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Embedded Algorithm of Fingerprint Recognition Using Novel Approach Based on Euclidian Distance

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Abstract:- Fingerprint is the technique to identify the identity of an individual. Fingerprint recognition system is the best technique for the security purpose, because of its unique characteristics like: core point, delta points, and bifurcation points for every individual. This paper presents a method for fingerprint recognition by using Novel Approach based on Euclidian Distance between core and minutiae points. Hong's enhancement is used to improve the quality of fingerprints and Otsu segmentation technique has been used to segment out the ridges and valleys from fingerprints. After segmenting out the ridges and valleys, feature have been extracted based on Euclidian distance. Artificial Neural Network is employed for classification and then the performance has been evaluated on the basis of Sensitivity, Specificity and Accuracy.

Keywords:- Fingerprint Identification, Hong's Enhancement, Euclidian Distance, Artificial Neural Network, Segmentation, Enhancement.

I. INTRODUCTION

Authentication was introduced for the purpose of security by using signatures, user-ids and passwords, palm, cards etc. but now a day's these authentication techniques can be forged as signatures can be copied, passwords can be guessed and cards can be stolen or lost. So, instead of these authentication techniques, biometric authentication proved more useful for the identification purpose.

Basically, biometric features are Anatomy based such as fingerprints, palm, face, iris etc. and behaviour based such as voice, heart-beat etc. From all the biometric techniques, Fingerprint recognition technique is explained in this paper. Various approaches have been used by the researchers over the years for fingerprint recognition using minutiae points, ridges, valleys etc [1].

According to Henry's classification fingerprints are classified as Left Loop, Right Loop, Plain Arch, Tented Arch, Plain Whorl, Accidental Whorl, Central-Pocket Whorl and Double Loop Whorl [2]

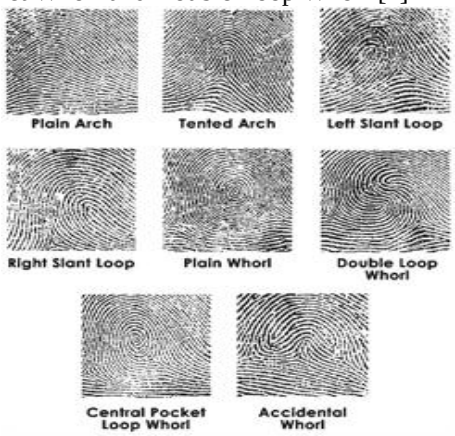

Fig 1: Types of Fingerprint[3]

Fingerprint identification is based on the unique and invariant features of fingerprints like ridges and valleys. Ridges is a combination of minutiae points and core point. These Minutiae points consists of minutiae endings and minutiae bifurcation points.

Different authors proposed a different technology for fingerprint recognition. Like Minutiae points has been detected by using minutiae detection algorithm i.e. given by Virgina [4] and Kuntal [5]. Core point has been detected by using singular point detection method i.e. given by Ali[6]. Hemlata[7] and Wen[8] also proposed a technique in which recognition has been done by counting number of minutiae points using minutiae matching algorithm.

Various methods have been proposed to identify the fingerprint such as counting number of minutiae points, determining Euclidian Distance between core point and bifurcation points. From above approaches Euclidian distance gives most promising results than others as different persons can have same number of minutiae points.

Various problems may occur during the fingerprint recognition such as quality of image, which may make the task difficult if quality is poor. The quality of image depends upon fingerprint type which can be Dry, Dirty and Diseased fingerprint. Removing random noise and enhancing images is the main task of fingerprint recognition [2]. Further, Feature Extraction and Fingerprint Classification design is also an issue as it has to be decided that what and how these features can be used and classified into categories [2].

II. MATERIAL AND METHODS

A. Proposed Methodology

In this paper, a method to classify the various types of fingerprints is proposed. Figure 1 shows the various steps of proposed methodology.

