Fingerprint Recognition Using Genetic Algorithm and Neural Network

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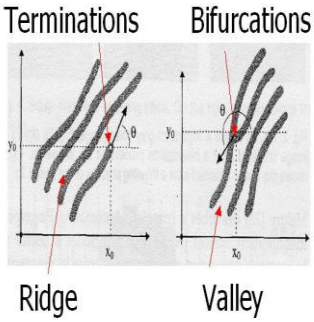
ABSTRACT:

Fingerprints are the most used biometric feature for the person identification. During research it has been observed that there are number of approaches has been implemented for recognition of fingerprints. Different algorithms and techniques have been used for enhancement purpose, minutiae extraction and for matching. In this thesis work a novel technique to enhance our results by using the combination of genetic algorithm and neural network. As we know that both techniques are the world's best techniques. Genetic algorithm is used for the extraction of minutiae and neural network is used for the recognition of a fingerprint. Firstly, fingerprint image has been enhanced using histogram equalization process so that our algorithm also capable of predicting good results even for dull or low intensity images too. Then Morphological Image Processing operations using MATLAB 2011b has applied for thinning the lines up to the predefined extent so that it will not further destroy or harm our structure of the image. After that we proceed towards predicting of discontinuities using Genetic Algorithm approach based upon nth last segment. Here genetic algorithm is used to find the best possibility for each discontinues segment in an image. Lastly Enhanced image has fed to NN (neural networks) based trained system to diagnose and match finger print with data set. Several features will be used to train the network so that precision will be made in recognition of finger print.

KEYWORDS: *Biometrics, fingerprints, minutiae enhancement, ridge endings, feature extraction, genetic algorithm, neural network*

I. INTRODUCTION

One of the topics of continuing interest in forensics is the automatic identification or verification of human users, where the applications are broad, including simple logins into computers, authorized access to systems, banking transactions and highly-secure infrastructure [1]. The most common biometric traits used by recognition applications are: fingerprints, retina, iris, hand geometry, face, veins, handwriting, voice, etc. Among all these fingerprints are today the most widely used biometric features for personal identification [2]. It has some features such as uniqueness, lifelong unchanged and inseparable with the body. As one of most reliable biometric identification technology, the fingerprint has been used for hundreds of years [3]. Most automatic systems for fingerprint comparison are based on minutiae matching [4]. Minutiae characteristics are local discontinuities in the fingerprint pattern which represent terminations and bifurcations. A ridge termination is defined as the point where a ridge ends abruptly. A ridge bifurcation is defined as the point where a ridge forks or diverges into branch ridges (Fig. I). Reliable automatic extracting of minutiae is a critical step in fingerprint classification. The ridge structures in fingerprint images are not always well defined, and therefore, an enhancement algorithm, which can improve the clarity of the ridge structures, is necessary. Skin on human fingertips contains ridges and valleys which together forms distinctive patterns. These patterns are fully developed under pregnancy and are permanent throughout whole lifetime. Prints of those patterns are called fingerprints. Injuries like cuts, burns and bruises can temporarily damage quality of fingerprints but when fully healed, patterns will be restored. Through various studies it has been observed that no two persons have the same fingerprints, hence they are unique for every individual.

