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A Digital Signature System based on Hand Geometry

Mays M. Taher

Informatics Institute for Postgraduate Studies/ Iraqi Commission for Computers & Informatics (IIPS/ICCI)

Lamita2269@gmail.com

Dr. Loay E. George

University of Information Technology and Communication

loayedwar57@uoitc.edu.iq

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Abstract

Biometrics refers to the automatic authentication of a living person based on physiological or behavioral characteristics. Hand recognition involves an analysis and measures of the features of the hand. In this work, an authentication system based on hand geometry (i.e., fingers' features) using artificial neural network are proposed and implemented. The features of the fingers are extracted from the hand images which are producing after passing through a sequence of preprocessing stages. The authentication process consists of two phases, enrollment phase: image capture, smoothing, binarization, gaps removal, edge detection, thinning and chain coding were implemented. In the verification phase, feature vector to the unknown person is extracted from its hand image and determine the most discriminating features. The proposed system suggested the BPNN for training and testing data. In final step, we encode and decode features to produce hash value based on base64 method. In this research the used data is the CASIA dataset, which consists of several image snapshots taken by scanners working at different wavelengths, in this study all the snapshots belong to different wavelengths are taken. The experimental results showed that the extracted feature vector has good discrimination capabilities that led to a recognition rate over 99.50%.

Keywords: Hand geometry, biometrics, pattern recognition, artificial neural network.

1. Introduction

In recent years, computers and sophisticated software have been employed in personal identification systems. The utilization of characteristics that are extremely distinctive (such that the likelihood of any two persons having the same trait will be limited), readily collected, avoid feature misrepresentation, and

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stable is what makes a successful biometric (i.e. Features do not change over time). The biological behavior that the stability circumstances might be characterized as [1]:

- Physiological characteristics: including facial features, hand geometry, eye (iris and retina),and fingerprint.
- Behavioral characteristics: including voice and signature.

In today's highly secure environments, biometric authentication techniques are commonly employed (e.g. banks, computer networks, government, and law enforcement agencies). The following biometric technologies are now in use: iris and retinal scanning of the eyes, hand and finger geometry , fingerprint scanning, face recognition, and signature recognition. The demands for institutional and individual security rise. The individual may recall several pins, passwords, and other security codes. This idea will eventually be replaced by the more practical and dependable biometric technologies [2]. [Hand recognition is a promising biometric due to its simplicity and somewhat strong identification performance. Over the past ten years, the use of hand geometry for biometric identification has skyrocketed in popularity [3].

Many studies in the field have been published by different researchers. Here, we highlight some of the productive studies done in the field:

- Mohmmad et al., 2020 [4], presented a gesture recognition system that interprets the American language has been introduced. This system helps people to understand communication as ordinary people. New fixed motions with MATLAB based on existing systems. Our camera system inputs use preprocessing. All features were checked by PCA. The comparison of functions is based on Euclidean distance using training sets. The nearest neighbor algorithm is used to classify the regression process. After all, it determines the optimal movements - text production or audio output. This frame app is designed to provide a scene with high definition for character interpretation, giving ordinary people a motion test of 19 people. The Accuracy rate is 95%.
- Haider et al., 2020 [5], based on multimodal biometric recognition, proposed an improved intrinsic hand In NIR images, these three approaches are integrated using a rule-based blurring mechanism that achieves 92 percent accuracy. Hand geometry is a biometric method that utilizes near-infrared photographs of human hands in this investigation. They also recommended utilizing convolutional neural networks to identify the biometrics of finger veins (CNN). In the NIR image data set, CNN obtained 90% accuracy. This system used three biometric methods to detect a live human body to improve the effectiveness of anti-counterfeiting attempts. This system achieved accuracy about 92% with 1 equivalent error rate (EER) and 0.113 FRR.
- Oldal and Kovács, 2021 [6], proposed an authentication System by using palm print and hand geometry. The proposed method provides an effective solution for a low-cost authentication system. Feature extraction include Fingertip Detection, Wrist Point Detection, Finger Valley Detection, Region of Interest (ROI) Extraction and Palm line Extraction. The palm print principal lines are used for ROI alignment and palm print matching as well, which results in a simpler

implementation of a palm print recognition system. Experimented on 14 persons. FAR is 4.6%, and FRR is 14.2%. They have proposed in the future to develop a matching algorithm of hand geometry and palm print features.

