Authentication System Based Palmprint Recognition Using Simple Structured Neural Network

Dr. Hasan Kareem Abdulrahman
Computer Systems Department,
Northern Technical University,
Iraq.
Hasan.abdulrahman@ntu.edu.iq

***Abstract*- Biometrics technology is gaining popularity every day. In most countries nowadays, academics are focusing their efforts on biometrics because it has an important function in security. Analyzing a large number of security cases provided researchers with significant motivation to conduct additional research and develop new ideas. Biometrics technology also has multiple uses outside of the security industry, including civil, commercial, and industrial applications. Biometrics measures and analyzes unique physical and behavioral characteristics of people. Palmprints are currently considered the preferred biometric for application in highly sensitive access control environments such as federal buildings, airports, and other critical locations. Palmprint contains a more distinctive feature and does not require a high-resolution palmprint image, unlike other biometric characteristics. This paper involves designing of high accuracy palm recognition system using simple structured neural network called single hidden layer neural network. accuracy score for the proposed state of the art is found 91.3 %.**

Keywords: Palm, Gober, LBP, DWT, FFT, CNN, FFNN, DNN.

I. INTRODUCTION

Palm recognition is considered as corner stone for identity verification based biometrical features recognition [7]. Such recognition system involves a complex process for differentiating of palm prints even if it belongs to same person. The challenges faced while implementing the palm recognition system can be illustrated under two categories; first is “features fusion and templates constructing challenges” and second is “templets matching challenges”. The templates constructing is preceded by several vital approaches such as: region of interest cropping/image segmentation and image enhancing for features extraction. According to [8] palm prints from different persons may not significantly varying which leads to a fact saying that palm recognition is complicated task. First category challenges are more likely related to none uniformity of image illumination, size scales of the palm and image alignment [9]. The common problem in palm recognition system is their trade-of between recognition accuracy and computational cost measured during the features matching stage. From the other hand, features extraction stage is highly influenced by none uniformity nature of samples/templates that lies on the variance in palms geometry and variance in sample alignment while image enquiry process. The current trend of features extraction involves analytical approaches either in spatial domain of in frequency domain such as Gober filters. Furthermore, spatial-frequency analysis is feasible using wavelet transform. Analytical analysis quality is limited for noise involvement and availability of computational power [10]. Features matching is usually performed by calculating minimum Euclidean distance; however, least attempts were seen in literature about deep learning deployment in palm recognition [11].

II. LITERATURE SURVEY

The principal lines in the human hand represent the basic feature of palmprint. This feature can be easily obtained from low-resolution palmprint images. Therefore, the extraction of accurate palm region plays essential tasks on recognition performance of the system. A novel method for extracting a palm region from the images of palms in the database proposed by [1] with various hand poses to enhance the recognition system called as contactless recognition. The proposed method consists of: binarization of the input image using discriminant analysis method, edge detection of binarized image. The experimental results proved the efficiency of the proposed method over the conventional methods with changing hand pose.

In [2], proposed a palmprint verification system to extract the palmprint texture features. In this system, hand segmentation was deployed for extracting the palm region of interest information from the background information, and the valley detection algorithm was used for reference point hand detection. Then, the features were extracted based on the combination between Discrete Wavelet (DWT) and Discrete Cosine transform (DCT) and Transform. Furthermore, Sobel operator and Local Binary Pattern (LBP) methods were used to increasing the no. of features. Finally, a simple Euclidean distance was used for matching purpose.

In [3], propose a palmprint recognition system to address the unconstrained hand image acquisition with no pegs to restrict the hand pose. In this system, the Cross Wavelet transform (XWT) was used for feature extraction. Furthermore, different Bacterial Foraging Optimization Algorithm (BFOA) versions were used for feature selection to reduce the feature space. Finally, the reduced feature was fed to Artificial Neural Network (ANN) classifier to verify a person. This study showed that the varying population (ABFVPA) and Adaptive Bacterial Foraging Algorithm are satisfying the score of accuracy to 97.85%.

In [4], proposed a palmprint authentication system to tackle the problems like illumination, pose variation, and orientation in palmprint images encountered when adopting a single algorithm. on [4], the dual-tree complex wavelet transform and contourlet transform with principal component analysis were used in the feature extraction stage. Next, the Euclidian distance was used to compute the matching score. Finally, the sum-rule, weighted sum-rule, and Support Vector Machine (SVM) score level fusion were used to fuse the matching score from two modules. The obtained outcomes revealed that SVM fusion method achieved the best Genuine Acceptance Rate (GAR) of 98% with 0.1% of Equal Error Rate.

To begin with, using veins to perform authentication provides a high level of security, as injuries to fingers or palms will not prevent the process from working [5]. Additionally, veins on palm can be isolated using a low-cost device and provides robust features for the identification system. This section presents some research has been done on palm vein recognition system.

