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Accurate Personal Identification Using Left and Right Palmprint Images Based on ANFIS Approach

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Abstract: The aim of present research work on palmprint recognition using discrete wavelet packet transform (DWPT) algorithm for feature extraction & ANFIS (Adaptive Neuro-Fuzzy Inference System) for palmprint matching. Biometrics based fingerprint, face, iris recognition has been investigated over many year. Palmprint recognition is an emerging technology in recent years due to the transaction frauds, security breaches and personal identification etc. compare to fingerprint, palmprint contain rich features like, principle line, wrinkles, ridges, and minute points, and it provides high standard security. This paper developing multibiometrics using left and right palmprint images and gives higher accuracy then single biometrics system. Registered IITD palmprint database is collected from IIT Delhi, biometric research library. It consist 2600 images from both left and right hand. This experiment perform palmprint recognition for enhance security using IITD database. MATLAB have been used as the programming tool to implement and investigate the performance of the segmentation and feature extraction method using image processing toolbox.

Keywords: Biometrics, Multibiometrics, Left and Right Palmprint Image, Feature Extraction, Discrete Wavelet Packet Transform (DWPT)

1. Introduction

Biometrics is an emerging technology in the field of various pattern recognitions. Biometric identification system used to deal with security problem and also for identifying individuals in a fast and reliable way through the use of unique biological characteristics. For security purpose, the identification of a person is carrying out with signature, user id, password and cards. At present day, these techniques are not appreciable because signature can be replicated, keys and passwords are difficult to forgot or lose. For such reason biometric system usually associate with the use of biological and physiological characteristic of people such as finger print, face, iris, gait, and voice for personal identification. Biometric refer two type of identity matching: identification and verification. Identification is a process of matching one image or biometric samples against N image of previously stored samples. Verification is a process of matching one-to-one between a previously acquired template of an individuals and a sample which we want to authenticate [1-2].

Palmprint identification has emerged as one of the popular and promising biometric technologies for personal identification. It is the process of matching an unknown palmprint against a database of known prints to establish a person's identity. Palmprint is a kind of human physiological trait, has considerable potential for person recognition. Palm is defined as the inner surface of our hand between wrist and fingers. The inner surface of palm contains three flexion creases, secondary creases, and ridges for each finger. The flexion and secondary creases are also called principal line and wrinkles respectively. Palmprint feature also includes singular point, ridges, wrinkles, and delta, datum and minutiae points. Palm has a larger area than, it contain lot of information compare to fingerprint. Palm features are unique for every individual and have rich information that can be used for feature extraction [4]. There are two methods for capture the palmprint images: offline and online. An offline palmprint identification system palm images are collected by ink on to the paper. In the past few years, some researchers have worked on offline palmprint images, which are obtained useful result. Recently work on online palmprint that are captured by

scanner, digital camera or CCD (charge-couple device) cameras that is typically connected directly to the identification system In past decades various palmprint identification method are proposed, such as coding based method, principle curve method and subspace based method. In recent years, 2D appearance based method such as 2D Principal Component Analysis (2DPCA), 2D Linear Discriminant Analysis (2DLDA), 2D Locality Preserving Projection (2DLPP) and Scale Invariant Feature Transform (SIFT) have been used for palmprint identification [3-9].

Biometrics system based on a single biometric characteristic are called unimodal biometric system. Unimodal biometric system uses a single biometric trait of person and it cannot gives as perfect identification. The Multimodal biometric systems are providing identification and human security over last few decades. Limitation of unimodal biometrics systems are Noisy data, Intra-class Variation, Inter-class Similarities, Non universality, Spoof attack etc, which tend to increase False Acceptance Rate [FAR] and False Rejection Rate [FRR], ultimately reflecting towards poor performance of the system. Multimodal biometrics solves the above defined problems by combining the two or more modalities in a verification or identification system. Multimodal biometric address the problem of non-universality, since multiple traits ensure sufficient population coverage and spoofing as it concern with multiple traits or modalities, it would be very difficult for an imposter to spoof or attack multiple traits of genuine user simultaneously. Because of these advantages of multimodal biometrics systems they may be preferred over a single modality even though the storage requirements, processing time and computational demands are much higher [5].

