SELF LEARNING HAND RECOGNITION SYSTEM USING SOFT COMPUTING

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Abstract— As the day to day security is a major concern the authentication problem is very crucial. The hand recognition system provides efficient way to produce the authentication using image processing. Hand recognition geometry as the name suggest uses the shape of the hand to identify the person. Unlike iris, face or fingerprints, the human hand is not unique. The existing systems use finger length, thickness and curvature for the purpose of verification but not for identification. Hand recognition geometry data is relatively easier to collect to other technologies e.g. for fingerprint collection good frictional skin is required by image systems. The main objective of this study is to develop a system which can increase the accuracy of the hand recognition using soft computing, the system should be capable to self-learn, about the correct and incorrect palm prints and add them to its database. A robust palm print recognition approach using neural network is proposed in this study. Neural networks offer a number of advantages, including requiring less formal statistical training, ability to implicitly detect complex nonlinear relationships between dependent and independent variables, ability to detect all possible interactions between predictor variables, and the availability of multiple training algorithms. Palm print recognition, Preprocessing, Feature extraction, Matching and Results and Feedback to the database are the six steps that are followed in the proposed approach.

Keywords-Palm print recognition, self-learning, neural networks.

I. INTRODUCTION

In today's world, we are often being asked for verification of our identity [1]. Normally, this is done through the use of passwords when pursuing activities like domain accesses, single sign-on, application log on etc. [2]. In the process, the role of personal identification and verification becomes increasingly important in our society. With the onslaught of improved forgery and identity impersonation methods, previous ways of correct authentication are not sufficient [4]. Therefore, new ways of efficiently proving the authenticity of an identity at a low cost are greatly needed. Various avenues have been explored to provide a solution and biometric based identification is proved to be an accurate and efficient answer to the problem [14]. Biometrics has been an emerging field of research in the recent years and is devoted to identification of individuals using physical traits, such as those based on iris or retinal scanning, face recognition, fingerprints, or voices.

Biometrics system is used almost everywhere for the security and personal recognition. The Palm print is one of the most reliable physiological characteristics that can be used to distinguish between individuals [3]. Palm print recognition refers to the process of determining whether two palm prints are from the same person based on line patterns of the palm. Palm print is referred to the principal lines, wrinkles and ridges appear on the palm.

Recently, many researchers have focused on face and voice verification systems; nevertheless, their performance is still far from satisfactory. Compared with the other physical characteristics, palm print authentication has several advantages [8]. Palm print serves as a reliable human identifier because the print patterns are not duplicated in other people, even in monozygotic twins. More importantly, the details of these patterns are permanent [13]. The rich structures of the palm print offer plenty of useful information for recognition [11]. The advantages of using a palm print as a biometric signature for authentication purposes are listed below:-

1. Low resolution imagery
2. Low intrusiveness

3. Stable features
4. High acceptance ratio
5. Low detail loss

Taking advantages of the above listed properties, a authentication system is developed that utilizes the features from palm print as a unique signature for the authentic users and allow or bar users from accessing the system based on the result whether the palm print has been successfully matched or not. The system utilizes feature extraction using SVD (singular value decomposition technique) and then applying neural networks for identification purpose based on the features extracted from the unknown user [5]. The system has an added advantage over the conventional systems that the system is capable of self-learning, every time the system is used for authentication purposes it gives a feedback to its master database about the user and stores the palm print as an authentic or a fraud user. The section II represent the complete methodology developed to design the system so described.

