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Palmprint Identification Based on Adaptive Neuro Fuzzy Inference System

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Abstract*— Biometrics plays a very crucial role in various pattern recognitions. Recognition systems are used for offline application and also for online applications. In the biometric family, palmprint based identification system has become one of the active research topics. Palmprint identification system as two phases one is the feature extraction phase and other is the identification phase. The purpose of this paper is to use adaptive neuro fuzzy inference system for the identification phase. The objective of ANFIS is to integrate the best features of fuzzy systems and neural networks. An ANFIS based identification system is described here which uses palmprint as input. Experiments are carried out using the samples. Obtained results show that the system is reliable when considering it as a part of the verification mechanism.

Keywords*— Biometrics, palmprint, feature extraction Identification.

I. Introduction

Biometrics based technologies are used to deal with security problems and also for identifying individuals in a fast and reliable way through the use of unique biological characteristics. Unlike keys and passwords, personal traits are extremely difficult to forget or lose. It is also very difficult to copy. For this reason, many people consider them to be safer and more secure than keys or passwords. Biometrics can use behavioral characteristics like your voice, handwriting or typing rhythm or physical characteristics, like your face, fingerprints, palmprint, irises or veins. The biometric system uses mainly three steps. First step is the enrollment phase i.e., it records the basic information about the person and then captures the image or recording of the specific trait. The next step is the storage i.e., analyzing the trait and, translating it into a code and recording it. In the third step, comparison is done. It compares the trait to whatever presented to the information on the file, it either accepts or rejects.

Over the past decade palmprint identification system has received much attention from the biometric family. Palmprint of an individual is unique and remains unchanged over a life time. Palmprint is the region between fingers and wrist. It has many features like principle lines, wrinkles, ridges, minutiae points, singular points and texture patterns which can be considered as biometric characteristics [1].

Palmprint identification system is an automated method of verifying a match between palmprint images. A palmprint identification system consists of four phases i.e., palmprint scanner, pre-processing, feature extraction, and identification [2]. In the first phase images are collected. In the next phase pre-processing takes place. It is a process of removing the low frequency background noise and normalizing the intensity of individual pixels in the image. Then comes the feature extraction phase where the input data is transformed into a reduced set of features. The last step is the identification phase where the individual is identified based on the traits. In this phase the result can either be accepted or rejected.

In a biometric authentication system, classifier must have the ability to correctly identify and retain the minute variations observed in the applied pattern. Fuzzy logic is a problem solving mechanism that has received wide acceptance. For image understanding applications such as edge detection, feature extraction, classification and clustering fuzzy logic is considered. Fuzzy logic provides an easy and simple way to draw a definite conclusion from imprecise, vague and ambiguous information. ANFIS is a fuzzy inference system implemented in a framework of adaptive network. ANFIS can construct an input output mapping based on both human knowledge and stipulated input output data pairs [3].

This paper investigates about the feature extraction phase and identification phase of the palmprint identification system. These two concepts are commonly been studied in the field of image processing. Here feature extraction is done by using classical lifting scheme and Pulse Coupled Neural Network (PCNN).

In the next phase that is identification, which is the most important phase, the results obtained must be correct in all aspects. In the previous work [6] Support Vector Machine (SVM) classifier was used . SVM is one of the best classifier. It gives a crisp output. Thus to improve the accuracy, in this paper for identification purpose the ANFIS classifier used.

This paper is organized as follows. In section 2, feature extraction phase is explained. In section 3 identification phase is explained. In section 4, the results after implementing this method are given. Finally, in section 5, conclusions are described.

II. FEATURE EXTRACTION

The problem with most of the palmprint identification system is their cost and accuracy. The proposed approach resolve this problem. The overall architecture of the proposed approach is given in Fig. 1.

Firstly, a palmprint image is given as input to this method. In the feature extraction stage first the image is given to the classical lifting scheme. It comprises of wavelet transform followed by an update and a prediction step. In this process a one level decomposition is done in order to get the Subbands.