- Mohammed et al., 2021 [7],introduced a reliable approach for biometric system based on measurements of hand geometry. Objective of this work is to increase the efficiency by enhanced reducing Magnitude of features like length of the finger, the finger width, and palm width. The proposed system extracted 21 features for right hand image. Then used multi model of neural networks algorithms for recognition which are cascade forward neural network, feed forward back propagation, and Elman. The system work on 10 persons (10 images) for each person was tested and validated in MATLAB. The accuracy recognition rate for the matching were 88% for CNN, 95% for FFBB and 92% for Elman.
- Malik et al., 2021 [8], proposed design framework for the hand geometry system is implemented in MATLAB environment. The first step is to extract images from the database using pre-image technology. The second step is the biometric properties of hand-extracting images. The third and final stage is the introduction of a neural network rely on healing system. ANN, which they proposed, is the most extensive learning controlled neural network. The system was installed on 20 people from the CASIA database. The properties are derived from the hand, such as the length of the finger the width, the span of the diameter the circumference. This system obtained Accuracy about 97.90%.

This article introduces a suggested approach that is based on hand geometry, one of several efficient biometric systems. In this work, we create a biometric authentication system. The program makes use of characteristics taken from the hand picture (after applying some preprocessing on the original hand image). The retrieved characteristics are then sent into an artificial neural network to classify the hand picture. then, give the characteristics that were extracted a hash. Artificial neural network networks have shown effective in a variety of image recognition applications, including biometrics and verbal communication.

The rest of the paper deals with the following sections: The second section explains the database that used in our work. The third section describe the proposed system. The fourth section explains in detail the neural network architecture and the basic layers that we used in our network that we designed to identify people through the hand. The five sections describe the results and are discussed. The last section is the conclusion and future work.

2. Dataset

CASIA database that used in our work contains 7,200 images taken for 100 people, both males and females, taken with 6 waveforms and for two periods between each time interval. The images are gray (with grey scale=256). The device supplies an evenly distributed illumination and captures palm images using a CCD camera fixed on the bottom of the device. All palm images are 8 bit gray-level JPEG files. In addition, each person contains six images. Wave length of the illuminator corresponding to the six spectrums are 460nm,630nm,700nm,850nm,940nm and white light respectively [9]. All the spectrums are used in this research work.

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3. Description of the Proposed System

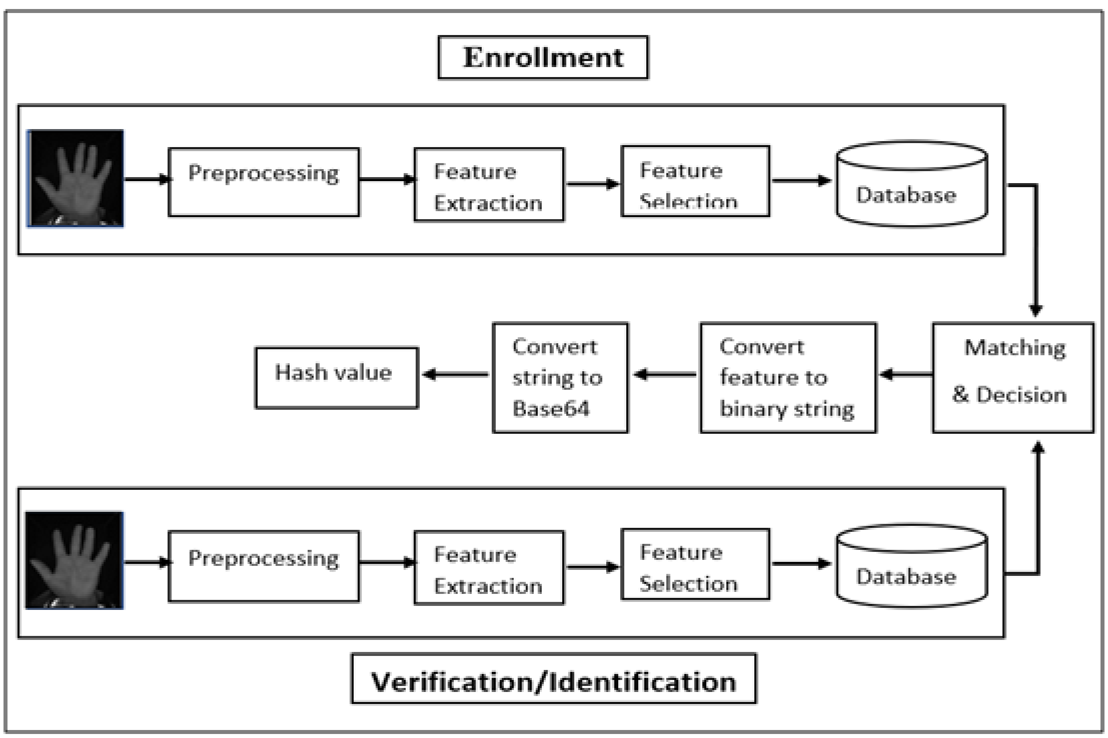
The proposed framework that used in designing of hand geometry recognition system was implemented in MATLAB environment. Figure (1) shows the layout of the proposed system. This system consists of two phases. The work flow of the system should consist of the following Enrollment (Training phase) implies three steps:

i. Enrollment (Training phase) implies three steps:

- Load the hand Sample image.
- Apply pre-processing (mapping +binarization).
- Extract the hand region boundary.
- Determine the "control points".
- Determine features (distances, angles, areas).
- Select the most discriminating features using the scatter ratios criteria.
- Determine the parameters required for biometric signature determination.
- Store the signature in the system database.

ii. Classification (Detection phase) implies three steps:

- Apply the steps (from 1 to 7)
- Determine the signature of the unknown tested sample
- Determine the degree of similarity (using different distance measures) between the claimed signature and that listed in the database to make verification decision.



Figure(1):The layout of the proposed system

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3.1 Image Acquisition

The hand image is acquired from CASIA Multi-Spectral Palmprint Image Database in order to build a template database. Figure(2) shows the different samples of right and left images belong to same class [9].

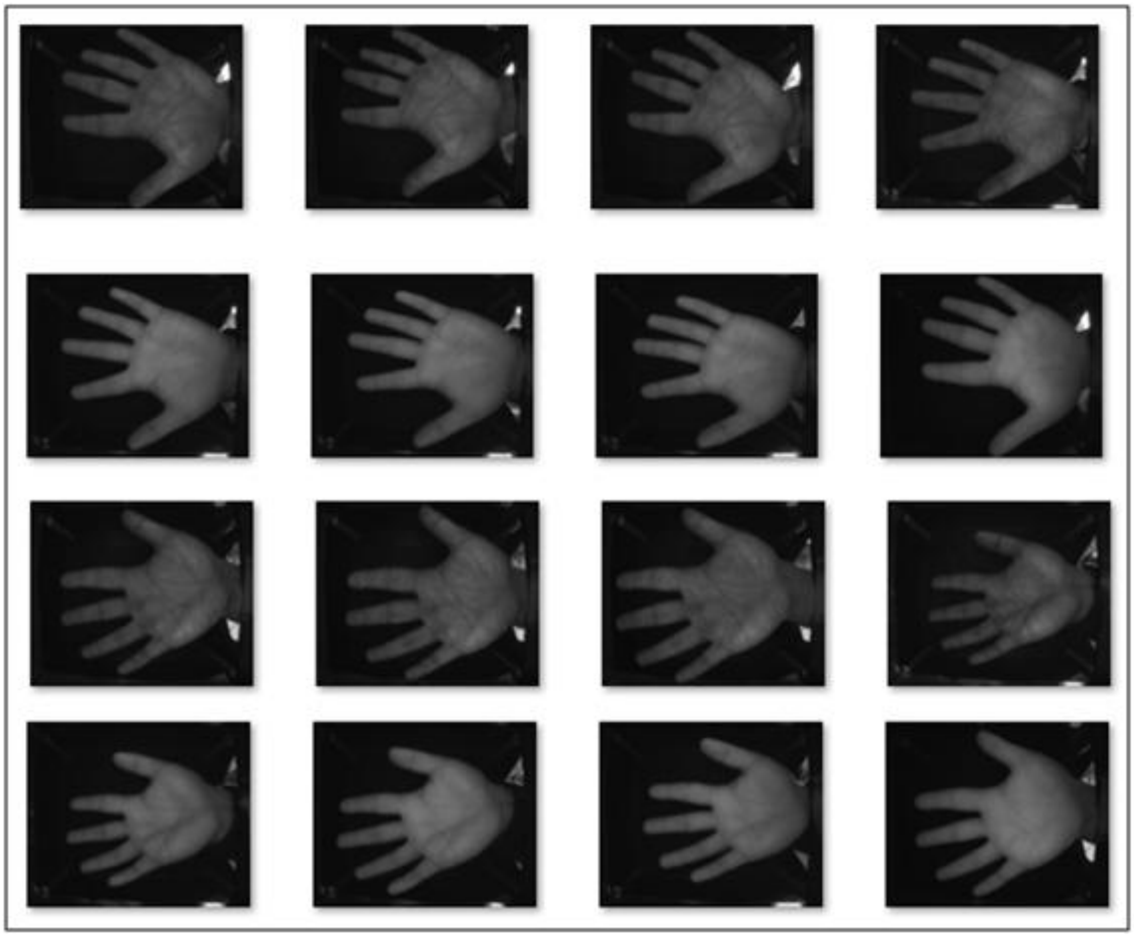

Figure (2) Examples for left/right hand image belong to same subject (class)