II. METHODOLOGY

The entire process of self-learning palm recognition system can be divided into 6 steps, which starts from Acquisition of palm print to final feedback to the database. These steps are explained below

1.Palmprint Acquisition: A palm print refers to an image acquired of the palm region of the hand. It can be either an online image (i.e. taken by a scanner, or CCD) or offline image where the image is taken with ink and paper. CCD standing for a charged coupled device. The image of the palm is captured using different orientation of the hand of users, the different orientation were so choose so as that every user rotate his or her palm by certain degree after each scan, the same degree of orientation was followed for all users too, who are supposed to be the authentic users of the system, which is guarded by the palm print identification or recognition system. The image of different orientation for same users were recorded so as to increase the entry in the master authentic user database which enhances the better training capability of the neural network and terminates the probability of false identification to least. The larger the number of images in different orientations the better the probability of authentic result. Orientation of the palm is governed by the peg positions it is done so that image of palm of all users are recorded in exactly the same orientation. The rest of the area other than the area of interest is masked using Physical and digital filters.

2. Database Creation and Sorting: The database so created by acquiring the palm images need to be stored in a logical structure. To store the images the most basic step of sorting and storing is applied. The users having higher order of preference in alphabetic order was stored first and least alphabetic preference is stored at last. For example a person named Ram has his palm prints stored before the person having name Saroj. The palm prints or images are further stored in order of their orientation i.e. zero degree followed by thirty degree and so on.

3. Data Compression and Grayscale storing: The data so captured using the CCD device is stored after it has been compressed the compression algorithm being applied during the acquisition only and is stored as a grayscale image the explanation to the statement follows: A. The data is segmented and compressed by the hardware only because if the data is compressed using digital compression algorithms or pre-processing techniques, there is a huge probability that the algorithm will distort the biometric characteristics of the palm image and will lead to false recognition of the print. B. The image is stored in grayscale only so as to capture the maximum possible resolution of the image as all the energy reflecting from the hand is stored and is not stored as separate bands after getting filtered from respective color filters. Storing the image as grayscale always enhances the resolution of the image so stored.

4. The Feature extraction from the palm image and Threshold Detection: Over the past decades, palm image compression, representation and recognition has drawn wide attention from researchers in areas of computer vision, neural network, pattern recognition, machine learning, and so on. The application of palm recognition includes: Access Control based on the palm recognition, Computer human interaction, Information Security, Law enforcement, Smart Car etc. When an image is SVD transformed, it is not compressed, but the data take a form in which the first singular value has a great amount of the image information. With this, we can use only a few singular values to represent the image with little differences from the original.

To illustrate the SVD image compression process, detail procedures are:

$$A = \sum_{i=1}^{r} USV = \sigma_1 u_1 v1^T + \sigma_2 u_2 v2^T + \cdots .. + \sigma_r u_r vr^T \quad (1)$$

SVD or Eigen decomposition approach treats a set of known palms as vectors in a subspace, called "palms space", spanned by a small group of "base palms". It's like Principal Component Analysis (PCA), recognition is performed by projecting a new image onto the palms space, and then classifying the palms by comparing its coordinates (position) in palms space with the coordinates (positions) of known palms. However, the SVD approach has better numerical properties than PCA.

In this case, we redefined the matrix A (equation (1)) as set of the training palm. Assume each palm image has $m \times n = M$ pixels, and is represented as an $M \times 1$ column vector $\mathbf{f_i}$, a 'training set' S with N, Number of palm images of known individual's forms an $M \times N$ matrix:

$$S = [f_1 f_2 f_3 f_4 \ldots\ldots f_N] \qquad (2)$$

The mean image $\bar{\boldsymbol{f}}$ of set S (equation (2)), is given by $\frac{1}{N}\sum_{i=1}^{N} f_i$

Subtracting $\bar{\boldsymbol{f}}$ from the original faces gives $a_i = f_i - \bar{f} \ldots\ldots i = 1,2,\ldots N$

This forms another M x N matrix A:

A= $[a_1 a_2 a_3 \ldots\ldots a_N]$

Since {$\mathbf{u_1}$, $\mathbf{u_2}$,...,$\mathbf{u_r}$ } form an orthonormal basis for $R(A)$, the range (column) subspace of matrix A. Since matrix A is formed from a training set S with N palm images, $R(A)$ is called a 'palm subspace' in the 'image space' of $m \times n$ pixels, and each $\mathbf{u_i}$, $i = 1, 2, \ldots, r$, can be called a 'base palms'.

