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Authentication of Biometric System using Fingerprint Recognition with Euclidean Distance and Neural Network Classifier

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Abstract- Nowadays, Fingerprint recognition is the one of the authentication used for security applications. It provides hope for the society in reliable authentic biometric systems. Fingerprint technology emerges in various sectors such as government, organizations, libraries, universities, banks etc. It is widely used for biometric systems other than Iris, Face, Hand, Voice and Signature because of its uniqueness and distinctness. Traditional methods are not effectively used for analyzing the texture feature of finger print than neural network classifier. Fingerprint recognition will be identified and classified with the help of Euclidean distance and NN classifier for better accuracy has proposed in this paper. It uses certain techniques in preprocessing the image such as Histogram equalization and Fast Fourier transform. The performance of the proposed approach has significant result than the existing techniques used in the finger print recognition system.

Keywords: **Euclidean distance, Fingerprint recognition, NN classifier**

I. INTRODUCTION

Human fingerprint consists of enormous range of details that provides distinctive data of the people. Biometrics has become the bottom of nice opinions of extremely secured identification and verification. (i.e.) security solutions. It's significantly predominant to secure and evidence data in an intelligent system. It cannot be shared, unnoted or taken, and formation is not possible much in a very biometric system. Fingerprint options cannot be simply duplicated which suggests solely the licensed person gets access and that we get high level of security. Factors such a generality, uniqueness, permanence, collectability, acceptableness, escape, performance should be applied for suitableness of attribute in biometric identification. Fingerprints area unit distinctive patterns, created by friction ridges (raised) and furrows (recessed), that seem on the pads of the fingers and thumbs. Fingerprint recognition can be done based on the ridge shape features and minutiae.

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Minutiae of the fingerprint provides accurate results compared to the ridge shape features since the ridge shape features contains only the loop (∩), arch (Δ) and whorl(o) information which may lead to false recognition. Minutiae details are precise and it consists of two types of minutiae feature namely Ridge ending and Bifurcation.

a) b)

c)

Fig.1 Minutiae features a) Ridge ending b) bifurcation c) Short ridge

The real time image which is taken should be pre-processed to enhance the intensity of the image. In preprocessing, the ridges of the fingerprint are retrieved by providing preprocessing approaches like Histogram equalization and FFT (Fast Fourier transform). Minutiae are extracted with the help of Binarization and ridge thinning. For the binary level (Black, White) representation of the image from 8 bit gray level image binarization technique is implemented. Thinning of the ridges shortens the width of the ridges which in turn gives precise details of minutiae. Fingerprint is classified with the help of the Euclidean distance and NN classifier. Euclidean distance between the images is calculated using the formula (2). The Euclidean distance of the images is found and the images are trained and tested. Fingerprint of an individual can be identified by comparing the trained image and the query image. If the distance equals to zero the fingerprint of the query image and the trained image matches and the fingerprint is recognized, otherwise it will not be recognized. Mean square error and processing time is found minimum. Thus the fingerprint images are classified with the help of Neural Network classifier. Overview explanation of the proposed Fingerprint recognition system is explained in the Fig 1.