3.2 Image Preprocessing

Because of the numerous flaws and noise present in the photos stored in the CASIA database, this stage is regarded as one of the most crucial ones for extracting the features. We tried a number of ways on the photographs before extracting the hand geometry and adding it to the suggested network because the images captured for each palm would make it difficult for us to extract the hand characteristics. Figure (3) shows us the steps that we have applied to extract a clear feature that entered into artificial neural network:

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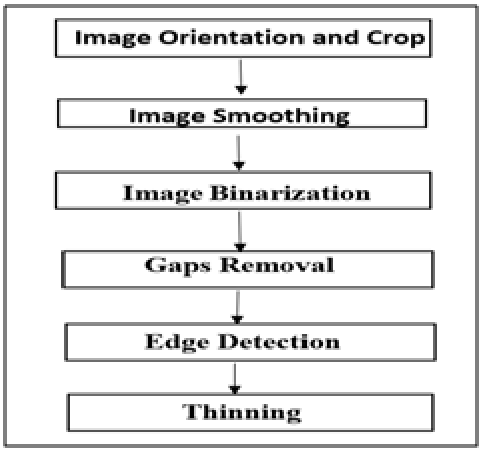
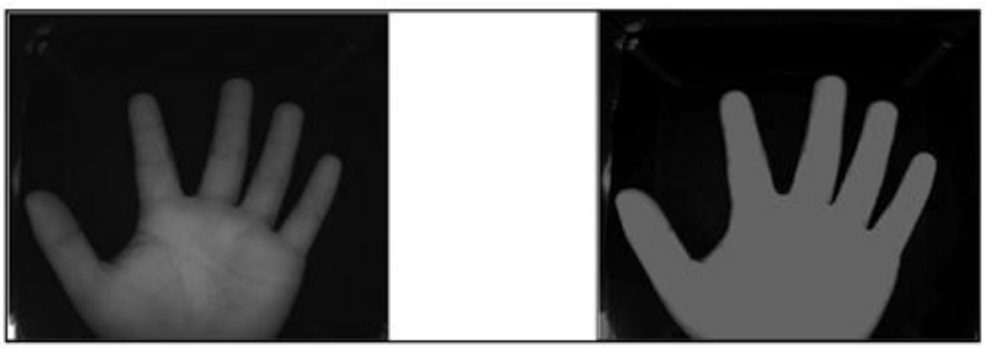


Figure (3) preprocessing steps

3.2.1 Image Orientation and Crop

The initial step of the processing stage is to rotate and then crop the hand image after the image acquisition procedure. To correctly set up the hand imagefor the feature extraction procedure, it must be rotated. After being turned by a -90degree angle, the hand image's orientation is altered. To draw attention to the area of interest in the photograph, certain unimportant portions of the image might be cropped out. Cropping is the process of removing elements of a photograph to modify the aspect ratio, emphasize a certain topic, or enhance framing. Figure (4) shows the image after rotated and cropped.



(A) (B)

Figure(4)The (A) original image, (B) rotated image, and (C) cropped image

3.2.2 Image Smoothing

As seen in Figure (5), the loaded hand picture contains impulsive noise. As noise may cause differences between the captured picture and the actual image, it is required to eliminate it from the image. There are several ways to reduce noise. The smoothing median filter is used to reduce this noise. The median filter is used to both smooth out the image and eliminate noise. When it decreases noise and retains edges at the same time, it is superior to convolution. It selects a section of the image, sorts through all of the values there, and then substitutes the median value for the center pixel [10].