Let x = $[x_1\ x_2 \ldots\ldots x_r]^T$ be the coordinates (position) of any $m \times n$ palm image f in the palm subspace. Then it is the scalar projection of f - $\bar{f}$ onto the basepalms:

$$x = [u_1\ u_2\ u_3 \ldots\ldots u_r]^T (f - \bar{f})$$

This coordinate vector x is used to find which of the training palms best describes the Palm f. That is to find some training palm $\mathbf{f_i}$,i= 1, 2, ..., N , that minimizes the distance:

$$\in_i = ||x - x_i||_2 = [(x - x_i)^T (x - x_i)]^{1/2}$$

Where $\mathbf{x}_i$ is the coordinate vector of $\mathbf{f_i}$, which is the scalar projection of $\mathbf{f} - \mathbf{f}_i$ onto the base palms:

$$x_i = [u_1\ u_2 \ldots u_r]^T$$

A palm **f** is classified as palm $\mathbf{f_i}$ when the minimum $\in_i$ is less than some redefined threshold. Otherwise the palm f is classified as "unknown palm". If **f** is not a palm, its distance to the palm subspace will be greater than 0. Since the vector projection of **f** - **f** onto the palm space is given by equation (3).

$$f_p = [u_1\ u_2 \ldots u_r]x \qquad (3)$$

The distance of, f to the palm space is the distance between f - $\bar{f}$ and the projection f p onto the palm space:

$$\in_f = [(f - \bar{f} - f_p)^T (f - \bar{f} - f_p)]^{1/2} \qquad (4)$$

If $\in_f$ is greater than some predefined threshold $\in_1$, then **f** is not a palm image.

5. Neural Network Training and Recognition: The neural network in this case is used to detect and the threshold and classify them to category of authorized data and unauthorized data or palm prints. The threshold so obtained, where feed to the neural network training algorithm. After the machine has been trained the data from a random user either authorized person or an unauthorized person is taken, and the same procedure that is from acquisition to obtaining the Euclidean or eigen distance is performed once the eigen distance is obtained from the random user it is then feed to the neural network recognition system that will be working on the training sets given previous generated by decomposition of master database.

6. Feedback to the database: After the palm print is recognized as a true or authentic palm print the acquired palm print with its features are then feed to the database are stored in the database as the information about the authentic user, the incorrect palm prints are straight forwardly rejected, due to memory restrictions only first 300 authentic palmprints are stored in the database after the system came into existence.

The diagram shown in figure 1, represents the architecture of the system so designed

