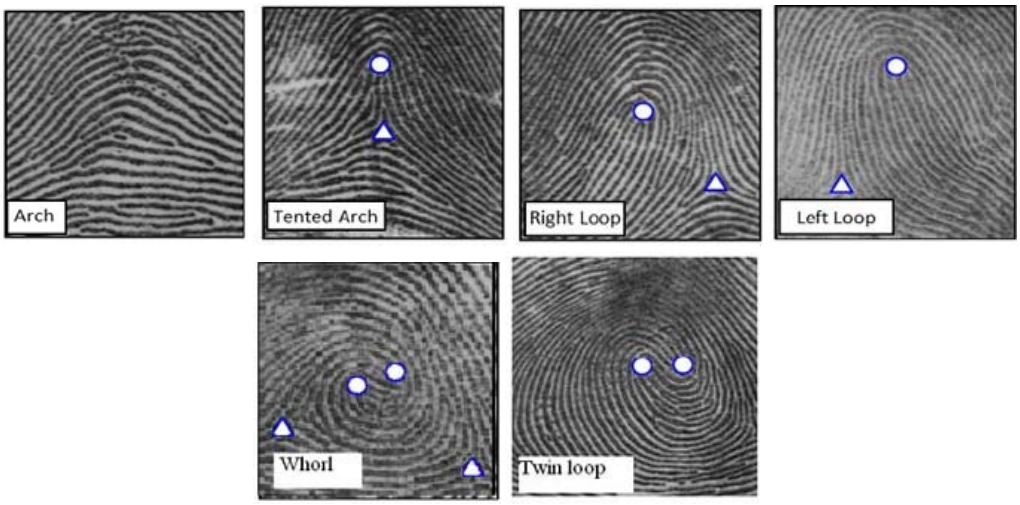
An accurate representation of the fingerprint image is critical to automatic fingerprint identification systems, because most deployed commercial large -scale systems are dependent on feature-based matching (correlation based techniques have problems as discussed in the previous section). A fingerprint is a unique pattern of ridges and valleys on the surface of a finger of an individual. A ridge is defined as a single curved segment, and a valley is the region between two adjacent ridges. Finger points are the local ridge discontinuities, which are of two types: ridge endings and bifurcations. A good quality image has around 40 to 100 minutiae. It is these minutiae points which are used for determining uniqueness of a fingerprint.

It is a process through which certain vital information and details of an image section is captured for subsequent interpretation. A feature extractor finds the core point and delta point from the input provided by pre-processing.

1. Orientation field estimation,

2. Ridge extraction, and

3.Singular point extraction and post processing



Training Using Back Propagation

The basic principle of the algorithm is to use the output error to estimate the output layer's direct leading layer's error, and then use this error to estimate the previous layer, layer by layer, and we get all the other layers error estimates. BP neural network is one of the most widely used neural network model. When the actual output is inconsistent with the given input, the gradient descent algorithm can be used to fix the old bond strength between layers, until it satisfies the given input-output relationship. The network is self-organization's neural network toward meeting a given input-output relationship. BP network consists of input layer, hidden layer and output layer, and adjacent layers are connected with neure, layer neurons with no connections.

Matching and Testing

A neural network is a computational structure inspired by the study of biological neural processing. There are many different types of neural networks, from relatively simple to very complex, just as there are many theories on how biological neural processing works. A layered feed-forward neural network has layers, or subgroups of processing elements. A layer of processing elements makes independent computations on data that it receives and passes the results to another layer. The next layer may in turn make its independent computations and pass on the results to yet another layer.

Finally, a subgroup of one or more processing elements determines the output from the network. Each processing element makes its computation based upon a weighted sum of its inputs. The first layer is the input layer and the last the output layer. The layers that are placed between the first and the last layers are the hidden layers.