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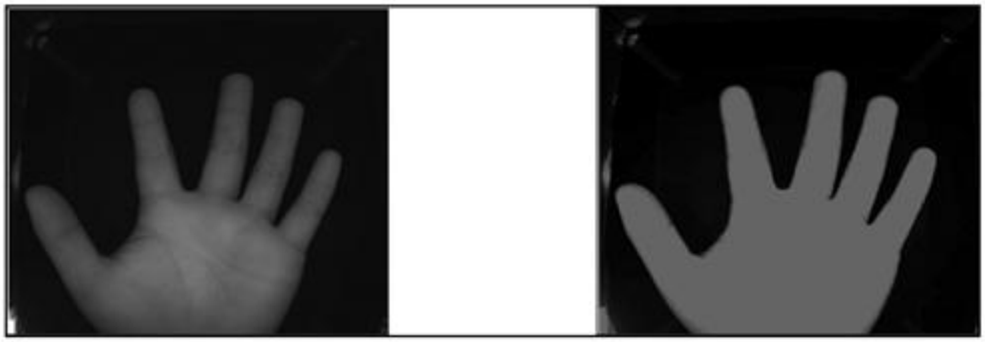

(A) (B)

Figure (5)The (A) Rotated and cropped image; and (B) smoothed image

3.2.3 Image Binarization

The method of "image binarization" turns a grayscale image into a binary image with two colors (black and white). This step's major objective is to divide the digital image into two important sections, namely the hand palm region (whose pixels are represented by 1s) and the backdrop (its pixels denoted by 0s). Thresholding procedure, which works to transform multilevel images into binary images by selecting an appropriate threshold (T), divides picture pixels into several areas in order to distinguish between objects and background [11].Any pixel I(x,y) whose intensity exceeds or equals the threshold value (i.e., I(x,y) T) is taken into account as a component of an object; otherwise, it is taken into account as a component of the background. One of the most effective techniques for thresholding grayscale image is the Otsu approach. To determine a threshold value and perform local thresholding on a picture, this approach is used [12]. Figure (6) shows how image is converted to binary image. The technique of thresholding is defined as:

$$I_{B(x,y)} = \begin{cases} 1, & for I_{(\mathrm{x,y})} \geq T \\ 0, & for I_{(\mathrm{x,y})} < T \end{cases}$$

(A) (B)

Figure (6)The (A) smoothed image; (B) Binarization by applying Otsu Thresholding.

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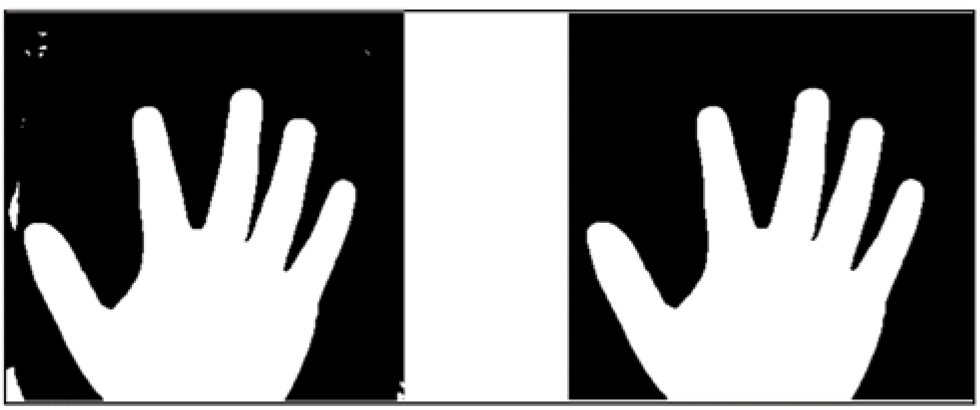
3.2.4 Gaps Removal

For a variety of reasons, the binary image contains some gaps. After binarization, this step is crucial because it reduces noise from the picture of the hand palm. Next, the flood-fill algorithm is utilized. It looks for the pixels that are above, below, to the left, and to the right of the one being tested [13]. This algorithm was utilized by the proposed system to close all gaps inside the hand palm and close all white gaps outside the hand palm. Applying this approach to eliminate internal and exterior gaps from a binary image is shown in Figure (7). Typically, it is used to eliminate objects from binary images.