2. Literature Survey

David Zhang et al. proposed a paper "Online Palmprint Identification". In this paper, presents a biometric based online personal identification technology using palmprint. These paper studies about online palmprint collection, pre-processing, feature extraction, and palmprint matching system. The online palmprint databases are collected from Hong Kong Polytechnic University. Database contain 7,752 images from 193 users, each user provide atlest 40 image from both left and right palm. For real time identification, palmprint image captured under different lighting condition using novel CCD based device. After image acquisition and database collection, pre-processing algorithm to extract a central area of palm then 2D Gabor phase encoding method is used for feature extraction from a low-resolution image. A normalized hamming distance is used for palmprint matching system to determine the degree of similarity between given dataset. The overall result shows that good performance in terms of speed. The total execution time is 0.6 seconds, which is fast for real-time identification [6].

S. Ribaric et al. proposed a paper "A Biometric Identification System Based on Eigenpalm and Eigenfinger Feature". In this paper, present a new approach for personal identification using multimodal biometric system. This paper studies about capturing the palmprint image, pre-processing, feature extraction of eigenpalm and eigenfinger, and matching. In image acquisition step, hand image capture using low-cost scanner. In this process created a database of 1,820 samples of 237 users in six month of duration. Then pre-processing is to convert standard image into grayscale image. Hand contour based, six ROI are localized: five strip-like region of finger and one square palm region. These systems based on eigenpalm and eigenfinger feature extraction using Karhunen-Loeve (K-L) transform. To recognize a person identity, matching process is perform between live template and database using K-NN rule. Result shows that 100% recognition rate, 0.58% equal error rate (EER), and 0.72% total error rate (TER) [7].

Rajkumar Mehar et al. proposed a paper, "Fuzzy Logic Approach for Person Authentication Based on Palm-print". In this paper, discuss a method for feature extraction, identification (recognition) techniques of palmprint based on fuzzy logic techniques and some publically available databases. Palmprint databases IITD and polyU are collected for person authentication. Pre-processing and segmentation step does not include in this paper because segmented image are also available in these databases, then these segmented image are used for feature extraction. Canny edge detection filter is to detect the principal line with a threshold value. After that images are divided into sub images and feature obtained from these sub images are combined to generate a single feature vector. This vector is provides to fuzzy inference system as input. The purpose of fuzzy logic is to perform classification task. Classification is to perform by using two component, membership function and fuzzy logic rule. Palmprint recognition system is trained by selecting the training data from any dataset. The testing for system has been performed on IITD, and PolyU databases. Experimental result shows the accuracy of 89.46% [8].

Yong Xu et al. proposed a paper, "Combining Left and Right Palmprint Images for More Accurate Personal Identification". In this paper, present a novel framework to perform multibiometrics by combining the left and right palmprint images. This framework uses a left and right palmprint image and calculates the scores of the test sample with respect to each class. After the crossing matching scores of the left palm image for testing with respect to the reverse right palm image of each class is obtained. The proposed framework performs matching score level fusion to integrate these three kinds of scores i.e. left palmprint image, right palmprint image, and reverse right palmprint image. As the proposed algorithm carefully takes the nature of the left and right palmprint images into account, it can properly exploit the similarity of the left and right palmprints of the same subject. Moreover, the proposed weighted fusion scheme allowed perfect identification performance to be obtained in comparison with different palmprint identification methods. Experimental result shows that the proposed framework obtained very high accuracy [9].

Dr. Raja Murali Prasad et al. proposed a paper, "Highly

Secured Bio-Metric Authentication Model with Palm Print Identification" In this paper, present palmprint based personal identification system, which is a most promising and emerging research area in biometric identification systems due to its uniqueness, scalability, faster execution speed and large area for extracting the features. The input palm image will be registered by applying region of interest (ROI) with morphological operation there by calculate the distance transform and then extracting the low level features using 3-level UDBW transform. These transform calculate feature vectors (FV) then comparison is done by calculating the Euclidean distance between registered palm feature vectors and testing palm print feature vector to obtain the most matched image, whether authorized person's identification is available or not. A simulation result provides higher accuracy and reliable recognition rate [10].