The processing elements are seen as units that are similar to the neurons in a human brain, and hence, they are referred to as cells, neuromimes, or artificial neurons. A threshold function is sometimes used to qualify the output of a neuron in the output layer. Synapses between neurons are referred to as connections, which are represented by edges of a directed graph in which the nodes are the artificial neurons. Nets consist of small units called cells, and these are connected to each other in such a way that they can pass signals to each other . The weights used on the connections between different layers have much significance in the working of the neural network and the characterization of a network

1. Start with one set of weights and run the network. (No Training)

2. Start with one set of weights, run the network, and modify some or all the weights, and run the network again with the new set of weights. Repeat this process until some predetermined goal is met. (Training).The connections have certain strengths or weights. The network is exposed to various inputs and the strengths adjust them according to some mathematical plan. This is what we call training and after it, the network can recognize input patterns or, at least, do something sensible whatever it has been trained to do. The information is therefore stored in the strengths of the connections, just as it is in the human brain.

IV. SAMPLE DATA

(a) (b)

Peel Skin Images

(a) (b)

Small Thumb Images

(a) (b)

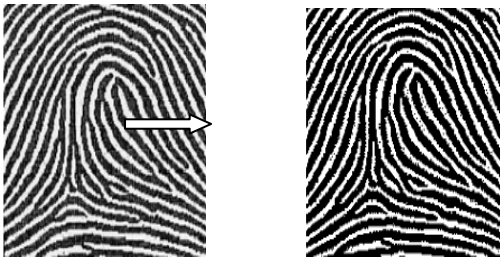
Scars Images

IMAGE BINARIZATION

A binary image is a digital image that has only two possible values for each pixel. The values in the two-dimensional (2D) image is converted into 0's and 1's values. The binary images are also called as bi-level or two-level image. In this research, the bitmap fingerprint image is converted into a binary image before applying for image filtering and this conversion is

called as image binarization. The objective of this conversion is to minimize the computation time during filtering, skeletonization and extraction of the image. Binary images often arise in a digital image processing as masks or as the result of certain operations such as segmentation, thresholding, and dithering.In this research, a dithering method is used for fingerprint image binarization. The dithering function is also used to increase the apparent color resolution of image.

The noises in the fingerprint image are indirectly increased after the image applied for binarization method.



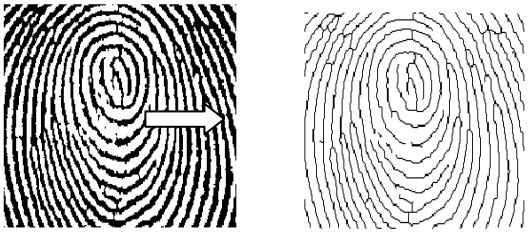
(a)original (b) Binarized

The difference between binarization and non-binarization.

IMAGE SKELETONIZATION

Skeletonization is a morphological approach that is used to remove selected foreground pixels from binary images to a skeletal remnant that largely preserves the extent and connectivity of the original region while throwing away most of the original foreground pixels.Skeletonization process is a very important factor in order to recognize characters, figures, and drawings.

Skeletonization methods are classified into two categories which are pixel based and non pixel based methods. The pixel based Skeletonization algorithm is used in this research. The function of pixel based Skeletonization algorithm is to exclude an outline-pixel from a boundary of object until slim lines with one-pixel width remains. It is also used to find the centerline of the object. The pixel-based algorithm is also classified into two categories which is called as sequential and parallel Skeletonization algorithm. In character recognition, parallel Skeletonization algorithm plays a very important rule. In this research work, a modified parallel Skeletonization algorithm is proposed. Instead of using 3 x 3 mask skeletonization this research proposed a 4 x 4 Mask skeletonization algorithm to reduce the computation time. In this process, the image is repeatedly applied for skeletonization until the boundaries of the object with slim lines is of one pixel width. Skeletonized image is shown in the figure



(a)Binarized (b) Skeletonized

The conversion of binarization to skeletonizatio.