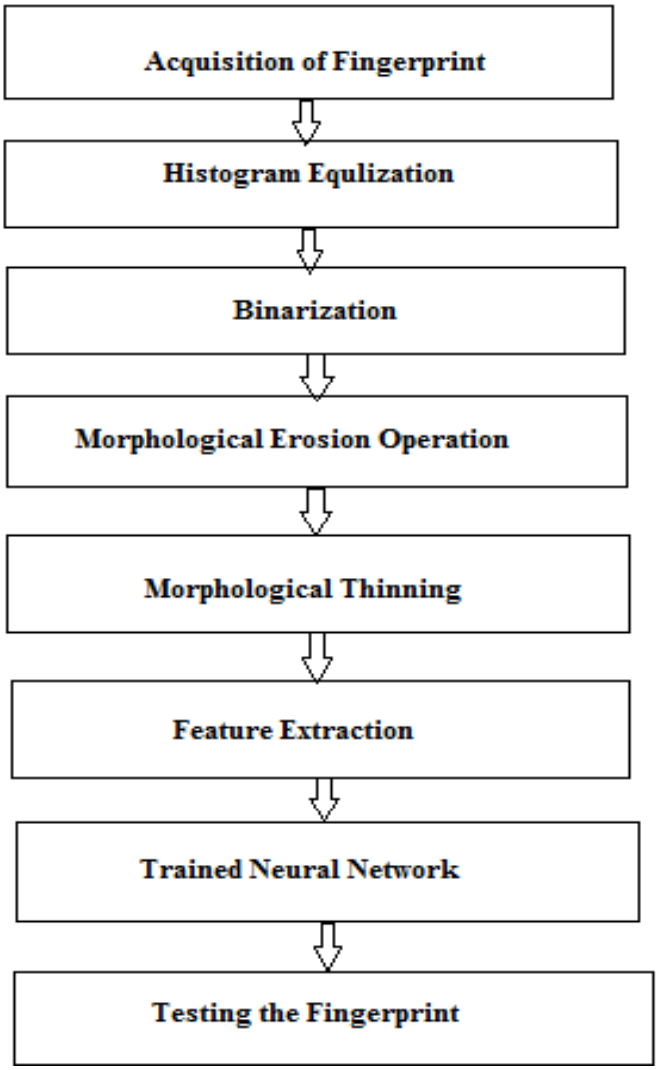


"Figure(1.1)Ridge and valley structure" " Figure(1.2)Fingerprint"

The performance of minutiae extraction algorithm is heavily depends upon the quality of input image. In fingerprint image minutiae can be precisely located from the thinned ridges. Fingerprint recognition methods can be grouped into three major classes: (i) correlation-based matching, (ii) minutiae based matching, and (iii) ridge feature-based matching [5]. While minutiae-based methods are the most popular because of their temporal performances, the correlation-based matching is considered to be more reliable, but very time consuming at the same time [6]. Minutiae-based recognition performs poorly on very well on low quality and partial input fingerprints [7]. The loss of singularity points makes ridge feature-based recognition and indexing techniques impossible to apply [8]. It can be observed from the previous work that there are number of algorithms has been used for the enhancement of the fingerprint image which consists of normalization, ridge orientation estimation, ridge frequency estimation , region of interest extraction, filtering, binarization, morphological thinning then the final step minutiae extraction and matching. For the filtering purposes, Gabor filter is the most common filter. Most of the existing enhancement techniques are based on Gabor filter. Gabor filter is both frequency and orientation selective tuned by ridge direction and ridge frequency. It works on both spatial and frequency domains [9].The main drawback of these methods lies in the fact that false estimate of local ridge direction will lead to poor enhancement. But the estimate of local ridge directions is unreliable in the areas corrupted by noise where enhancement is most needed [10]. Gabor filter is time consuming and parameter selection such as ridge centre frequency, radial bandwidth and central orientation, requires am empirical setup. Moreover, this is very old method.

Fingerprint recognition is always a field of research for researchers and security industries. Here we are developed a noble technique to enhance fingerprint results. To achieve a better result of matching we proposed a method of fingerprint recognition system using Genetic Algorithm and Neural Network. In this study, we apply a histogram equalization method for the enhancement of fingerprint image which is then followed by binarization and morphological operations. Optimization technique is used for the minutiae extraction and these extracted features are given to train the neural network. Enhanced image will fed to NN (neural networks) based trained system to diagnose and match finger print with data set. Several features will be used to train the network so that precision will be made in recognition of finger print. Here we are first discussing about optimization technique using genetic algorithm and neural network, these both are the world's best techniques.

Proposed Algorithm



"Figure2. Algorithm"

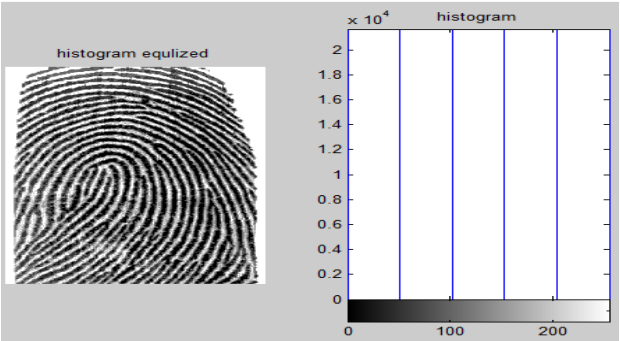
In this proposed work we introduce a new algorithm of fingerprint recognition system. It is very well known that to develop a reliable fingerprint recognition system image enhancement and features extraction are needed. This proposed algorithm is divided into main three stages: Preprocessing, post processing and final minutiae matching stage. Preprocessing stage involved enhancement of image by using histogram equlization, binarization and morphological operations after applying this enhancement algorithm a binarized thinned image has been obtained. In second stage minutiae are extracted from the enhanced fingerprint by using the optimization technique. Final stage is the recognition of the fingerprint which has been done with the help of neural network.

"A. Acquisition of Fingerprint"

A number of methods are used to acquire fingerprints. The quality of the fingerprint image is very crucial for the recognition process. It is always prefer to use a good quality of fingerprint sensor hat can tolerate the miscellaneous skin types, dryness or humidity of the fingerprint.

"B. Image Enhancement"

Histogram Equlization: This is the first step which is used for the image enhancement process. It is a technique for adjusting the pixel intensities of image to enhance the contrast [4]. Through this adjustment the intensities can be better distributed on the histogram. This allows the lower contrast region of the image gain the higher one. The original histogram of image is of bimodal type. After the histogram equlization the histogram of the image occupies all the range from 0 to 255 and the contrast of the image is enhanced.



