IJDACR
ISSN: 2319-4863

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 4, Issue 10, May 2016)

Effective Approach of Palmprint Recognition using PCA, DWT and Neural Network

Mamta Dewangan
mmtdewangan@yahoo.co.in

Lalit Kumar P. Bhaiya
lalit04bhaiya@yahoo.com

Abstract –**Palmprint is an important counterpart and reliable biometric that can be used for identity verification because it is stable and unique for every individual. The procedure of implementation is divided into two phases, training phase and testing phase. In training phase there are three sub processes; pre-processing, feature extraction and feature matching. Pre-processing is done with the help of image resizing and RGB to Gray conversion. For feature extraction, we have used Gabor Filter and Discrete Wavelet Transform (DWT). Principal Component analysis (PCA) is used for dimensionality reduction. The extracted features are then stored in database. In the testing phase the same process is done up to the PCA and then the similarity measure with database is done. Neural Network Classifier is used for similarity measure.**

Keywords – **DWT, Neural Network, PCA, RGB to Gray.**

I. INTRODUCTION

The term "biometrics" is derived from the Greek words "bio" (life) and "metrics" (to measure). Automated biometric systems have only become available over the last few decades, due to significant advances in the field of computer processing. Many of these new automated techniques, however, are based on ideas that were originally conceived hundreds, even thousands of years ago.

One of the oldest and most basic examples of a characteristic that is used for recognition by humans is the face. Since the beginning of civilization, humans have used faces to identify known (familiar) and unknown (unfamiliar) individuals. This simple task became increasingly more challenging as populations increased and as more convenient methods of travel introduced many new individuals into - once small communities. The concept of human-to-human recognition is also seen in behavioural-predominant biometrics such as speaker and gait recognition. Individuals use these characteristics, somewhat unconsciously, to recognize known individuals on a day-to-day basis. The need for biometrics can be found in federal, state and local governments, in the military, and in commercial applications. Enterprise-wide network security infrastructures, government IDs, secure electronic banking, investing and other financial transactions, retail sales, law enforcement, and health and social services are already benefiting from these technologies.

Biometric System

Biometric is automated method of recognizing a person based on a physiological or behavioural characteristic. Among the features measured are; face fingerprints, hand geometry, handwriting, iris, retinal, vein, and voice. Biometric technologies are becoming the foundation of an extensive array of highly secure identification and personal verification solutions. As the level of security breaches and transaction fraud increases, the need for highly secure identification and personal verification technologies is becoming apparent.

Biometric-based solutions are able to provide for confidential financial transactions and personal data privacy.

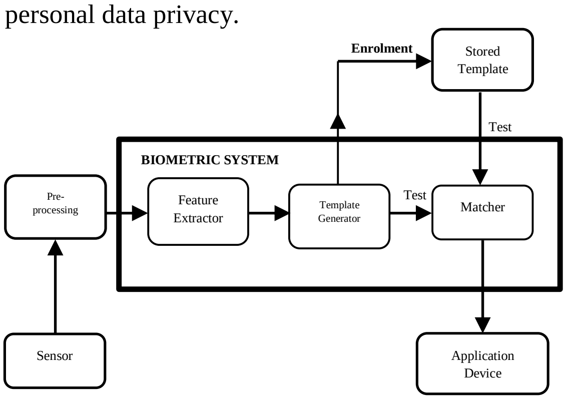

Figure 1: Biometric System

Palmprint Recognition

Palmprint has become an important complement to personal identification because of its advantages

IJDACR
ISSN: 2319-4863

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 4, Issue 10, May 2016)

such as low resolution, low cost, non-intrusiveness and stable structure features. The palm, the inner surface of the hand between the wrist and the fingers, consists of three parts: principal lines, wrinkles and ridges. There are three principle lines made by flexing the hand and wrist in the palm, which are usually defined as life line, heart line, and head line. Wrinkles and ridges are the coarse and fine lines of the palmprint respectively. The high resolution images can generally extract all the features while in low resolution only principal lines, wrinkles can be extracted. For real time applications low resolution images are used as they have less storage memory and fast matching speed.

Figure 2 shows the generalized palmprint recognition system.