V. THE 4X4 MASK SKALETONIZATION ALGORITHM

A	B	C	D
L	P1	P2	E
K	P4	P3	F
J	I	H	G

a	b	C	d
l	P1	P2	e
k	P4	P3	f
j	i	H	g

a	b	c	d
l	P1	P2	E
k	P4	P3	F
j	i	h	G

a	b	C	d
l	P1	P2	e
k	P4	P3	f
j	i	H	g

Figure Representation of P1, P2, P3 and P4 in 4x4 Mask. Let P1 represent the pixel for the location (2, 2) in the 4x4 mask, P2 represent the pixel for the location (2, 3) in the 4x4 mask, P3 represent the pixel for the location (3, 3) in the 4x4 mask, P4 represent the pixel for the location (3,2) in the 4x4 mask and alphabets a, b, c,…, l represent the neighborhood pixels for P1, P2, P3, and P4.Each of the P1, P2, P3, and P4 has eight neighbor pixels. P1's neighbor is a, b, c, P2, P3, P4, k, and l. P2 has b, c, d, e, f, P3, P4, and P1 as neighbor. P1, P2, e, f, g, h, i, and P4 are P3's neighbor and P4 has l, P1, P2, P3, h, I, j, and k as neighbors. The P1and it's neighbor is represented as top and left section (TL), P2 and it's neighbor is represented as top and right section (TR), P3 and it's neighbor is represented as bottom and right section (BR) and P4 and it's neighbor is represented as bottom and left section (BL) .

4x4 Mask Algorithm

The algorithm of 4x4 mask are the combination of four 3x3 mask skeletonization algorithm.

Step 1:read filtered image

Step 2:for z and y <= to size of the image

Step 3: assign P1 and it's neighbor to the variable of top left (TL)

Step 4: assign P2 and it's neighbor to the variable of top right (TR)

Step 5:assign P3 and it's neighbor to the variable of bottom right (BR)

Step 6: assign P4 and it's neighbor to the variable of bottom left (BL)

Step 7:apply TL to the A(Pi) and B(Pi) detection

Step 8 : apply TL to the 1st iteration of

Step 9: apply TR to the A(Pi) and B(Pi) detection

Step 10: apply TR to the 1st iteration

Step 11:apply BR to the A(Pi) and B(Pi) detection

Step 12:apply BR to the 1st iteration

Step 13; apply BL to the A(Pi) and B(Pi) detection

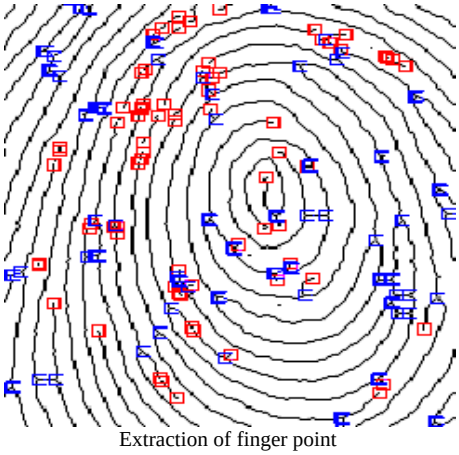
Step 14: apply BL to the 1st iteration

Step 15: repeat steps 2 until 13 with replace the rule 1st iteration with 2^{nd} iteration .

End

VI. FINGER POINT EXTRACTION

The binarized and skeletonized images are next considered for the finger point extraction. Extracting finger point from the skeleton of the fingerprint requires a method that is able to distinguish and categorize the different shapes and types of finger point. The finger points are detected by using 3x3 pattern masks. After a successful extraction of finger point, they are stored in a template, which may contain the finger point position (x,y), finger point direction (angle), finger point type and in some case the finger point quality may be considered. During the verification or identification, the extracted finger points are also stored in a template and are used as query template during the matching. Training of the neural network is conducted with the back-propagation algorithm.