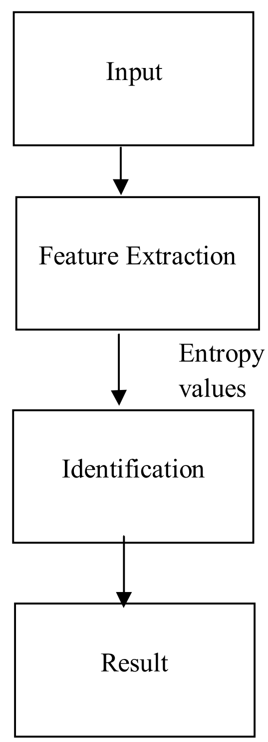

Fig 1. Flow chart for the proposed system

The original signal S : Zd → R is first split into subbands that is approximation signal x and detail signal y by a particular wavelet transform or simple polyphase decomposition. The update map U acting on y is used to modify x, resulting in a new approximation signal x’, i.e.

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$$x' = x + U(y) \tag{1}$$

Then, prediction map p acting on x' is used to modify y, yielding a new detail signal y' i.e.

$$Y' = y + P(x') \tag{2}$$

Thus after the lifting scheme the output is given to the PCNN that is one approximate image and three detail image. These parameters are calculated based on the information from [6].

The palmprint image is decomposed into an approximate image and three detail images with the adaptive scheme. Then PCNN is used to decompose each detail image into 30 binary images. In this the number of neurons in the network is equal to the number of input image. One-to-one connection exists between image pixels and neurons [4]. Each pixel is connected to a unique neuron and each neuron is connected with the surrounding neurons with a radius of linking field. The neuron receives input signals from other neurons and from external sources through the receptive fields. After the receptive fields have collected the inputs, they are divided into two or more internal channels. One channel is the feeding input F and the other is the linking input L. The feeding connections are required to have a slower characteristic response time constant than those of the linking inputs. The linking inputs are biased and then multiplied together, and further multiplied with the feeding input to form the total internal activity U. The pulse generator of the neuron consists of a step function generator and a threshold signal signal generator. At each time step the neuron output Y is set to 1 when the internal activity U is greater than the threshold function T. The threshold input at each time step is updated. The output of the neuron is consequently reset to zero when T is larger than U. Thus at one time step the pulse generator produces a single pulse at its output whenever the value of U exceeds T.

The PCNN can be described mathematically as:

$$F_{ij}[n] = \exp(-\alpha_F)\, F_{ij}[n-1] + V_F \sum M_{ijkl} S_{ijkl} \tag{3}$$

$$L_{ij}[n] = \exp(-\alpha_F)\, L_{ij}[n-1] + V_L \sum W_{ijkl} Y_{ijkl} \tag{4}$$

$$U_{ij} = F_{ij}[n]\big(1 + \beta L_{ij}[n]\big) \tag{5}$$

$$Y_{ij}[n] = \begin{cases} 1, & U_{ij[n]} > T_{ij}[n] \\ 0, & U_{ij}[n] \le T_{ij}[n] \end{cases} \tag{6}$$

$$T_{ij}[n] = exp(-\alpha_T) T_{ij}[n-1] + V_T \sum V_{ij}[n-1] \tag{7}$$

where n is current iteration, (i, j) represents the position of a neuron. S denotes input image, M and W are weight matrices, VF, VL and VT are inherent voltage potentials, β is linking constant, αF, αL and αT are decayed constants. At the time of the realization of this work, there was no analytic procedure to determine the parameters, thus the parameters were estimated by experimentation. The entropies of these binary images are calculated and regarded as the features. These parameters are calculated based on the information from [6][9-10].

III. IDENTIFICATION

ANFIS is a fuzzy inference system (FIS) implemented in the framework of an adaptive fuzzy neural network. It combines the explicit knowledge representation of an FIS with the learning power of artificial neural networks. The objective of ANFIS is to integrate the best features of fuzzy systems and neural networks. Using a given input/output data set, ANFIS constructs a FIS whose membership function parameters are tuned (adjusted) using either a back propagation algorithm alone or in combination with a least squares type of method[5] [7]. This adjustment

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allows your fuzzy systems to learn from the data they are modeling. General architecture of ANFIS is shown in fig 2.

An ANFIS architecture has five layers of different functions which constitute the system. Layer 0 is the input layer. In this layer the external inputs are transmitted to the next layer. In the next layer i.e., layer 1 is the fuzzification layer. This layer includes the antecedent fuzzy set of fuzzy rules. Fuzzy rule layer is the second layer. This layer receives the input from the first layer. Then comes the layer 3 which is the normalization layer. Last layer is the defuzzyification layer [3], [7-8].