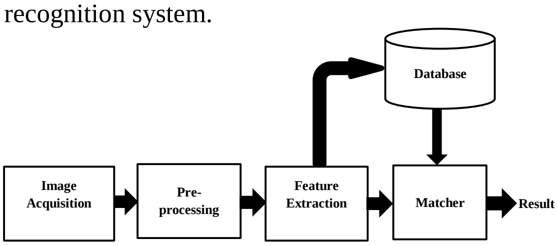

Figure 2: Basic block diagram of palmprint recognition system

Current framework has numerous disadvantages as far as recognition accuracy that they cannot perceive the palm print in the most pessimistic scenarios, and these shortcomings are specifically relies on the feature extraction strategy utilized. This persuade us to utilize PCA and DWT based feature extraction approach which perform better as contrast with alternate methodologies and with make a framework by utilizing that feature extraction procedure which is more effective as contrast and the present situation.

II. Previous Work

Some papers are reviewed for palmprint recognition and after reviewing them, aimed methodology is proposed:

Sang et al. proposed a robust, touchless, palmprint recognition system which is based on color palm-print images. This system uses skin-color thresholding and hand valley detection algorithm for extracting palmprint. Then, the local binary pattern (LBP) is applied to the palmprint in order to extract the palmprint features. Finally, chi square statistic is used for classification [1].

Khalifa et al. presented an authentication system based on the palmprint. This paper particularly interested in the feature extraction step. Three feature extraction techniques based on the discrete wavelet transform, the Gabor filters and the co-occurrence matrix are evaluated. The support vector machine is used for the classification step [2].

Puranik et al. proposed an innovative touch-less, web camera based palm print recognition system. It describes to use a low-resolution web camera to capture the user's hand at a distance for recognition. The user does not need to touch any device for their palm print to be acquired. This system consists of two parts: a novel device for online palmprint image acquisition and an efficient algorithm for fast palmprint recognition [3].

Shriram et al. proposed a Biometric Palm print lines extraction using image processing morphological operation. This work discusses the significance; since both the palm print and hand shape images are proposed to extract from the single hand image acquired from a sensor. The basic statistical properties can be computed and are useful for biometric recognition of individual. It describes biometric recognition of individual by using basic statistical properties of palm print image [4].

Seshikala et al. presented a paper in which the feature extraction of palm print is carried out using multi scale wavelet edge detection. The performance is compared with conventional edge detection techniques like Sobel and Canny methods. The experiment is carried out on a poly-u database and from the analysis it is shown that the performance of multiscale edge detection using wavelet is much superior to that of Sobel and Canny for palm print feature extraction [5].

Shashikala et al. proposed a palmprint identification framework based on DWT, DCT and QPCA (PIDDQ). Histogram equalization is used on palmprint to enhance contrast of an image. The DWT is applied on Histogram equalized image to generate LL, LH, HL and HH bands. The LL band is converted into DCT coefficients using DCT. QPCA is applied on DCT coefficients to generate features. The test and database palmprint features are compared using Euclidean Distance (ED) [6].

Ashutosh et al. proposed a technique for palmprint recognition in context to biometric identification of a person. The palmprint images are mapped to Eigen-space and a robust code signature is generated from different camera snapshots of the same palm to incorporate tonal and lighting variations. To enable real-time identification, the signature is represented by a low dimensional feature vector to reduce computational overheads [7].

Gayathri et al. presented a palmprint based identification approach which uses the Gabor wavelet to extract multiple features available on the palmprint, by employing a feature level fusion and classified using nearest neighbour approach. Here, the features are extracted using wavelet entropy

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 4, Issue 10, May 2016)

consist of contrast, correlation, energy, and homogeneity. The features are fused at feature levels. Palmprint matching is then performed by using nearest neighbour classifier [8].

Guo et al. presented an approach for palmprint recognition from a single image per person based on local information. First, a palmprint image is partitioned into several smaller sub-images, then the feature vectors are extracted by five methods. They are statistics feature, Fourier transform, DCT transform, Gabor transform and local binary pattern (LBP). The feature vectors of all the sub-images are combined together to form the feature vector of the palmprint image. Finally the pattern classification can be implemented by the nearest neighbour classifier. To verify the effectiveness of this approach, an extensive experimental investigation is conducted using Poly U palmprint database [9].