In [6], used the k-means segmentation and principal curvature algorithm with normalized gradient-based are used for feature extraction to mitigate noise and enhance the recognition rate. Then, the Best matching region (BMR) was determined by adopting the matched pixel ratio to improve LBP performance. Finally, SVM performed a score level fusion between LBP and BMR to improve the recognition accuracy. The experimental results achieved an equal error rate of 0.267%, which is effective for contact-free palm vein recognition.

In [7], proposed an identification system using Near-Infrared band (NIR) dorsal hand veins images. The system consists of the following stages: image acquisition device, image pre-processing for geometric correction, feature extraction using scale-invariant feature transform to extract the key points, segmentation of vein patterns and matching. The database with 2000 dorsal hand veins images is used to training the proposed system. There are multiple training images for each hand class to produce multiple key point set: union, intersection, and exclusion based on interaction with intra-class and inter-class. The experimental results showed that the fusion of key point sets of class (union, intersection, and exclusion) achieved 100% accuracy. Another identification system proposed by [8] based on NIR dorsal hand veins images using a palm vein reader sensor. In this system, the dilation process adopted to extract the outline of the veins. Then, the verification has been done based on measuring the coincidence of vertical and horizontal displacements of skeletonized and dilated images. Based on the experimental results, the system achieved a 0.47% false rejection rate and 0.00% false acceptance rate with a processing time post-capture of 1.8 seconds.

In [9], a palm vein recognition system proposed by utilizing two local texture descriptor method: Local Derivative Pattern (LDP) and Local Binary Pattern. The experimental results showed that the LDP more efficient than LBP in the features descriptor for palm vein. It is also concluded that the LDP method performs better than the combination between LBP and LDP in the recognition performance.

At [10] proposed an identification system to extract the finger vein texture. The Random transfer and Signal Value Decomposition (SVD) algorithms have been used in the feature extraction stage, and a simple distance measure has been used in the matching stage. The identification system performs well based on the experimental results regarding false rejection rate and false acceptance rate. Another study proposed by [11] to improve the performance of the finger vein identification system by a simultaneous combination between low-resolution fingerprint images and finger vein images have been performed based on a novel score level combination technology. The database collected from 156 volunteers with a total of 6264 images has been used in this experiment. The experimental results showed an improvement in equal error rate of 65.6%, 90%, and 70% for the index finger, middle finger, and combination between them.

In [12] proposed a Deep Neural Network (DNN) model to predict finger vein image quality. The database with low image quality will degrade the performance of the identification system. In this model, the quality of the low images is falsely rejected using verification error minimization. The DNN trained using several finger vein image patches. Finally, the patches are combined and fed to Probabilistic Support Vector Machine (P-SVM) to enhance the performance quality. This model achieved high accuracy in identifying low and high-quality finger vein images compared with another state of the art methods.

III. Proposed System

Novel hybrid palm recognition system based on smart features extraction and classification models is proposed where both classification accuracy and processing time are expected to be enhanced. The proposed system is to be performed using PCOE database [21], the proposed system architecture is shown in Figure 1. In order to tackle the problems in the database such illumination, size/scale variation, rotation, existence of foreign objects (rings, bracelets, etc.) which are degrading the image region of interest (ROI) cropping as well as features extraction and classification; the proposed work is suggested in the following sequence. Using PCOE database [21], automatic palm recognition system is implemented using base line Artificial Neural Network (ANN). With reference to point “c” in the previous section (Methodology); ROI are cropped form the images.

The database contained of eight various snaps of each person’s palm print. The database contains by whole 1344 images belonging to 168 person. The database was gathered twelve month period and the images are being captured through digital camera. Each image is perverted a resolution of 1600X1200 pixels.

A. Illumination adjustment

problem is realized as common/popular problem in palm print images; as single user may provide multiple image of the same palm; the problem is raised as different lighting conditions of the image is producing a significant variation in the image. Correlation approach is to be used for determining the similarity between any two samples of same palm under different light circumstances, however, it is proposed at [13] that illumination adjustment is permissible approach for tackling the illumination variance. This adjustment is usually performed by pixel intensity reduction by subtracting the average image intensity from each pixel intensity.

B. Features extraction

Stage A: since the features extraction performing over spatial domain is highly influenced by the aforementioned noise sources impact (e.g. illumination) [14] and since the frequency domain features involves extra computation cost (e.g. intervention of Fourier transform [15]; wavelet transform is best option which yielding both spatial and frequency information. Hand palm is having three main lines called as principle lines, those lines are creating unique identity for the hand and cannot be repeated even in case of identical twins. From this point, it is proposed to extract the principle lines information from the palm image using discrete wavelet transform (DWT).