3. Proposed Methodology

Proposed methodology adopted for palmprint image feature extraction is shown in Figure 1. In this work discussion about collection of palmprint database, image preprocessing and segmentation, feature extraction using discrete wavelet packet transform (DWPT) and matching using ANFIS. The detail discussion of all steps in explained below

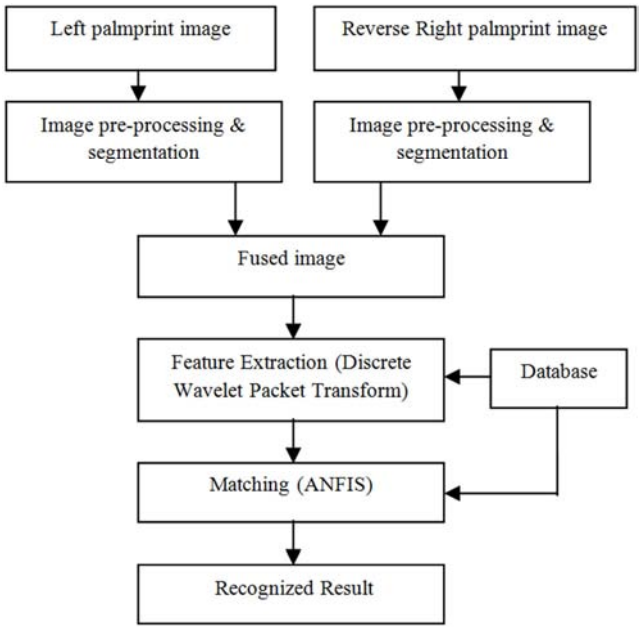

Figure 1. *Block diagram of proposed method.*

3.1. Image Acquisition and Database Collection

Image acquisition is the first and most important step in palmprint identification system. Image acquisition is divided into two categories: offline and online. Recently work in online acquisition method, these can also divide into two types: touch based and touches less. Online palmprint image is captured by different sources like- digital scanner, digital cameras, video cameras, and CCD (charge-couple device) based scanner. CCD based palmprint scanner collect high quality palm images [6].

Figure 2. *Palmprint Scanners; (a) CCD-based palmprint scanner, (b) digital camera.*

The proposed system collect palmprint image from public IITD database developed from staff member and student of IIT Delhi. These are contactless based palmprint database was captured in the indoor environment. This database collected in Biometric Research Laboratory during January 2006 to July 2007 using a CMOS camera. The IITD palmprint database consists of left and right hand 2600 image from 230 users. These are corresponding to 460 different palms in JPG image format. Each hand contribute at least 5 hand image sample in various rotation, translation and variation in pose. In additional segmented image of each sample are also available. These are 800 x 600 pixels in BMP format. In this paper we created segmented image using MATLAB R2016a. After image collection reversed the right palmprint image by using flip function [13].

3.2. Image Preprocessing and Segmentation

As a palmprint is captured using palmprint acquisition device, it may exhibit some distortion through varying condition of time, temperature, humidity, brightness, or other external factor, regardless of the acquisition method. Pre-processing aims to correct these distortions by placing each image under the same coordinate system, so that the correct area of each palmprint is extracted. Palm images acquired are pre-processed to extract its features. The principal lines are significant and minutiae and textures are used as unique information in forensic [8]. The pre-processing steps are summarized as,

a. Binarize the palmprint image with a proper threshold
b. Extracting contour of hand and/or fingers
c. Detect the key points between fingers
d. Establish a coordination system
e. Crop the ROI