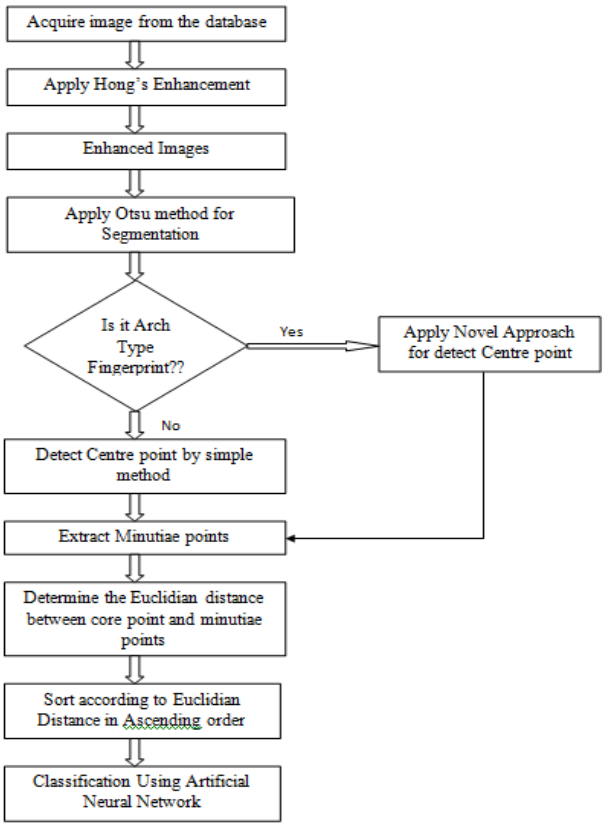

Figure 1: Proposed Methodology of Fingerprint Recognition

B. Dataset

This dataset was acquired from FVC2000 which is publically available. This dataset contains 80 fingerprints from 10 different people and collecting 8 samples from each person. Size of an image is 142kb with dimensions 388 x 374.

C. Enhancement

Enhancement is the process of remove a noise from an image. In this paper, from all the enhancement techniques, Hong's enhancement is used. Sometimes there are false minutiae points exist in the image. For the purpose of remove these false minutiae points, Enhancement is performed and it preserves only true ones.

The implementation of the enhancement algorithm is done as follows:

i. Calculate the Mean and Variance of an image.

If value of pixel is greater than mean then normalization is done using:

nimg(gmidx) = m0 + sqrt((v0*(img(gmidx)-m).^2)/v);

If it is less than equal to mean then normalization is done:

nimg(lmidx) = m0 - sqrt((v0*(img(lmidx)-m).^2)/v);

where,

m = mean
v = variance
gmidx = pixel with value greater than mean.
lmidx = pixel with value less than or equal to mean.

ii. Orientation image is estimated by using Complex Gradient.
iii. Region mask generation is calculated.
iv. Frequency image estimation derives the average inter-ridge distance in each block based on the distance between the ridge peaks.

v. Use Gabor Filter to enhance the image.


Figure 2(a):Original Image Figure 2(b): Enhanced Image

Figure 2: Hong's Enhancement

D. Segmentation

Segmentation is used to separate the foreground and background region. It computes an optimal threshold value and turns the pixels below that value to zero and the remaining pixels to one. This method is implemented by following the steps given below:

i. Threshold level of the image is calculated using the matlab command 'graythresh'.
ii. Convert the gray scale image to binary, using the threshold value calculated from step1.
iii. The small holes in the obtained image are filled by using command 'imfill'.


Figure 3(a):Histogram Equalized Image after Pre-processing Figure 3(b): Binary Image after apply Segmentation

Figure 3: Otsu Segmentation

E. Feature Extraction

Euclidian Distance is the main feature for fingerprint recognition and this distance can be determined by following the steps given below:

i. Extract Core point from an image.
ii. Check?? Is it Archtype fingerprint.
    (a) If yes, then apply Novel Approach For extract core point
    (b) Otherwise we can simply extract the core point.
iii. Extract all Minutiae Points i.e. Ridge Ending and Ridge Bifurcations and store the result in two different arrays. One for Ridge Ending and one for Ridge Bifurcation.
iv. Sort both arrays in ascending order.
v. Determine Euclidian Distance between core point and minutiae points by applying this Formula:

$$ED(i) = dist(M_C, M_{i,j})$$ Equation(4.2)

Where,

M_c is Core Point

$M_{i,j}$ are minutiae points.

vi. Take First 5 elements from both the arrays and store into the final array.