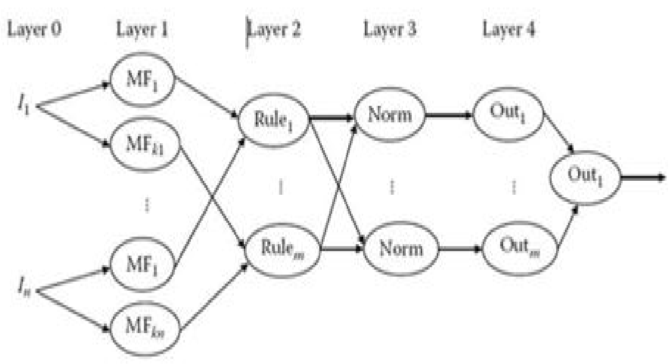

Fig .2 General architecture of ANFIS

ANFIS consists of if–then rules that couples input and output. Also for ANFIS training, learning algorithm of neural network is used. The FIS under consideration is assumed to have two inputs (x and y) and one output (z). For a first order of Sugeno fuzzy model, a typical rule set with base fuzzy if–then rules can be expressed as

Rule 1: If x is A1 and y is B1 then f1=p1x+q1y+r1

Rule 2: If x is A2 and y is B2 then f2=p2x+q2y+r2

where p, r, and q are linear output parameters. These parameters are calculated based on the information from [7].

IV. RESULT ANALASIS

The proposed algorithm is applied on the images in IIT Delhi Touchless Palmprint Data base version 1.0. This database is publicly available for download. This database contains left and right hand images from more than 230 subjects. The database contains left hand , right hand and the segmented image is given in Fig. 3.

In this experiment 20 images are taken as the testing data and 100 images as training data. For the proposed approach, after performing the wavelet transform, the results obtained are the subbands. We get four subbands one approximate and three detailed as shown in Fig. 4. From this subbands binary images are obtained by using PCNN.

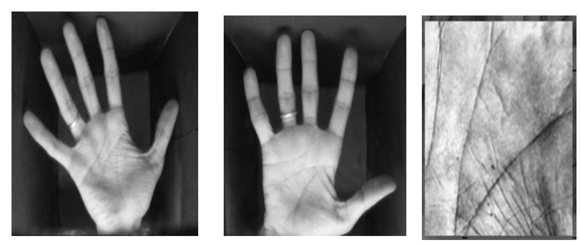

Fig. 3. Sample images of IIT database

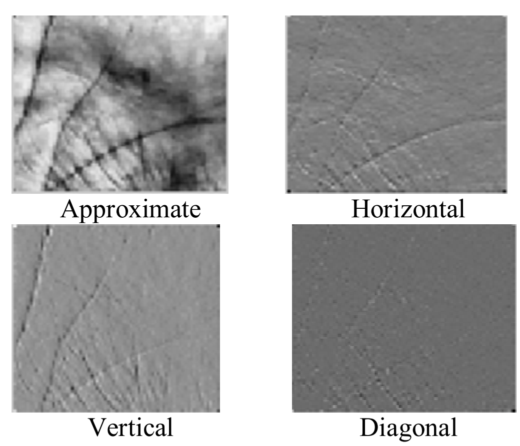

Fig. 4. Decomposition result at level 1 of the wavelet

From these binary images the entropy values are calculated. These entropy values are considered as features. Entropy is referred to as the measure of

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randomness that can be used to characterize the texture of the input image. The entropy values are obtained for the binary images. For each training image 90 entropy values are calculated. Sample of entropy values for 5images are shown in Table.1.

Table 1. Entropy values obtained

	1	2	3	4	5
Person 1	0.1643	0.0266	0.1874	0.0204	0.0085
Person 2	0.0311	0.0493	0.0234	0.0301	0.0393
Person 3	0.3085	0.3071	0.0150	0.0277	0.0311
Person 4	0.0622	0.0605	0.0512	0.0599	0.0612
Person 5	0.0850	0.0750	0.0633	0.0712	0.0813

Entropy values are the features and are given to the classifiers where we get the result as identified or rejected. The performance was analyzed using correct classification percentage (CCP) which is defined as the number of correctly identified images by total number of images tested. The CCP for the non trained images was found to be 70% using ANFIS and in the case of SVM, it was found to be less, as shown in Table 2. Results can be further improved by using adaptive lifting scheme for feature extraction technique.