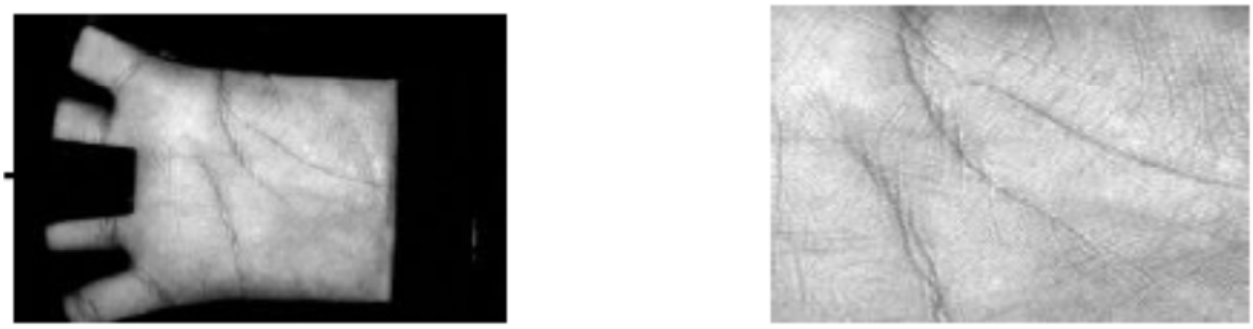

Figure 3. *ROI extraction.*

3.3. Feature Extraction

In image processing application, discrete wavelet transform (DWT) is a mathematical tool applies image decomposition. Wavelet transforms works on both frequency and time domain. DWT works as a filter, it involve two types of filter such as "wavelet filter" and "scaling filter". The wavelet filter is a high pass filter while scaling filter is a low pass filter. DWT has a different transforms such as Haar wavelet, Daubechies wavelet, and other. The discrete wavelet transform represents the signal in its sub-band coefficients. The discrete wavelet transform decompose the signal into its wavelet coefficients. In DWT the decomposition of signal using discrete wavelet transform decomposed in two parts, approximated component and detailed component. Then approximated component again decomposed into two parts but further decomposition of detailed component is not possible.

Discrete wavelet packet transforms similar to the DWT, with difference between them is that the DWPT uses more filters than DWT to decompose the discrete time signal. In the decomposition of signal using wavelet packet transform first of all signal is decomposed into two part approximated component and detailed component then there are further decomposition of both component is possible. There is more data loss occur in discrete wavelet transform as compare to wavelet packet transform because of in DWT the further decomposition of detailed component is not possible where as in WPT further decomposition of detailed component is possible. When image are trained, their respective feature vector are generated. Two feature vectors are generated for per images, obtained using discrete wavelet packet transform (DWPT) algorithm [11].

Feature vector generation using DWPT:

(1) Palm image is masked by Difference in Strength (DIS) Mask.
(2) The masked image is the subjected to Thresholding followed by thinning (using 3 x 5 thinning mask). This separates the principal lines from rest of the lines on palm and also detected principal lines are thinned.
(3) All rows of the palmprint image are scanned and whenever a zero value (black colored) pixel is encountered the row variable is incremented by 1.
(4) DWPT-2 is carried out of this row variable.
(5) All columns of the palmprint image are scanned and whenever a zero value (black colored) pixel is encountered the column variable is incremented by 1.
(6) DWPT-2 is carried out of this column variable.
(7) Feature vector is generated using the row and column DWPT variable.

3.4. Matching

Matching is a process to compared test sample feature vector to the feature stored in the database, and checked with that template from which maximum similarity is obtained. Next matching is successful if the defuzzified value obtained by ANFIS is greater than the threshold value otherwise unsuccessful match. Fuzzy logic has been applied to many biometric matching systems such as face, fingerprint, palmprint recognition and so on. In this paper applied ANFIS (Adaptive Neuro-Fuzzy Inference System) for palmprint matching. The ANFIS combines both fuzzy logic principle and the neural networks concepts. ANFIS can construct mapping based on both human knowledge (in the form of fuzzy if-then rules) and hybrid learning algorithm. ANFIS consists of if–then rules that couples input and output. Also for ANFIS training, learning algorithm of neural network is used. Neural system has multiple inputs and also has multiple outputs, but the fuzzy logic has multiple inputs and single output, so the combination of this two is known as ANFIS [12].

3.5. Recognized Result

The users are authenticated by the palmprint identification system. These accept the users, who are authenticated, i.e. whose palmprint match with a palmprint present in the database. If the user is not authenticated, then the user is rejected. This accepting and rejecting process is done on the basis of matching algorithm and this matching is done on the basis of extracted features.