II. LITERATURE REVIEW

Fingerprint recognition system is composed of preprocessing, Feature extraction and classification techniques. Different methods were proposed for each stage of the system, however high performance metrics are considered for better improvement of the systems. System should be designed to avoid limitations on position of fingerprint, matching rate, accuracy which could also be an important source for identifying the individuals. Comparative study of different techniques has been done in depth. Techniques were made to improve the security of the system but it has its own disadvantages. Preprocessing is a technique which enhances the images for acquiring a good quality of images. Certain approaches like Normalization, image orientation, Gabor filtering were applied for enhancing the image. Fourier transform which happens in frequency domain enhancement technique used for removing noise and increasing the quality of the image. Histogram equalization is used for filtering the noise in the image [23]. Wavelet transform is suggested as a good enhancement technique without any proof or comparative results in [24]. Galton points otherwise known as minutiae have been used for fingerprint identification or classification [22]. Normalization and Gabor filter performance in [20] provided only 89.6% of efficiency inspite of the Euclidean distance classification because of poor preprocessing approach. Euclidean distance is one of the best approaches recommended for classification. Excellent degree of accuracy is achieved with the minutiae points and Euclidean distance classification. Extraction of minutiae is significant for Euclidean distance classification. In Correlation based fingerprint matching the fingerprint images suffered from non-uniform shape distortion. Complexity of chain coding method is high for extracting the minutiae. The quality of the image is significant for binary image in chain coding technique. Minutiae based matching is performed by crossing number technique which consists of a 3x3 window. Minutiae based matching is found to be best as compared to the pattern based matching where only the relative position is needed for minutiae based matching. On the other hand pattern based matching acquires overall features of the fingerprint [19].Therefore, minutiae based matching is concerned for high accuracy. Anil K Jain [4] has proposed a technique called Orientation estimation where Fingerprint matching can be done by the directionality of image. Time taken to analyze the finger print is 1.4 seconds according to this author. Feng Zhao[8] has considered Rutovitz Crossing Number (CN) for thinning the ridges and Valley of the fingerprint is considered for minutiae extraction which resulted in low accuracy performance having mean square error of 27.5 %. Method of crossing number proposed in [21] is also found to be time consuming. Gabor filter for image enhancement is suggested and achieved a good quality of image. Algorithm proposed by P.Gnanasivam provided accuracy of 94%. Fingerprint recognition is better than Iris recognition because of the unique minutiae details which prevents false entries and security attacks [10]. Mouad.M.H.Ali proposed a method with 80.3 % accuracy which is similar to this work but classification is different. Line tracing algorithm and NN classifier is used for fingerprint recognition where the features of fingerprints such as loop, arch and whorls are considered which may lead to false recognition. Direct method of minutiae extraction using CNN (Convolutional Neural Network) provided 94% of accuracy with 4.97% of error. Summarizing the different method of classification technique, AFRs is designed based on Euclidean distance classifier which provides good accuracy and consumes less processing time [2].

III. PROPOSED METHOD

In general, Pre-processing deals with the operation of images with low intensity. The images obtained from the sensors are the input to the pre-processing techniques. The main objective of the pre-processing technique is to improve the image data by suppressing the unwanted distortions and enhancing the image features which are used for further processing techniques. In fingerprint recognition the input image consists of lots of redundant information such a s scars, excessive dryness and moist, dust, variable pressures etc. To overcome these redundancies pre-processing technique is used.

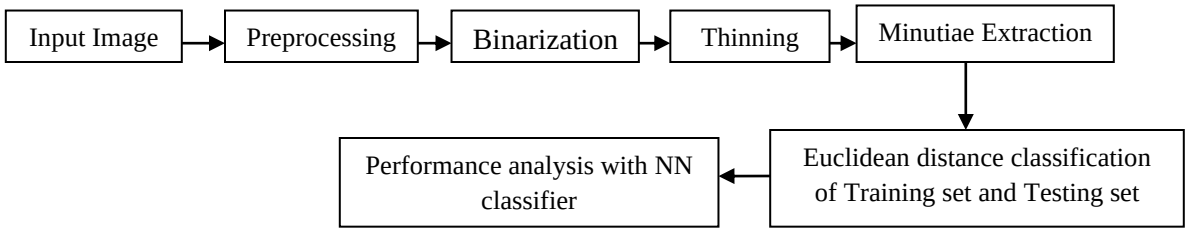

Fig.2 Overview of Fingerprint recognition system

3.1. Image acquisition

For fingerprint recognition system the first step is to acquire the training data set. For acquiring the training dataset, the images are collected from FVC2002 which is the Second International Competition for Fingerprint Verification Algorithms.