Jayashree et al. presented a paper that attempts to improve the performance of hand-geometry based identification system by integrating palmprint features. Hand-geometry and palmprint features can be collected simultaneously from the same hand image. Fourteen different hand-geometry distances are extracted from the hand image. Texture information from palmprint is extracted using Symmelt-8 wavelet transform. Both hand-geometry and palmprint features are combined at feature level. The identification of the user is carried out using Euclidean distance classifier [10].

III. PROPOSED METHOD

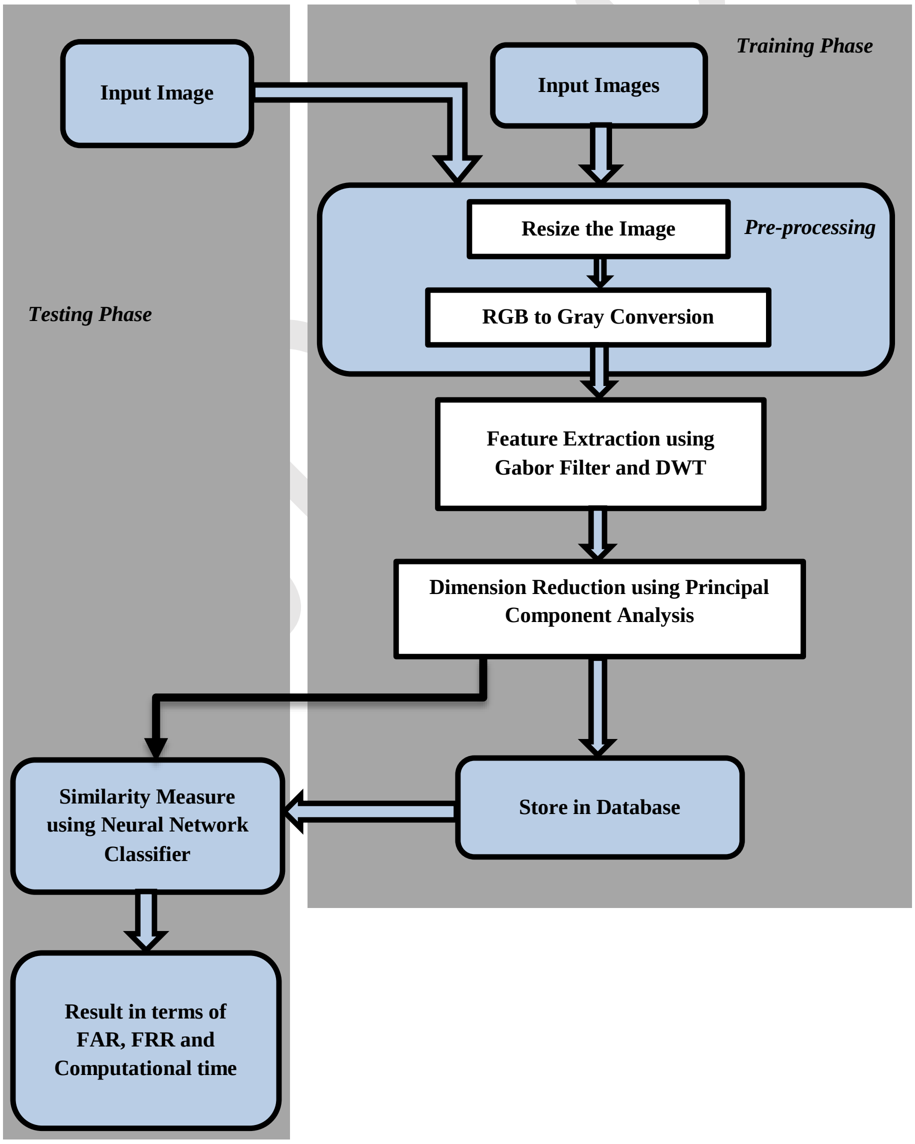

Figure 3: Flowchart for training and testing process for Palm-print recognition

IJDACR
ISSN: 2319-4863

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 4, Issue 10, May 2016)

Palm-print recognition system is developed using Gabor filter, Discrete Wavelet Transform (DWT), Principal Component Analysis (PCA) and Neural Network Classifier. The proposed flow for this research work is shown in Figure 3. Rest of the methodology is explained in following sub-sections:

Pre-Processing Block

The steps involved in pre-processing are shown in Figure 3. The details are as follows:

1. The input image to this block is resized using the inbuilt resize function available in MATLAB. We have resized the image to 250×250 pixels.
2. After resizing, the RGB image is converted to a grey scale image using rgb2gray function.