4. Applications

(1) It is used for personal identification in security for banking, lockers etc.
(2) Used as keyless entry system in automobiles' such as Car, Bus.
(3) Computer logging.
(4) Entering into protecting sites.

5. Result and Discussion

The proposed algorithm is applied on the images in IIT Delhi Touchless Palmprint Database version 1.0. This database is publicly available for download. This database contains left and right hand images from more than 230 subjects. In this experiment 400 palm images of 50 persons which consist of 200 images of right hand 200 images of left hand are taken as the testing and training data. For the proposed approach, after performing the discrete wavelet packet transform, train and test data by comparing ANFIS. The simulation is performed in MATLAB R2016a software by using image processing toolbox.

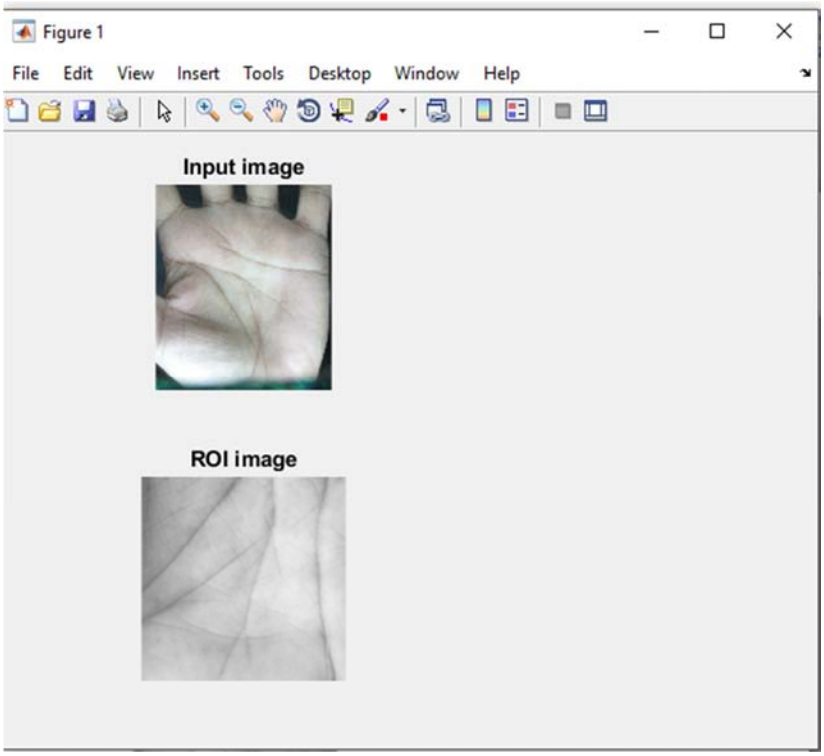

Figure 4[a]. *Left palmprint image & ROI image.*

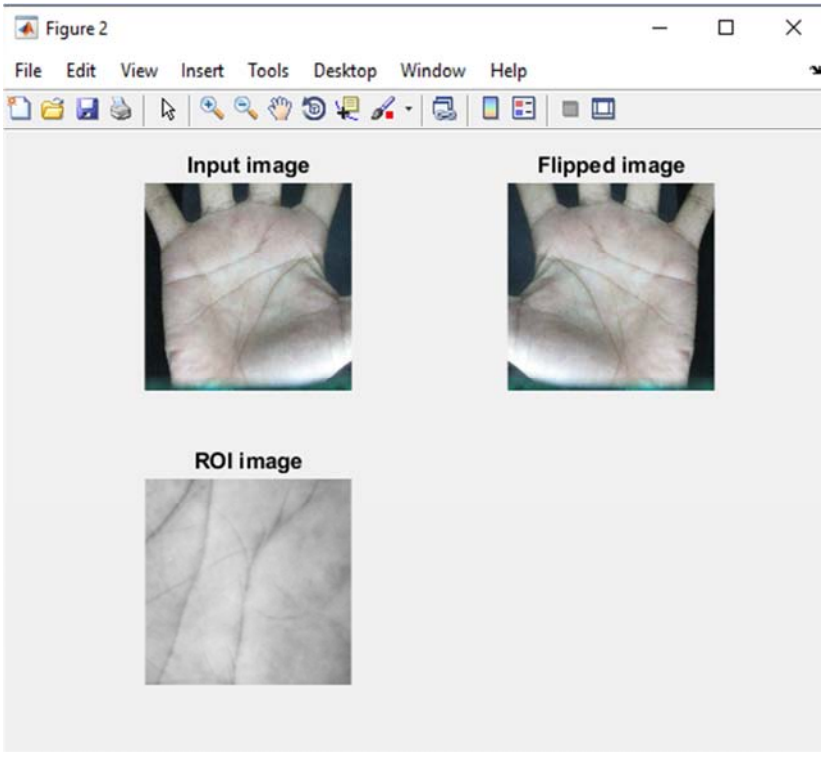

Figure 4[b]. *Reverse right palmprint image & ROI image.*

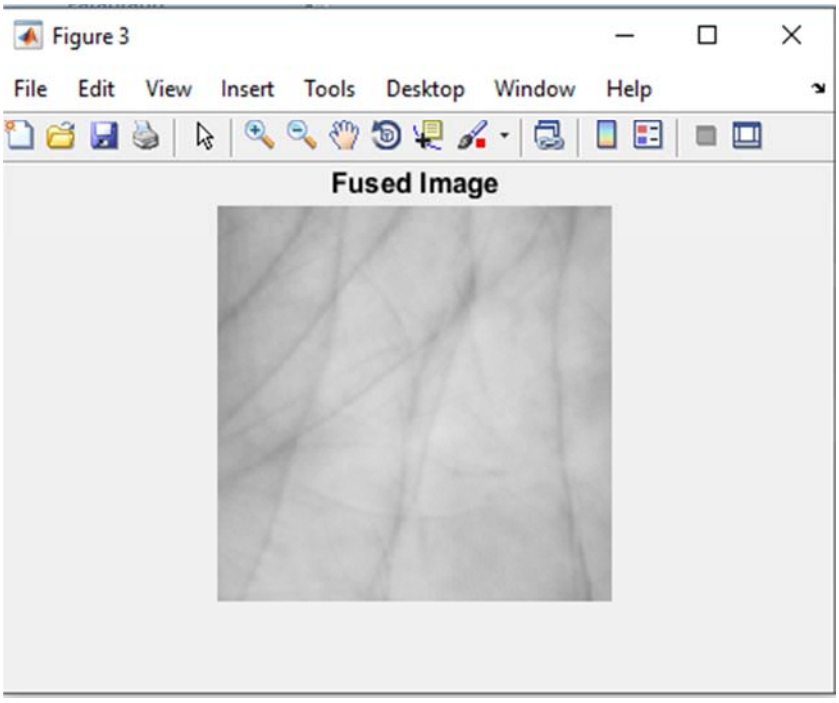

Figure 4[c]. *Fused image.*