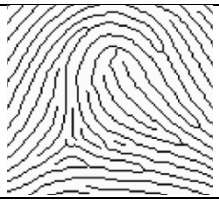
Extraction of finger point

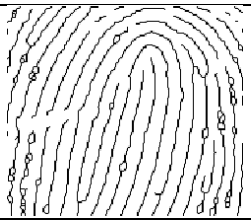
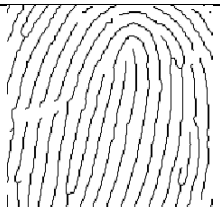
VII. FINGER POINT MATCHING

The collection of finger point received from above process is given as a input data set to neural network. Fixed target output based on average feature value of fingerprint image. After that train the network for each fingerprint image. Error is calculated from the distance between target and desired output value. The back-propagation algorithm is sensible approach to dividing the contribution of each weight. As in the network-training algorithm, it tries to minimize the error between each target output and the out-put actually computed by network. The size of the training vector sets was expanded from its initial position. The finger point positions used to make up the training and testing sets were randomly separated to test the generalization properties of these back propagation networks.

VIII. RESULT OF 4X4 MASK SKALETONIZATION ALGORITHM

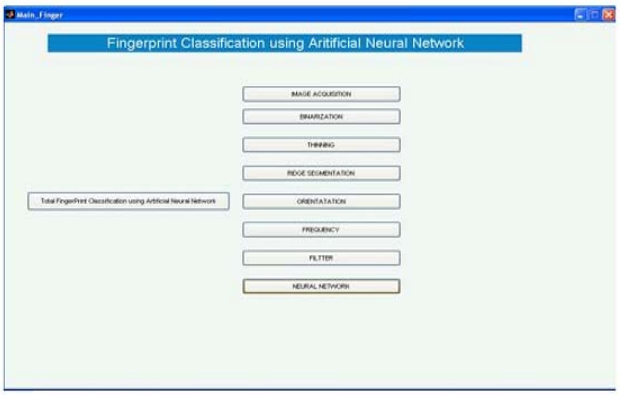
The binarized images are entered as a input for skeletonization. The main objective for developing the 4x4 mask thinning algorithm is to minimize the computation time. In theoretical, the more pixels selected in a mask and applied for thinning processes, the computation time and looping will be reduced. The computation time of the 3x3 mask skeletonization processes are smaller the compared to the computation time of the 4x4 mask skeletonization processes. This is because the 4x4 skeletonization processes are the combination of four times 3x3 skeletonization algorithm. However, the looping of the 4x4 skeletonization processes is less than 3x3 skeletonization processes. Comparison Results for 3x3 Mask and 4x4 Mask

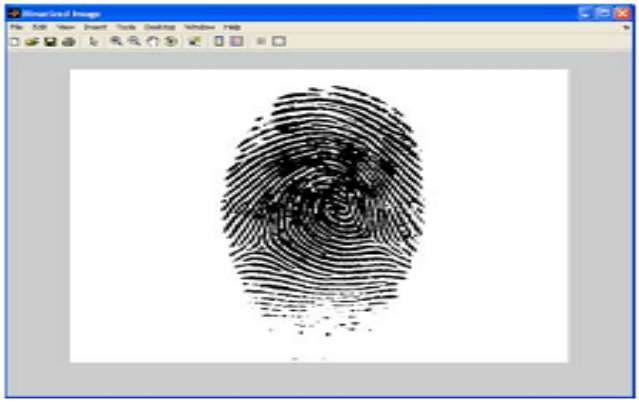
Comparison	**Skeletonization Method**	
	3x3 Mask	**4x4 Mask**
Image 1		
Looping Times	19	15
Computation Times	1.156	1.187
Image 2		
Looping Times	21	15

Computation time	0.688	0.843
Image 3		
Looping times	20	14
Computation time	0.756	0.647