Feature Extraction Block

Gabor Filter

An image represented in terms $f(x,y)$ where x and y signifies the coordinates of pixels having size M×N is convolved in frequency domain. The Fourier transform is applied as the solution for this step:

$$F\{f(x,y)\} = F(u,v) = \int_{-\infty}^{M-1}\int_{-\infty}^{N-1} f(x,y)e^{-j2\pi\left(\frac{ux}{M}+\frac{vy}{N}\right)}\,dx\,dy \quad (1)$$

In frequency domain the Gabor feature for an image $f(x,y)$ is the multiplication of convoluted image with Gabor filter bank $\Psi(x,y,\omega_m,\theta_n)$ given by:

$$O_{m,n}(x,y) = F(u,v) * \Psi(u,v,\varpi_m,\theta_n) \quad (2)$$

Where, * is the convolution operator. The filter bank is created using m frequencies and n rotations $G(m \times n)$ that provides features points and is saved in form of vector.

Generate Feature Vector: Feature vectors are the matching templates that calculate the distance among the features of exerted information. For an M×N image with centre points (c_i, c_j), the spatial tessellation of region under interest is given by collection of sectors (S_i is the i^th sector)

$$S_i = \{(x,y)|b(T_i+1).r < b(T_i+2), \theta_i \le \theta \le \theta_{i+1}, 1 \le x \le N, 1 \le y \le M\} \quad (3)$$

Where, (Let's say b=10 pixels, K=8 Sectors in each band) and

$$T_i = i\ div \quad (4)$$

$$\theta_i = (i\ mod\ k)\left(\frac{2\pi}{k}\right) \quad (5)$$

$$r = \sqrt{(x-x_c)^2 + (y-y_c)^2} \quad (6)$$

$$\theta = \tan^{-1}\left(\frac{(y-y_c)}{(x-x_c)}\right) \quad (7)$$

On application of Gabor filter, the planes of Gabor response is generated is equal to the number of angles. The mean and standard deviation of Gabor response provides feature vector of single plane and thus in this manner total feature vector can be generated.

Discrete Wavelet Transform (DWT)

Discrete Wavelet transform (DWT) is a mathematical tool for hierarchically decomposing an image. It is useful for processing of non-stationary signals. The transform is based on small waves, called wavelets, of varying frequency and limited duration. Wavelet transform provides both frequency and spatial description of an image. Unlike conventional Fourier transform, temporal information is retained in this transformation process. Wavelets are created by translations and dilations of a fixed function called mother wavelet.

The DWT is nothing but a system of filters. There are two filters involved, one is the "wavelet filter", and the other is the "scaling filter". The wavelet filter is a high pass filter, while the scaling filter is a low pass filter. DWT includes many kinds of transforms, such as Haar wavelet, Daubechies wavelet, and others. Figure 4 shows the workflow of DWT.

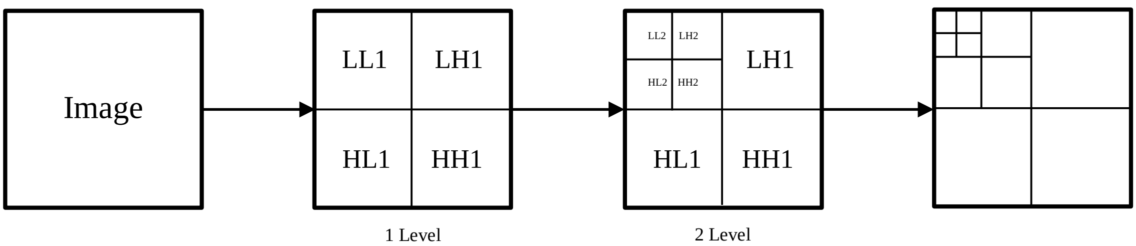

Figure 4: The workflow of discrete wavelet transform

IJDACR
ISSN: 2319-4863

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 4, Issue 10, May 2016)

After applying a 1-level DWT on image, we get the approximation sub-band LL, the horizontal sub-band LH, the vertical sub-band HL, and the diagonal sub-band HH. Moreover, if we apply a 2-level DWT on the image, we just simply apply another 1-level DWT on the approximation sub-band LL. After applying a 2-level DWT, we also get the approximation sub-band LL2, the horizontal sub-band LH2, the vertical sub-band HL2, and the diagonal sub-band HH2 of the approximation sub-band LL other than sub-bands LH, HL, HH. Applying IDWT to LL, HL, LH, and HH, we can get four different frequency's images that are low frequency image, middle-low frequency image, middle high frequency image, high frequency image separately.