"Figure3. Histogram equilized"

Binarization: The operation that converts the gray scale image into binary image is known as binarization. It is used to transform 8-bit gray fingerprint image into 1-bit image with 0 value for ridges and 1 value for furrows.

Morphological Erosion: Morphological techniques are used as pre-processing and post-processing such as filtering and thinning. There are two fundamental morphological operations, dilation and erosion, in terms of union (or intersection) of an image with a translated shape (structuring element).

Morphological Thinning: The final enhancement method prior the minutiae extraction is thinning. Thinning is a morphological operation that erodes the pixels. Thinned image helps minutiae extraction. The thinning of the image is to reduce the ridges till the ridges one pixel wide.

(a) (b) (c)

"Figure4. The results of main enhancement steps: (a) Binarized image (b) image obtained after erosion operation (c) Thinned image"

"C. Feature Extraction"

After a fingerprint image has been enhanced the next step is to extract the minutiae from the enhanced image. In this present work genetic algorithm based optimization technique has been used for this purpose. Genetic algorithm is the heuristic search and optimization technique that mimic the process of natural evolution. It was first developed by John Holland from the University of Michigan in 1975 [11]. It was proven to be the most powerful optimization technique. Genetic algorithms are considered to be the part of the evolutionary algorithms which produce the solution to the optimization problems. In a genetic algorithm, a population of a candidate solution (called individuals) to an optimization problem is evolved toward better solutions. Each candidate solution has a set of properties (its chromosomes and genotype) which can be mutated and altered; traditionally, solutions are represented in binary as strings of 0s and 1s, but other encodings are also possible. The evolution usually starts from a population of randomly generated individuals and is an iterative process, with the population in each iteration called a generation. In each generation, the fitness of every individual in the population is evaluated; the fitness is usually the value of the objective function in the optimization problem being solved. The more fit individuals are stochastically selected from the current population, and each individual's genome is modified (recombined and possibly randomly mutated) to form a new generation. The new generation of candidate solutions is then used in the next iteration of the algorithm. Commonly, the algorithm terminates when either a maximum number of generations has been produced, or a satisfactory fitness level has been reached for the population. Before applying GA firstly the enhanced binary thinned image is to convert into RGB image so that the extracted minutiae can show with a color. In this work we have extracted the ridge endings in the fingerprint image which will be the input of the neural network for training. Similarly, extract the ridge endings of the image in the database which are going to be tested. Figure (4) shows the extracted ridge endings showing with green color.

"Figure5. Extracted ridge endings"

"D. Training of Neural Network"

The ability of the ANN to learn given patterns makes them suitable for such applications. Fingerprint recognition is one such area that can be used as a means of biometric verification where the ANN can play a critical rule. An ANN can be configured and trained to handle such variations observed in the texture of the fingerprint. Artificial Neural networks have been proved very effective in performing complex function in various fields. In this research work neural network has been used for the recognition of fingerprints. Firstly the neural network has been trained before test the matching operation. Extracted features of all the images in the data set are the input of the neural network. With the help of these inputs the network has been trained and the network should be trained till then we get the minimum MSE value so that the desired number of true results can be obtained. Retrain the network at least twenty times. For training the network, MATLAB neural network toolbox has been used.

"E. Testing the Fingerprint:" This is the final step of the proposed work. To test or recognize the fingerprint first take any image from the data set and fed that image to the trained network then it gives the result by showing whether it matches to the right person or wrong. For instance, second sample of 6^{th} person has taken for testing then it showed that fingerprint is matched with 6^{th} person. If it matched to another person instead of 6^{th} person then the results is considered to be false. In this way all the fingerprints in the database has been tested.

II. EXPERIMENTAL RESULTS

We worked on 128 images of 16 persons, each has 8 samples. The data base has been taken from http://www.advancedsourcecode.com/fingerprintdatabase.asp. All the images in database are in TIF format (Tagged Image File). TIF is lossless, which is considered the highest quality format for commercial work. It is the most versatile and TIF does not have compression. The work has been done in MATLAB 7.12.0(R2011a).

"Table1. Results"

Total No. of Samples	No. of tested Samples	No. of Correctly predicted samples	Correct Rate	Incorrect Rate
128	**112**	**77**	**68.75%**	**31.25%**

III. CONCLUSION"

A method of fingerprint recognition based on Neural Network is presented. Our feature selection method is based on Genetic algorithm. The fingerprint image is enhanced before extracting features. Enhancement method included histogram equilization, binarization, morphological operations, it has made a great improvement of recognition accuracy for recognition method. The combination of both genetic algorithm and neural network techniques provided the better and efficient method for fingerprint biometric. Experimental results show that the presented method has the better recognition accuracy compared with the previous fuzzy logic based recognition methods.

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