Table 1. Database Information

Image Size	640x480
Greyscale image	Yes
Number of Classes	10
Number of Sub-classes	8
Total Number of Images	80
Image Format	TIFF

Database can be collected in two forms; first one is using inkless optical capturing devices such as optical sensor and solid state sensor. On the other hand, the database is performed using the classic method of ink over a paper and then scanned. For fingerprint recognition system the first step is to acquire the training data set. For acquiring the training dataset, the images are collected from FVC2002 which is the Second International Competition for Fingerprint Verification Algorithms.

3.2. Preprocessing

The main objective of the preprocessing technique is to boost the image knowledge by suppressing the unwanted distortions and enhancing the image options. Image enhancement technique includes two processes for the reduction of noises and for the better acquisition of image. They are

- ✓ Histogram equalization
- ✓ Fast Fourier Transform

Histogram equalization is that the method that is employed to reinforce the distinction of the image by increasing the magnitude of the image. It's a wide accepted technique because it directly works on pixels or on spatial domain. Varied grey level pictures square measure delineated diagrammatically in bar chart. In Fourier transform the improved image is split into little blocks (32x 32) and also the Fourier transform is performed by exploitation of the formula

$$F(p,q)=\sum_{x=0}^{M-1}\sum_{y=0}^{N-1} f(x,y)\, x e^{\{-j2\pi\left(\frac{px}{M}+\frac{qy}{N}\right)\}} \quad \text{.....(1)}$$

Where, p=0, 1, 2 …31 and q=0, 1, 2… 31

a) b) c)

Fig.3 Fingerprint image Enhancement a) Original image b) Histogram Equalization c) FFT image

3.3. Binarization and Thinning

Binarization is a necessary process for minutiae extraction. Intensity of the ridges is neutralized using Adaptive binarization. Transforms a 256 level image into 2 level image. (Black-0, white-1). The grayscale image is transformed into black and white colour image with respect to the determined threshold value.

Threshold value > pixel value = Black

Threshold value<pixel value=White

Ridge thinning is a method of reducing the thickness of every line of patterns into one picture element. It improves the standard of the fingerprint binary image. Also, ridge thinning removes the redundant pixels.

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a) b)

Fig.4 Results of preprocessed fingerprint image a) Binarized image b) Thinned image

3.4. Minutiae Extraction

The construct of Crossing number (CN) is wide used for extracting the trivia. Crossing number technique minimizes the false acceptance rate (FAR). As ridges have nearly a hundred and fifty options and singularity, it's easier to search out the various trivia varieties of the fingerprint [21]. In general, for every 3x3 window, if the central picture element is one and has specifically three one-value neighbors, then the central picture element may be a ridge branch. If the central picture element is one and has only one one-value neighbor, then the central picture element may be a ridge ending (i.e., for a picture element X, if Cn(X)==1 it's a ridge finish and if Cn(X)==3 it's a ridge bifurcation point).

Fig.5 Minutiae Extraction

3.5. Classification

Euclidean distance classifier

In comparison of binary pictures distance play a necessary role within the fields of native features, morphological operations and distance between 2 points in a picture. Euclidean distance could be a natural distance between 2 points that is usually mapped with a ruler. the distance between trivia points during a fingerprint image is calculated. If x values are x1, x2 till xn and values of y are y1, y2 till yn are the two points in Euclidean space then the distance from P to Q is given by:

$$d(x,y)=d(y,x)=\sqrt{\sum_{i=0}^{n}(y_i - x_i)^2}$$

……(2)

Matching method determines whether or not the two trivia sets are from identical finger or not. Exploitation of Euclidean distance in minutiae based fingerprint matching offers correct matching results. Euclidean Distance could be a distance matching technique that is generally perusal in mathematical geometry and accuracy. If the distance is Zero then the input image and the query image is perfectly matched.

NN Classifier

Artificial Neural Network (ANN) uses the process of the brain as a basis to develop algorithms which will be an accustomed model for advanced patterns and prediction issues. Regression of the training and also the testing set is found; further the Mean square error is analyzed. The images were trained and so tested during this classification. The weights of the network are mounted within the classification section. A pattern given at the inputs are going to be remodeled from layer to layer till it reaches the output layer. Currently classification will occur by choosing the class related to the output unit that has the biggest output worth. For classification, we tend to tend to entirely got to select Associate in Nursing FFNet and a Pattern List on. Classification section is incredibly quick in comparison to the training section.