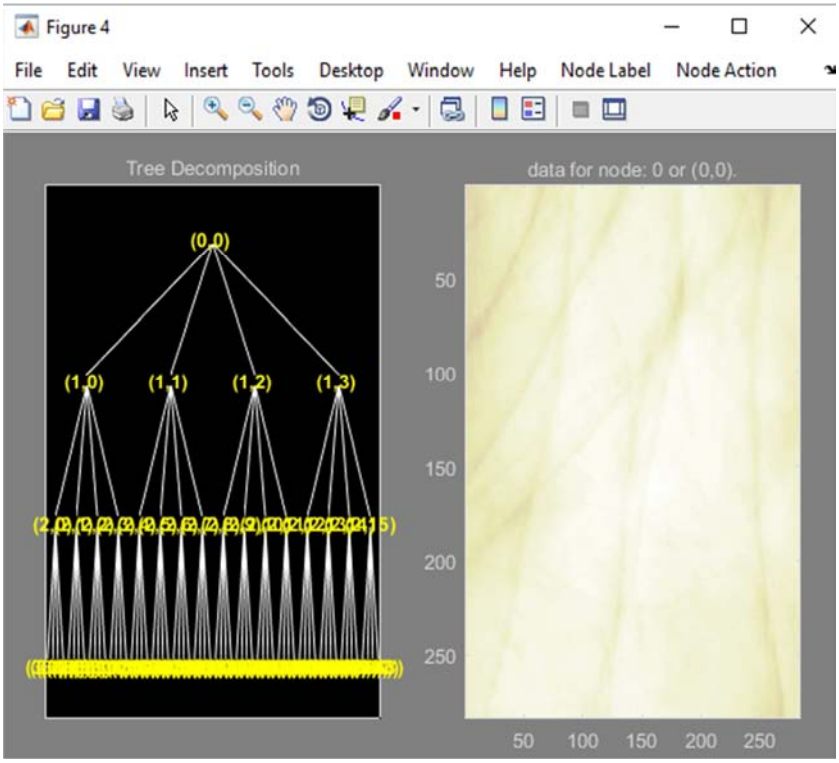

Figure 4[d]. *Feature extraction of fused image using DWPT.*

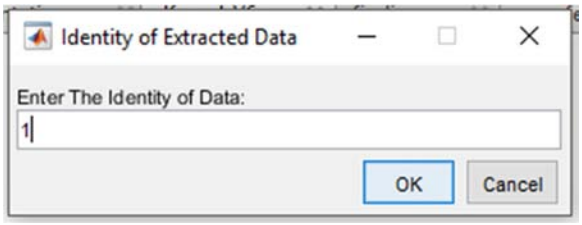

Figure 4[e]. *Message box for saving the identity of person with number.*

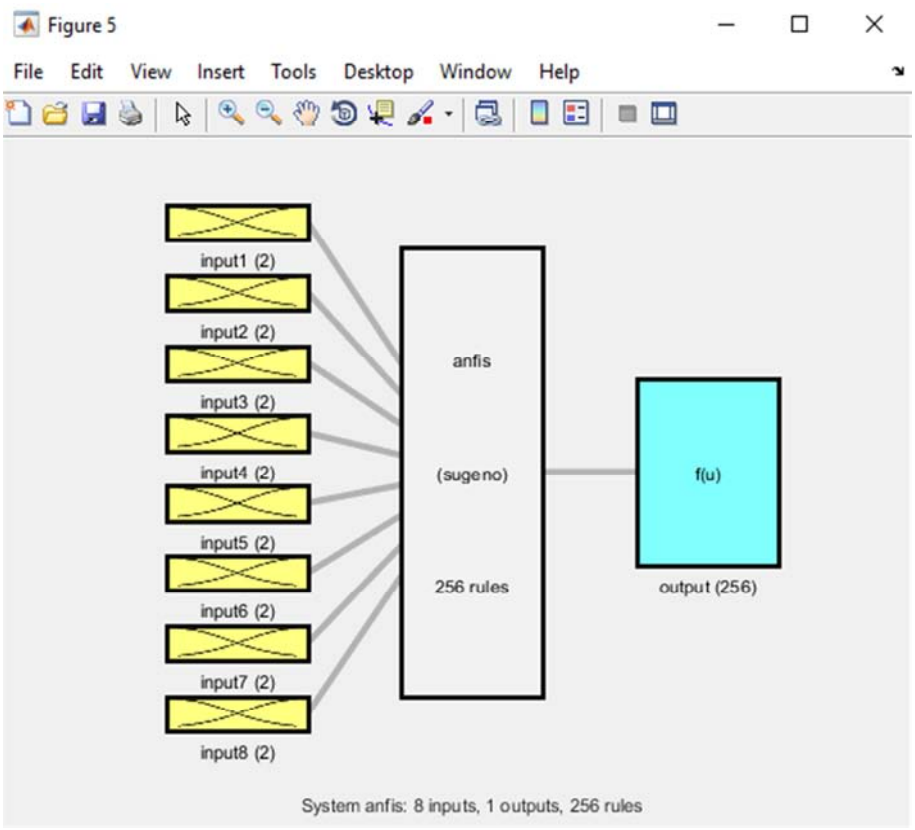

Figure 4[f]. *ANFIS structure.*

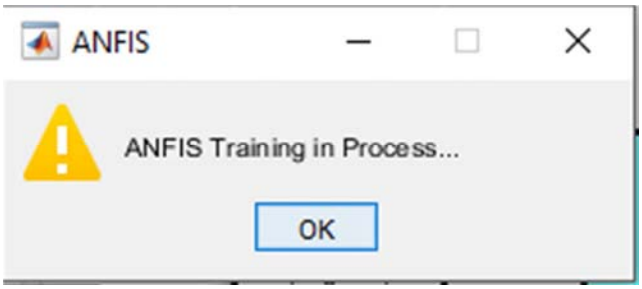

Figure 4[g]. *Message box when ANFIS matches the train and test data.*

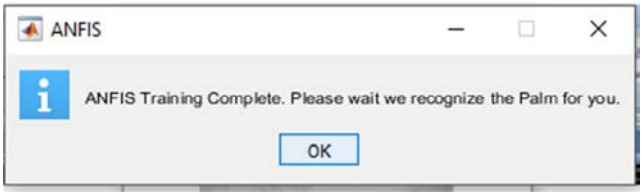

Figure 4[h]. *Message box when ANFIS taining is complete.*

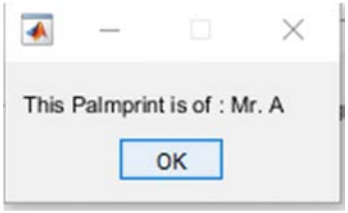

Figure 4[i]. *Recognized result.*

Above figure shows the palmprint recognition in different steps. Figure 4[a] shows input left palmprint image & their respected ROI image; Figure 4[b] shows reverse right palmprint image & their respected ROI image. The ROI images are extracted using preprocessing and segmentation step. Figure 4[c] shows fused image, Figure 4[d] shows Feature Extraction of Fused image using DWPT, Figure 4[e] shows Message box for saving the identity of person with number. In this experiment, used left and right palm image for same person and enter the identity 