F. Classification

Back Propagation Neural Network (BPNN) is used for pattern classification problems and it is a multilayer neural network. Three layers are included in this network i.e. Input Layer, Hidden Layer and Output Layer. Every layer has one or more nodes. Forward signal is propagated through input layer, via hidden layer, to the output layer. Input layer takes the input from outside environment and passed to the hidden layer with some weighted values. Nodes in the hidden layer calculate our result and passed to the output layer. Then output layer calculate our result by using activation function with the help of sigmoid function expressed as:

$$y(x) = \frac{1}{1 + e^{-x}}$$

G. Performance Parameters

Evaluating the performance of Fingerprint recognition system is vital to the result by selecting the correct metrics. There are three types of performance parameters i.e. Sensitivity, Specificity, Accuracy.

Sensitivity: Also called the True Positive (TP) rate that measures the proportions of positives which belong to the class and are correctly identified [9].

$$\text{Sensitivity} = \frac{TP}{TP+FN} \times 100$$

Specificity: Also called the True Negative (TN) rate that measures the proportions of negatives which do not belong to the class and are correctly identified [9].

$$\text{Specificity} = \frac{TN}{TN+FP} \text{ x } 100$$

Accuracy: It takes the results of both TP and TN among total number of cases [9].

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN} \text{ x } 100$$

Where,
FP is False Positive i.e. belong to the class and are incorrectly identified.
FN is False Negative i.e. not belong to the class and are incorrectly identified.

III. EXPERIMENTAL RESULTS AND DISCUSSIONS

Implementation is done by using Matlab®2010a. This proposed methodology is tested for 40 samples. 70% of data from the database is used for training and left 30% for validation and testing.

Table 1: Results for Fingerprint

Person Name	**No. of samples**	**True positives (*TP*)**	**False negatives (*FN*)**	**False positives (*FP*)**	**True negatives (*TN*)**
P1	8	8	0	0	0
P2	8	8	0	0	0
P3	8	8	0	0	0
P4	8	8	0	0	0
P5	8	8	0	0	0
P6	8	8	0	0	0
P7	8	8	0	0	0
P8	8	8	0	0	0
P9	8	8	0	0	0
P10	8	8	0	0	0

Therefore, Sensitivity, Specificity and Accuracy for all the persons is equal to 100% shown in the figure 4:

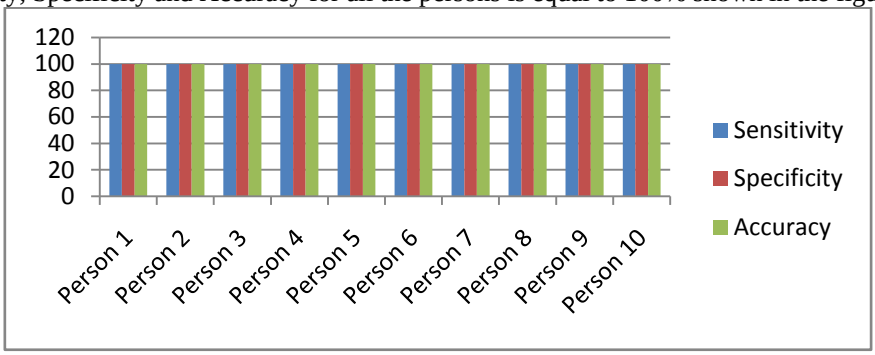

Figure 4: Calculated Performance Matrices for Fingerprint

IV. CONCLUSION

This embedded algorithm of fingerprint recognition was implemented in Matlab®2010a. Our proposed methodology gives 100% result as compared to the existing methodology which was published in 2014 [10]. Novel Approach is also apply in this methodology to detect core point of the fingerprint having no centre point.
Fingerprint Recognition is one of the simplest and successful method for authentication. This is the misconception that problems regarding fingerprint was fully solved but the truth is that research on fingerprint will never stop because of its complexity and poor quality images. Most common problem is the average quality of an image which creates difficulty in recognizing the image.

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