Dimension Reduction using Principal Component Analysis (PCA)

Dimension Reduction of palmprint features is done using the PCA method. Let there are R images in the training set and each image X_i is a 2-dimensional array of size $m \times n$ of intensity values. An image X_i can be converted into a vector of D ($D = m \times n$) pixels, where $X_i = (x_{i1}, x_{i2}, \dots., x_{iD})$. The rows of pixels of the image are placed one after another to form the vector.

Define the training set of R images by:

$$X = (X_1, X_2, \dots, X_R) \subset \Re^{D \times R} \quad (8)$$

The covariance matrix is defined as follows:

$$\text{con (X, Y)} = \frac{\sum_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y})}{(n-1)} \quad (9)$$

$$= \emptyset\emptyset^T$$

Where,

$\emptyset = (\emptyset_1, \emptyset_2, \dots, \emptyset_R) \subset \mathcal{R}^{D \times R}$ and $\bar{X} = \frac{1}{(n-1)}\sum_{i=1}^{n} X_i$

which is the mean image of the training set. The dimension of the covariance matrix Γ is $D \times D$. Then, the eigenvalues and eigenvectors are calculated from the covariance matrix Γ. Let Q= $(Q_1, Q_2, \dots, Q_R) \subset \mathcal{R}^{D \times R} (r < R)$ be the r eigenvectors corresponding to r largest non-zero eigenvalues. Now, each of the images of the training set X_i is projected into the eigenvector to obtain its corresponding feature $Z_i \subset \mathcal{R}^{D \times R}$ which is defined as follows:

$$Z_i = Q^T Y_i, i = 1,2, \dots, R \quad (10)$$

Where, Y_i is the reduced dimension image of X_i.

Similarity Measure using Neural Network Classifier

The dissimilarity of sample and model distance is a performance parameter (accuracy). In this paper, the dissimilarity between a training set and a testing set is measured by the Neural Network approach.

The Artificial Neural Network (ANN) is the replica of animal's central nervous system specifically designed to meet the interests of machine learning for pattern recognition. The Neural Network is a three layer paradigm that entertains the input and processes it to generate output. Being user dependent for its design ANN has no single definition [11].

Back Propagation Neural Network (BPNN) generates complex decision boundaries in feature space. BPNN in specific circumstances resembles Bayesian Posterior Probabilities at its output. These conditions are essential to achieve low error performance for given set of features along with selection of parameters such as training samples, hidden layer nodes and learning rate. In else case, the performance of BPNN could not be evaluated. For W number of weights and N number of nodes, numbers of samples (m) are depicted to correctly classify future samples in following manner:

$$m \geq O\left(\frac{W}{\epsilon}\log\frac{N}{\epsilon}\right) \quad (11)$$

The theoretical computation of number of hidden nodes is not a specific process for hidden layers. Testing method is commonly entertained for selection of these followed in the constrained environment of performance [11].

IV. Simulation And Results

The performance of proposed algorithms has been studied by means of MATLAB simulation.

For Left Palm

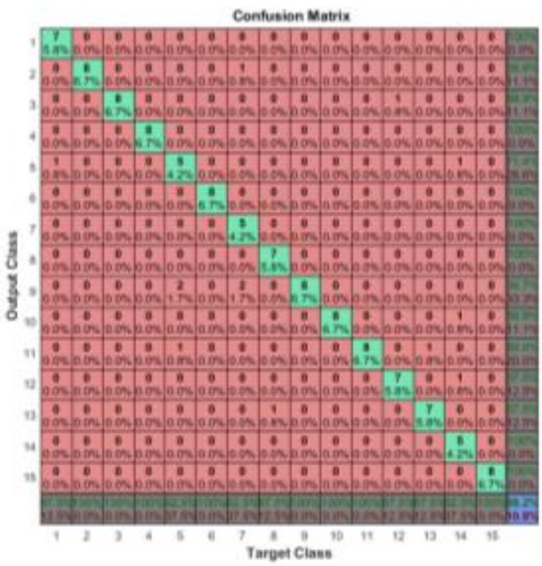

Figure 5: Confusion matrix plot for left palm

IJDACR
ISSN: 2319-4863

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary Research

Website: www.ijdacr.com (Volume 4, Issue 10, May 2016)