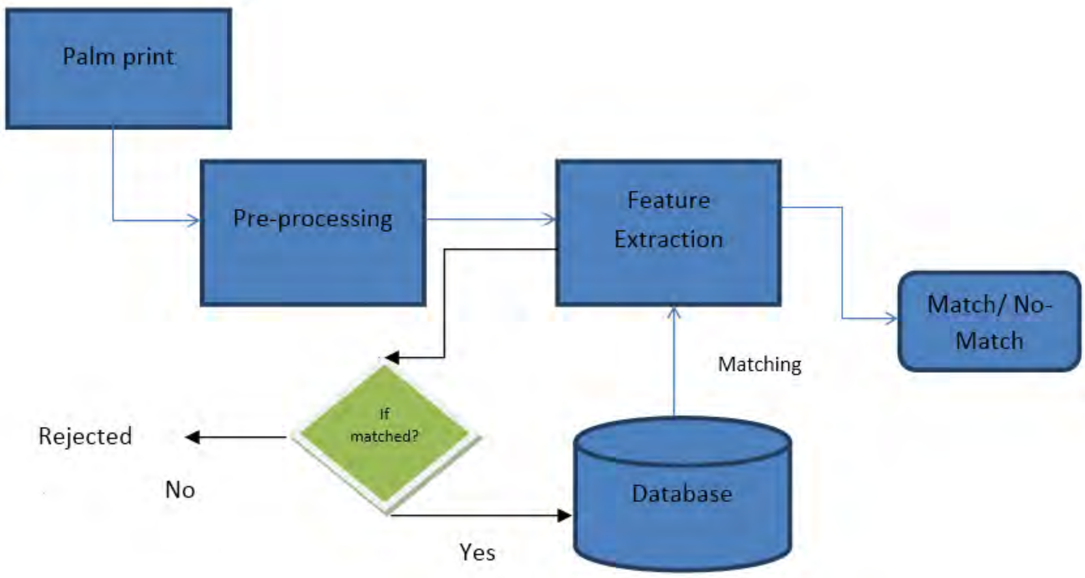

Figure 1: The system design architecture of Palm print recognition system: Self-Learning

Figure 2 Shows, the process flow diagram for the recognition system.

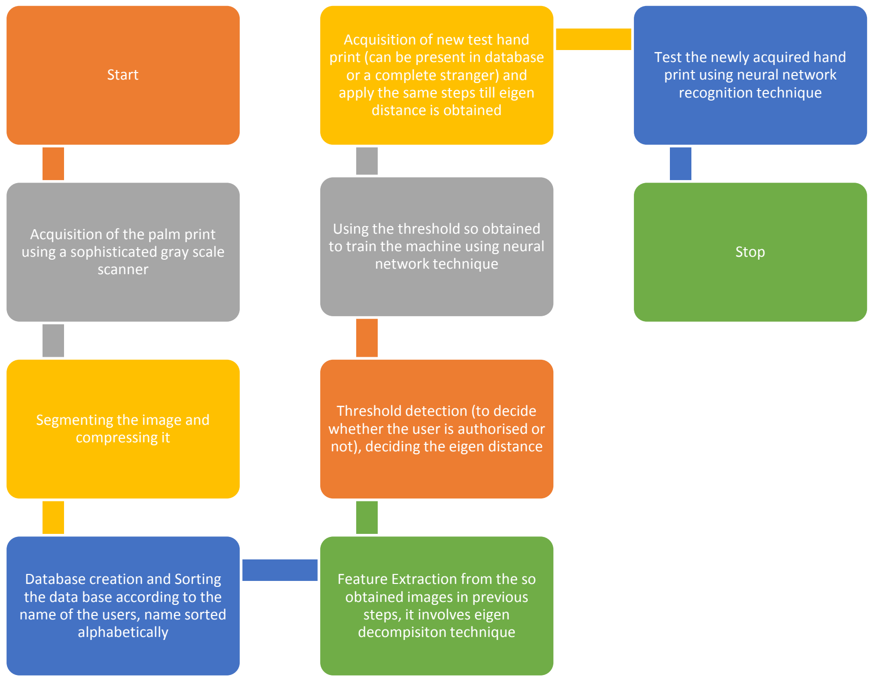

Figure 2: The process flow diagram for the palm print recognition system: self-learning

III. RESULTS

Data used: palm prints for testing were acquired from the IIT Delhi Touchless Palmprint Database. The data was then segmented to get the desired palm print. Software used was Matlab 2013. Figure 3 shows the result obtained from segmentation process also known as masking process.

Figure 3: Depiction of Masking Process, segmentation

After segmentation is done the rearrangement of the palm prints in the desired format discussed in the methodology section is performed, depicted in figure 4, this process is at most important as a little discrepancy in arrangement schedule will result in erroneous results.