Stage B: palm veins tracking is another method that provide robust palm features, it is however includes tracking the blood vessels located underneath skin of palm. In this stage, Local binary pattern (LBP) can be used for extracting the veins network under the skin. LBP [15] involves assigning each pixel with array of binary numbers that calculated as each pixel is compared with its four sides neighbours. The process can be illustrated in the Figure 1 with light of following points.

a. Images with near infrared (NIR) band is required to perform the process; the same is available in the proposed database.

b. Each image with NIR band is then treated with edge detection in order to reduce the dimensionality. We propose using Radon transformation as edges detection method due to its lesser computation budget unlikely other methods e.g. [16].

1			2			3
8			PR			4
7			6			5

Fig. 1. LBP features calculation demo.

c. To define a radius and number of blocks and reference pixel location in order to begin the process. for demonstration purpose, let radius to be 2, number of blocks to be 8 and reference pixel is located is "PR" as in Figure 1.

d. The pixel "PR" is to be compared with each neighbour pixel (as number in Figure 2) in such way; if the PR > (neighbour pixel) the result is 1 and if otherwise then result is 0. Eventually, each pixel in the image will be represented by array of 8 numbers i.e. [11010010].

e. Similar the veins network can be identified by tracking the local coordination of the similar pixels. This can be performed by calculating the Euclidean distance between the resulted arrays.

C. *Region of Interest Cropping*

in order to minimize the computational cost of palm image recognition, the regions other than principle lines region is to be neglected. That can be performed by cropping the required region in accurate fashion. The state of the art of palm region of interest (ROI) cropping is using the so-called global geometrical transformation which involves detecting the hand palm with reference to the palm size and structure [11]. Thus, gap between two fingers as demonstrated in Figure 2 is been used as reference for width of ROI. Image alignment is vital for accurate palm ROI detection; hence, it is required to rotate the image (in-clock wise or anti clock wise) in accordance with alignment angle which can be obtained by determining the line slop (Figure 3). Slop angle can be determined in "Line 1" with reference to horizon angle "Line 2".

D. *Classification*

As soon as palm ROI is extracted; the approach proposed at (a) is to be conducted for extraction of principle lines features. The following points are to be implemented in regard of features classification. Convolutional neural network (CNN) [17] is most reliable classifier in terms of image processing; hence, it is proposed for classification purpose with intension of monitoring the performance of the same under the purposed performance metrics. From the other hand, Long short term memory neural network (LSTM) [18], is then proposed for performing the classification, performance of this classifier is to be monitored under different layers configuration with efforts to increase the classification accuracy to maximum possible value. Our proposed state of the art is using artificial neural network (single hidden layer) with particle swarm algorithm based k-nearest neighbour algorithm (KNN). A preface about the proposed approach can be made as following:

i. Single hidden layer feed forward neural network is expected to provide good accuracy with lesser execution time as compared with points in 1 and 2. Due to its simplest structure and simplified input dimensions.

ii. Input image fusion is required for reshaping the featured image into a single dimensional array that compatible with FFNN paradigm.

iii. In order to meet the high accuracy classification and to tackle the computational cost problem, FFNN model is tuned up using PSO-KNN algorithm.

iv. We proposed seeded random swarm generator based PSO [19] using KNN algorithm [20] in order to reduce the computational cost and increase the classification accuracy.

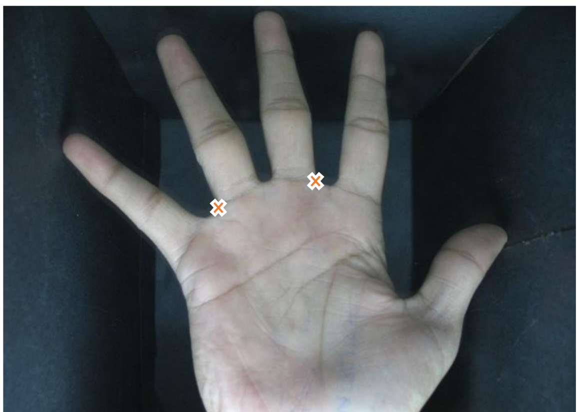

Fig. 2. Palm scale problem demonstration.