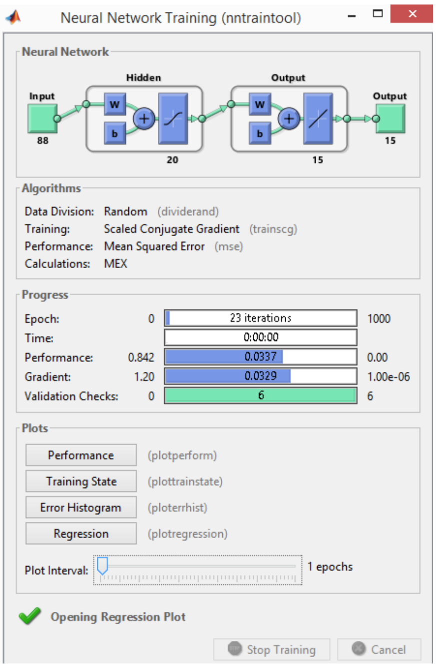

Figure 6: Neural Network training

Figure 6 shows the training of neural network. Epoch are set to 1000 iterations.

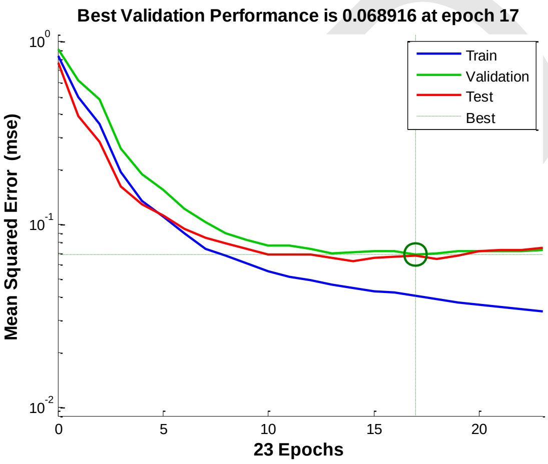

Figure 7: Mean squared error performance graph

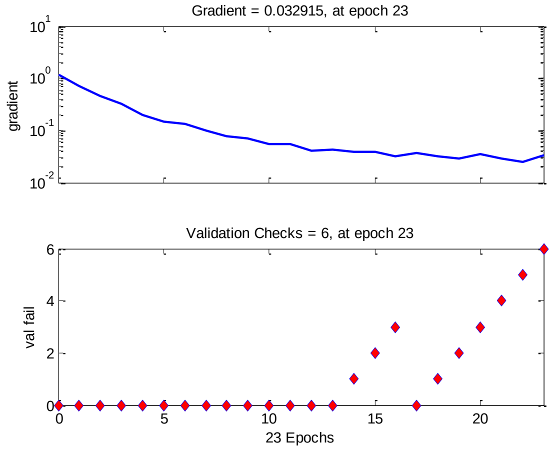

Figure 8: Performance graph for gradient and validation checks

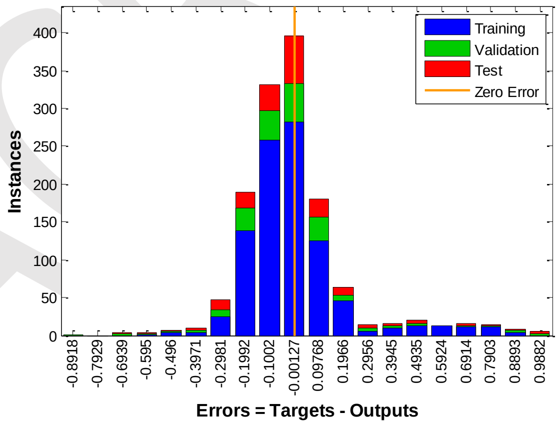

Figure 9: Error Histogram plot

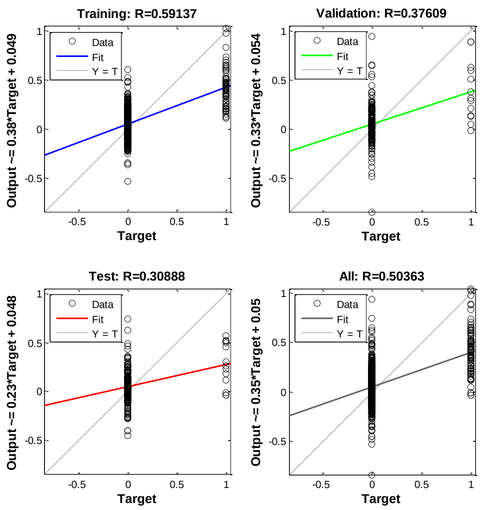

Figure 10: Final output

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 4, Issue 10, May 2016)