1. Similarly for another person give different identity with different number. Figure 4[f] shows ANFIS structure which matches the train and test data with threshold value. Figure 4[g] shows Message box when ANFIS matches the train and test data. Figure 4[h] shows Message box when ANFIS taining is complete. Figure 4[i] shows Recognized result. Here dialogbox shows "This palmprint is of: Mr. A", because decided a threshold level for output functioning. If threshold value is not matches then dialogbox shows unrecognized person.

The performance of the proposed approach is evaluated using performance metrics i.e. FAR, GAR, FRR and Accuracy. False acceptance rate (FAR) is the percentage of invalid matches. FAR is defined as,

$$\text{FAR} = \frac{\text{Number of accepted imposter claims}}{\text{Total number of imposter accesses}} \times 100\% \quad (1)$$

The Genuine acceptance rate (GAR) is the percentage of genuine matches. The GAR is defined as,

$$\text{GAR} = \frac{\text{Number of accepted genuine claims}}{\text{Total number of genuine accesses}} \times 100\% \quad (2)$$

The False rejection rate (FRR) is percentage of genuine users rejected. The FRR is defined as,

$$\text{FRR} = 100 - \text{GAR}(\%) \quad (3)$$

The Accuracy of the proposed approach is evaluated using the equation given below,

$$\text{Accuracy} = \left(100 - \frac{\text{FRR+FAR}}{2}\right) \quad (4)$$

6. Conclusion and Future Scope

This paper performs multibiometrics using combination of both left and right palmprint image because left and right palmprint images of the same subject are somewhat similar. It gives better recognition rate with high standard security. Simulation is performing using MATLAB software. Preprocessing and segmentation process extract the Region of Interest (ROI) for feature extraction. This paper represent discrete wavelet packet transform (DWPT) algorithm for palmprint feature extraction. Feature vector obtained using DWPT provides better segmented feature as compare to DWT. Matching is done using ANFIS, hence recognition of palmprint is accurate. In future can be analyze the proposed system using different wavelet and one can do hardware implement of the proposed system.

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