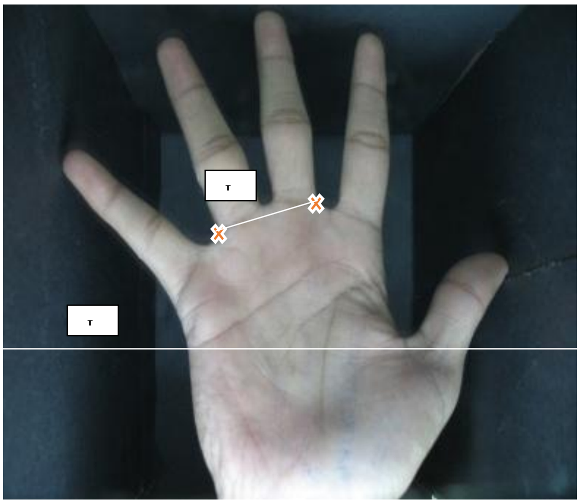

Fig. 3. Illustration of line slop method in

Study Outcomes

Results are demonstrated in Table 1 showing that accuracy score for the proposed state of the art i.e. single hidden layer feed forward neural network based on Particle swarm optimization (PSO-FFNN) is outperformed over the Convolutional neural network (CNN) and Long short term memory neural network (LSTM). Another performance metric is being applied i.e. Mean square error (RMSE); results shown that lowest RMSE is yielded by PSO-FFNN as well. Figures 4 and 5 are demonstrating the obtained results graphically.

TABLE I. NUMERICAL RESULTS OF ACCURACY SCORES AND RMS FOR THE PERFORMED EXPERIMENT.

Algorithm	Accuracy	RMSE
CNN	78.2	0.014
LSTM	77.9	0.0186
FFNN	76.4	0.0218
PSO-FFNN	91.3	0.0027

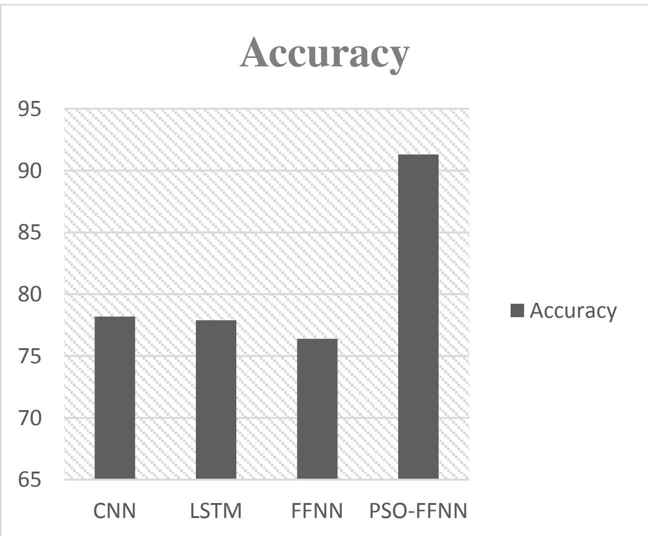

Fig. 4. Accuracy scores of the proposed algorithms.

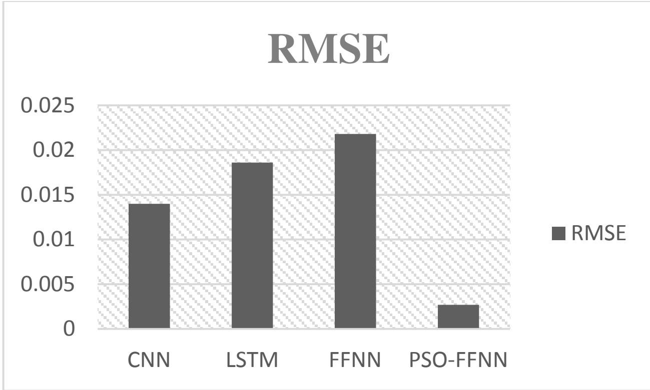

Fig. 5. Root mean square error of the proposed algorithms.

IV. CONCLUSION

Soft biometrics has grown in popularity recently as a way to improve the performance of traditional biometric systems. Gender, height, weight, hair type, scars, marks, and other soft biometric characteristics are examples of soft biometric traits. Soft biometrics are a set of characteristics that provide information about an individual but are not strong enough to identify them on their own. Since the advent of soft biometrics, this has enabled the database search to be more narrowly targeted, thus decreasing the computational time. An alternative approach to creating reliable systems is to use soft biometrics and traditional biometric traits to enhance system reliability. Researchers in different populations have investigated gender dimorphism in fingerprint ridge density in the recent past. The palmprint has many of the same features as fingerprints, with an additional advantage in the increased skin area available. While it has a lot of potential for personal identification, palmprint recognition is very complicated and complex. Using gender classifications to differentiate palmprint images is a rather novel and exciting field of research. It could be useful in human-computer interaction, such as personal identification, if automatic gender classification were developed. When gender classification is applied to palmprints, the search space is greatly reduced, allowing identification to proceed much more quickly [13]. This paper is demonstrated a performance optimization approach for enhancing the performance of personal recognition based palm recognition system. The achievements of this work involves using signal hidden layer artificial neural network e.g. FFNN to perform high accuracy recognition tasks. Results shown that proposed method (PSO-FFNN) is outperformed by scoring of 91.3 % of recognition accuracy over the other deep learning methods like CNN and LSTM.

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