For Right Palm

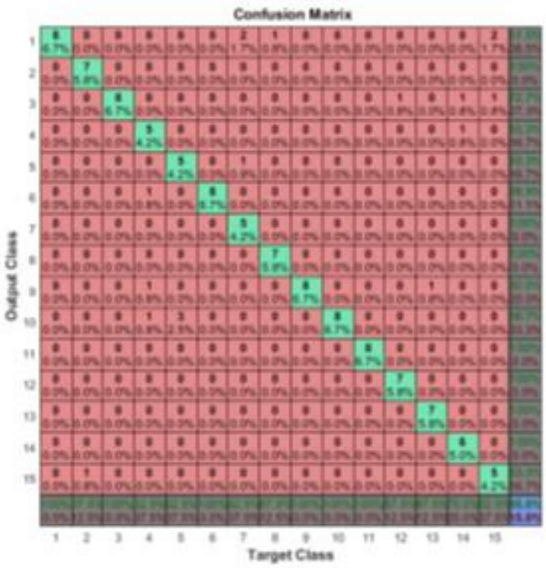

Figure 11: Confusion matrix plot for right palm

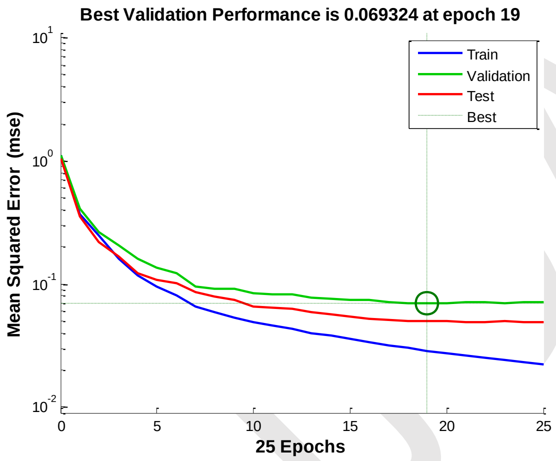

Figure 12: Mean squared error performance graph

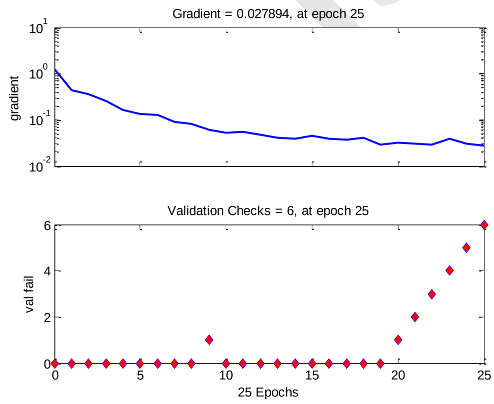

Figure 13: Performance graph for gradient and validation checks

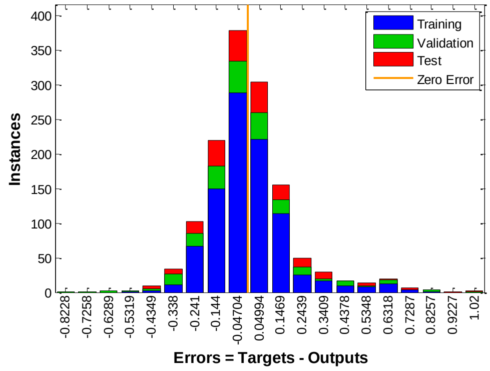

Figure 14: Error Histogram plot

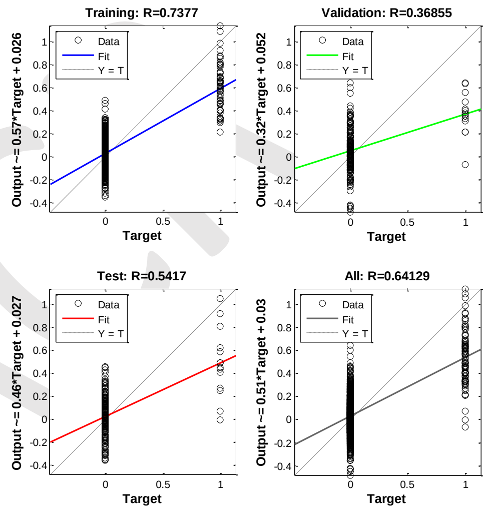

Figure 15: Final output

V. CONCLUSION

A training procedure is necessary to construct palmprint model in our approach, that is, the method is entirely dependent on the training set. Verification tests on our palmprint database are used to choose a group of optimal parameters for the proposed method. The proposed method with these appropriate parameters is used to perform accuracy test on our palmprint database and the palmprint database. There is another phase called testing phase is used for an image for which the similarity measure is done with the help of neural network classifier method. The experimental results demonstrate that the proposed approach give a better performance in terms accuracy.

REFERENCE

[1] Haifeng Sang, Yueshi Ma, Jing Huang, “Robust Palmprint Recognition Base on Touch-Less Color Palmprint Images Acquired”, Journal of Signal and Information Processing, PP.134-139, 2013.

[2] Anouar Ben Khalifa, Lamia Rzouga, Najoua Essoukri BenAmara, “Wavelet, Gabor Filters and Co-

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 4, Issue 10, May 2016)

occurrence Matrix for Palmprint Verification", International Journal of Image, Graphics and Signal Processing (IJIGSP), ISSN: 2074-9082, Vol. 5, No. 8, June 2013.

[3] Apurva Puranik, Rahul Patil, Varsha Patil, Milind Rane, "Touch less, Camera Based Palm Print Recognition", International Journal of Applied Research and Studies (IJARS) ISSN: 2278-9480, Volume 2, Issue 4, April 2013.