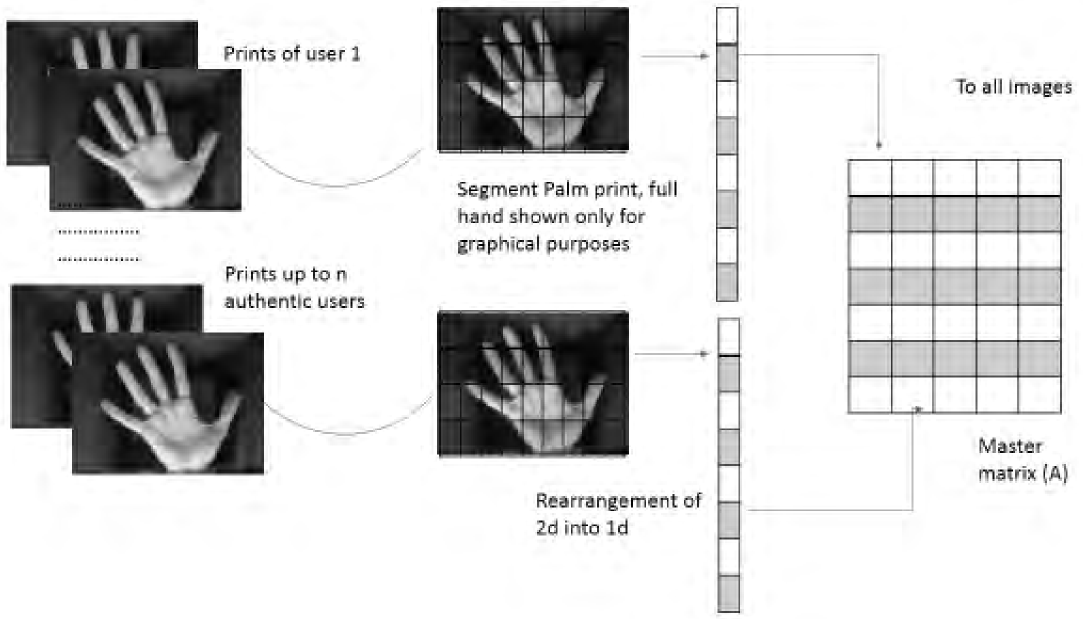

Figure 4: Representation of rearrangement process for master database creation

After the rearrangement is done using the methods explained in the methodology section is continued on the data so obtained by rearrangement, the operations are performed and features of authentic user are extracted and subsequently the machine is trained for recognizing the authentic user of the system. A newly acquired palm print is tested for authenticity, using the process described in the methodology, starting first by segmenting the touch less palmprint acquired by the system to rearrangement followed by calculating the Eigen distance and then making the decision on the basis of neural networks.

In the figure 5, the confusion matrices generated by the network are depicted. Each matrix is representing the number of classes that are correctly matched to the actual result shown in green cells and number of classes that are not correctly matched as shown in red color for training, validation and testing palm samples. The non-diagonal elements being zero confirms that we have 100 percent accuracy.

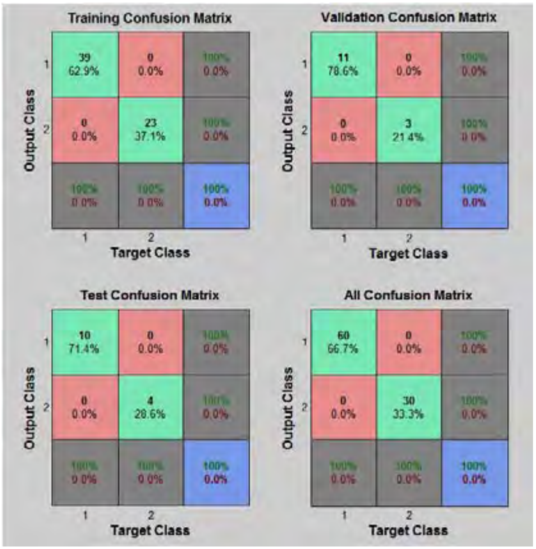

Figure 5: Result Matrices after training

The Graphs in the figure 6 and 7 are Showing 100 % correlation between actual output and desired output which means there is a 100% correlation.