IV. RESULT AND DISCUSSION

The above explained approaches have been executed and the output has been examined. The Euclidean distance classifier works well with all the 80 images. Also the resultant value is implemented in NNtool for further classification. This approach gives us the better performance in computation time, minimum error and accuracy.

Table 2.Euclidean classifier result

Input Images	Number of images used for recognition	Number of images recognized correctly	Accuracy (%)
1	8	7	90
2	8	8	100
3	8	8	100
4	8	8	100
5	8	8	100
6	8	8	100
7	8	8	100
8	8	8	100
9	8	8	100
10	8	8	100
Overall	80	79	99

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Table3. NNtool performance

Epoch 0-1000	442 iterations
Time	0:00:06
Performance 1.70e^{+05} - 0.00	0.0149
Validation checks 0-6	6
Mean Square error	10^{-2}

As mentioned in Table 3 the NN classifier performance metrics is obtained which has 0.01 MSE and low computation time or matching speed. The trained and tested data are given below:

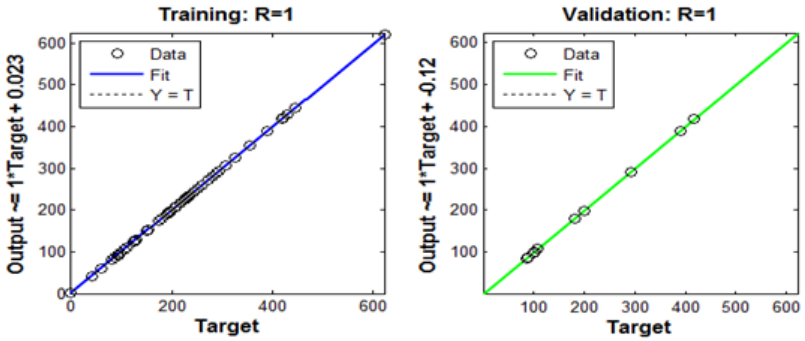

Fig 6 Trained Fingerprint images

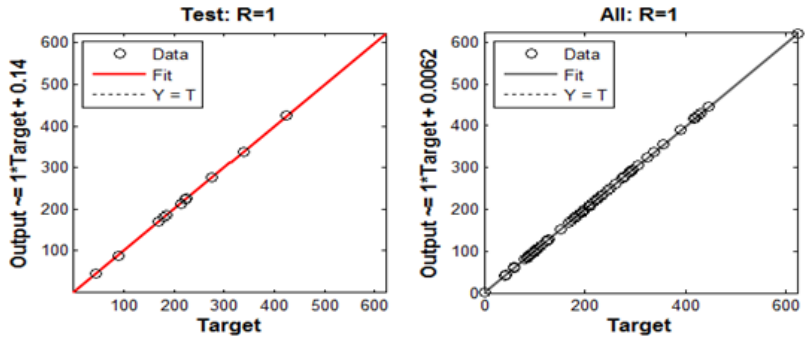

Fig 7 Tested fingerprint images

V. CONCLUSION

The Euclidean distance and neural network classifier analyses the test image and the input image accuracy but when the query image is enrolled in different angle the matching between the input image and the test image is quiet challenging. In future we can improve the system with distance and angle calculation. NN classifier shows the exactness as of the Euclidean distance classifier. The field of Fingerprint recognition system can be exploited and explored for more accurate results and outcomes.

Table 4 Comparison with the other methods

Methods	Accuracy	MSE(Mean square error) %
Proposed method	99%	0.01
P.Gnanasivam [7]	94%	-
Feng Zhao[8]	78%	0.02
Mouad.M.H.Ali [11]	80.3%	0.2
Lu Jiang [12]	94%	4.97

Comparing the other methods of fingerprint recognition techniques, the proposed method provides a superior outcome. It has high acceptable accuracy with average access time for testing data sets.

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