[4] Mr. Shriram D. Raut, Dr. Vikas T. Humbe, "Biometric Palm Prints Feature Matching for Person Identification", International Journal of Modern Education and Computer Science (IJMECS), ISSN: 2075-0161, Vol. 4, No. 11, December 2012.

[5] G. Seshikala, Dr. Umakanth Kulkarni, Dr. M. N. Giriprasad, "Palm Print Feature Extraction Using Multi Scale Wavelet Edge Detection Method", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, ISSN: 2278 – 8875, Volume 1, Issue 1, July 2012.

[6] K. P. Shashikala, K. B. Raja, "Palmprint Identification Based on DWT, DCT and QPCA", International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-1, Issue-5, June 2012.

[7] Ashutosh Kumar, Ranjan Parekh, "Palmprint Recognition in Eigen-space", International Journal on Computer Science and Engineering (IJCSE), ISSN : 0975-3397, Vol. 4, No. 05, PP. 788-794, May 2012.

[8] R. Gayathri, P. Ramamoorthy, "Multifeature Palmprint Recognitionusing Feature Level Fusion", International Journal of Engineering Research and Applications (IJERA), ISSN: 2248-9622, Vol. 2, Issue 2, PP.1048-1054, April 2012.

[9] Jinyu Guo, Yuqin Liu, Weiqi Yuan, "Palmprint Recognition Using Local Information From a Single Image Per Person", Journal of Computational Information Systems, ISSN: 1553-9105, Vol. 8, Issue 8, PP. 3199-3206, April 2012.

[10] Jayashree I. Kallibaddi, S.M. Hatture, Sadanand R. Inamdar, "Hand Image Analysis for Personal Authentication", XI Biennial Conference of the International Biometric Society (Indian Region) on Computational Statistics and Bio-Sciences, March 2012.

[11] Christos Stergiou and Dimitrios Siganos, "Neural Networks", Report available at: http://www.doc.ic.ac.uk/~nd/surprise_96/journal/vol4/cs11/report.html