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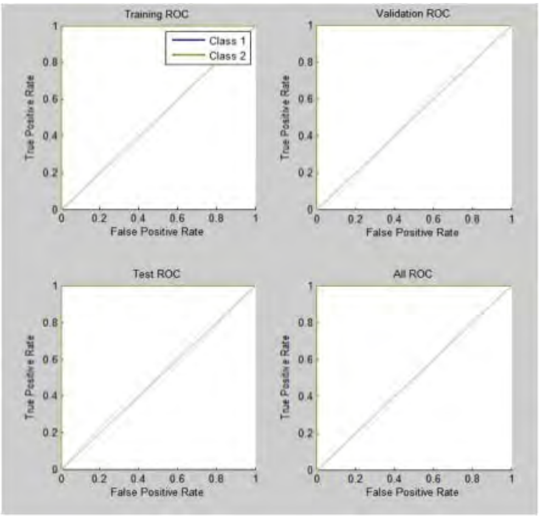

Figure 6: Correlation Graphs

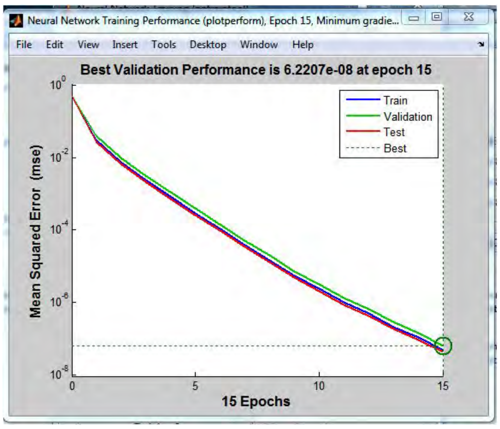

Figure 7: Best Validation Performance

Figure 7 showing rapid MSE decrease in very less time which concludes efficient response. One epoch can be considered as the time taken by the network to learn once. Yet again the figure 8 shows impressive response as most of the samples are shoeing very low error. 20 error levels or bins are considered. Legends are shown along with the figure. Out of every sample tested our system gave a 100% rejection rate that means it never allowed a false identity to pass as authentic user while good rejection percentage was 98.6% that means out of 100

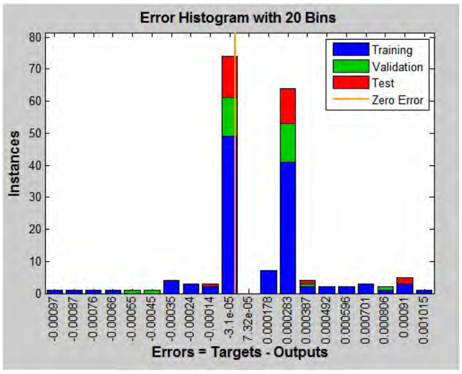

Figure 8: Error Histogram

CONCLUSION

After completing this study, the first conclusion is that for extraction of features, SVD is one of the best approaches in terms of dimensionality reduction as well as in terms of stability. SVD is a stable and effective method to split the system into a set of linearly independent components, each of them is carrying own data (information) to contribute to the system. SVD has the advantage of providing a good compression ratio, and that can be well adapted to the statistical variation of the image, but it has the disadvantage that it is not fast from the computational point of view, and the problem of which its application is strongly conditional due to the excessive work of associate calculations While performing such studies there should be a data resource available within the vicinity of study site. In this study, due to limitation of such resource, a library of palms has to be imported from IIT Delhi and University of Beijing under the request of use for educational purposes. Next is that SVD is a good technique for feature extraction as it removes the limitation of input image being square matrix. Apart from this it is better than PCA. Lastly, neural networks are very good pattern classifiers. Any pattern classification problem can be solved efficiently using neural networks by optimally selecting the number of hidden layers. Increased efficiency can be observed by the time to reach to the minimum MSE.

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