Table 2. Correct Classification Percentage

Approach	CCP %
ANFIS	70
SVM	40

V. CONCLUSION

In this paper, we emphasized mainly on two concepts. First is the feature extraction and the identification phase. In the first phase classical lifting scheme and PCNN are used for feature extraction. Entropy values from PCNN are considered as the features. In the next phase that is identification, ANFIS classifier is used. The proposed method is evaluated using publicly available IIT Delhi Touchless Palmprint Database version 1.0. Experimental results show that ANFIS is better than SVM for palmprint identification.

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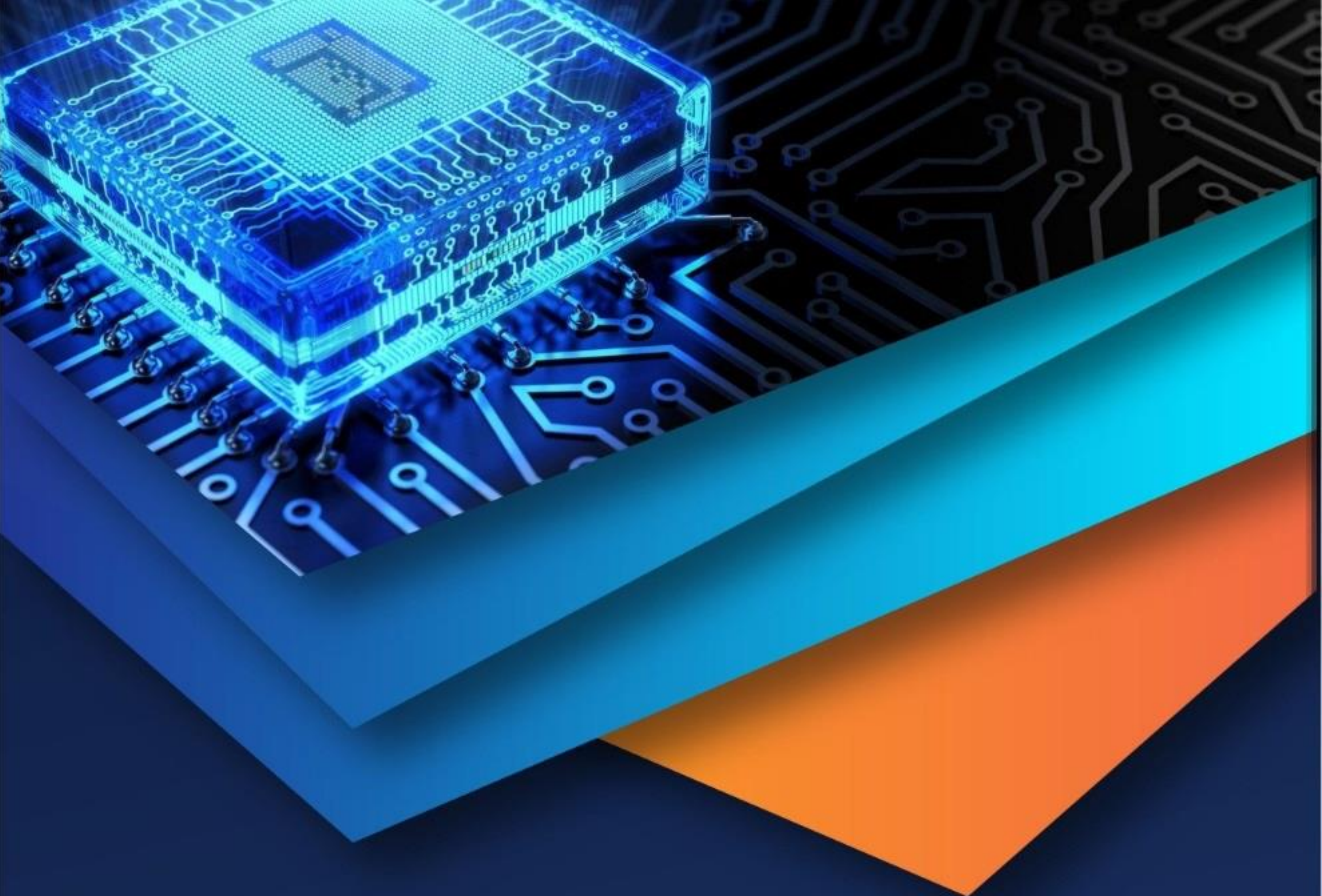

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