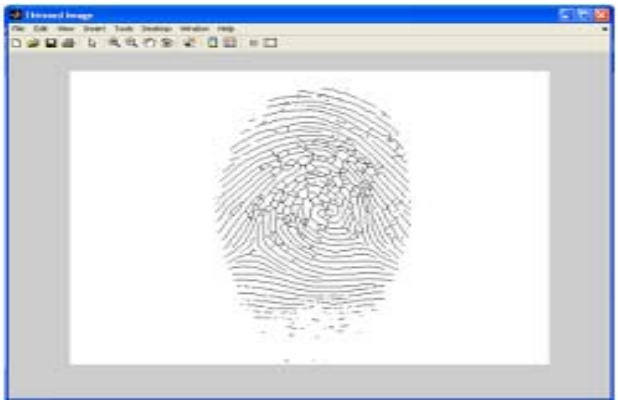
The proposed algorithm is tested with more than 15 images. The above table represent the few of them. In this result the (3×3) Mask computation time of image1 is 1.156. But it is reduced in the result of 4×4 Mask. Looping times also reduced in 4×4 Mask. The proposed algorithm reduced the computation time of images.

IX. GUI REPRESENTATION OF MAT LAB

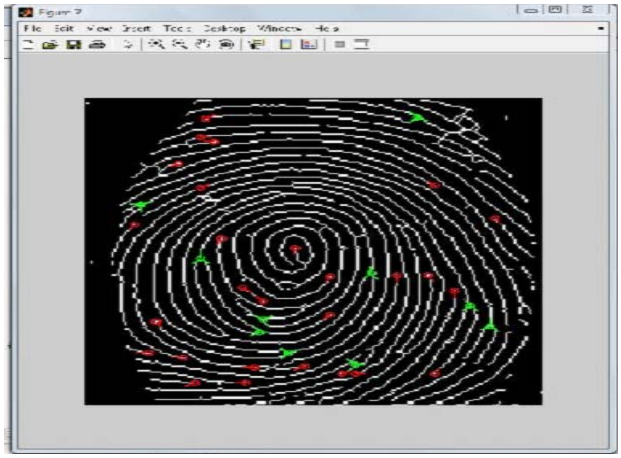




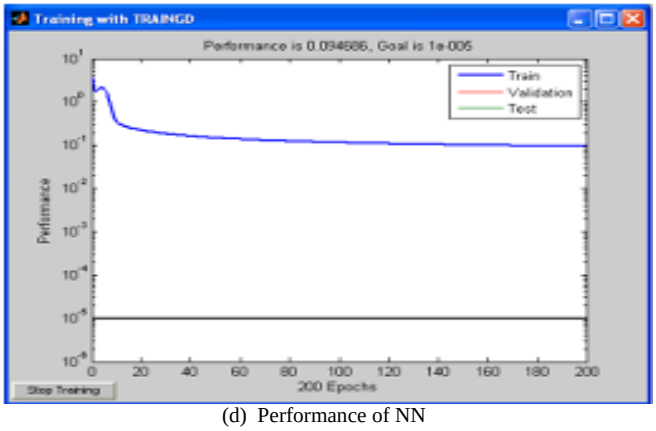
(a). Binarization



(b) Skeletonization using 4×4 Mask algorithm



(C) Finger point Extraction



(d) Performance of NN

(e) Result of Classification of finger type

X. Suggestion for Future Work

To implement the data collection in different situations and environments, especially in the conditions of very noisy, rainy, stormy, under air conditioning and outdoors.

To improve the back propagation system in order to train the collected data with less computation time. To minimize the computation time for back propagation neural network training time.

XI. Conclusion

The proposed method of skeletonization reduces the computation time and number of iteration, pre-processing improves the accuracy of images also. Extraction methods that are successfully applied for fingerprint images. A number of neural network models are reviewed and analyzed. In this research back-propagation N.N has been trained as a fingerprints classifier to identify fingerprints with time effective preprocessing, which greatly increases the performance of the network.

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8. Avinash Kumar Jha et al. (2010) Devise Neural Network based scheme for FR. The test result for same fingerprint show recognition quotient of 0.937 and less than 0.5 for different fingerprint.

AUTHOR(S) PROFILE

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