(A) (B)

Figure (7) shows (A) Binarization; (B) Gaps Removal

3.2.5 Edge Detection

The hand image must only contain edges in order to extract the geometric aspects of the hand geometry. Therefore, it is necessary to transform white space areas into an image that just contains the perimeter of the white pixels. By utilizing an edge detection algorithm, this is accomplished. Prewitt has been employed in this study's analysis to determine the border of the binary image [14]. It uses two 3×3 convolution masks, one to calculate the gradient in the x-axis and the other to calculate the gradient in the y-axis, to identify the hand edges:

$$G_X = \begin{bmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{bmatrix} \quad (2)$$

$$G_Y = \begin{bmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{bmatrix} \quad (3)$$

Each of these masks has changed as the image has. Two integers are present at each pixel location: GX, which represents the outcome of the row mask, and GY, which represents the result of the column mask. The edge magnitude and edge direction, which are described as follows, are two metrics that we utilize to determine from these findings:

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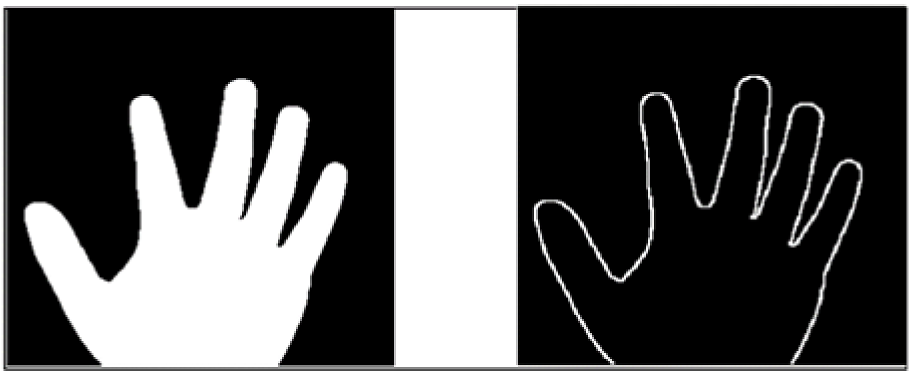
$$Edge\ Magnitude = \sqrt{G_X^2 + G_Y^2} \quad (4)$$

$$Edge\ Direction = tan^{-1}\left(\frac{G_X}{G_Y}\right) \quad (5)$$

The upper and bottom margins of the hand area should be defined by the two main horizontal lines (i.e., the upper and lower edges).Figure (8) show the process of edge detection.

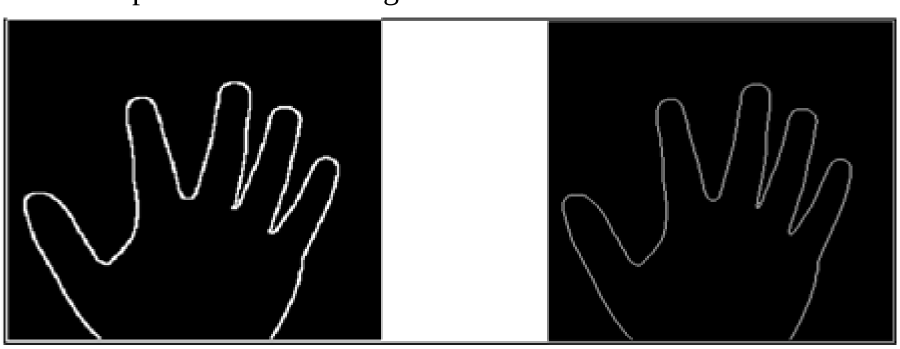


(A) (B)

Figure (8) The hand before and after edge detection

3.2.6 Thinning

Due to its critical function in conveying an object's shape description and in capturing both the border and region information of the hand, the thinning process is an essential stage in the picture preprocessing process. In this step, we reduce the ridges' unnecessary pixels until they are only one pixel wide. Operators for thinning accept two bits of data as input. The input picture, which may be binary or grayscale, is the first. The second is the structural element, which establishes the specifics of how the operator will affect the image [15]. This is done using the MATLAB's built in morphological thinning function as shown in Figure (9).



(A) (B)

Figure (9)The hand before and after thinning operation

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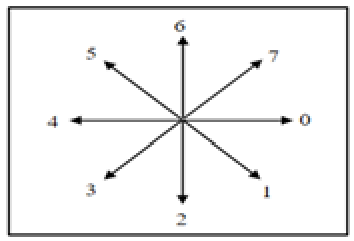
3.3Chain Coding

The Chain code is used to represent the boundary as a connected sequence of straights line segments of specific length and direction. So, the produced edge image contains only the boundary points of the hand as white points. Now we need to represent those boundary points as a sequence of adjacent points. The main idea of chain code is constructing one dimensional array of point type records, each contain the X and Y of the boundary pixel. The chain coding process begin by finding the start point of the hand edge and check the 8-neighbors of the start point to detect the next connected (chain) point [16].

X-1,Y-1	X,Y-1	X+1,Y-1
X-1,Y	X,Y	X+1,Y
X-1,Y+1	X,Y+1	X+1,Y+1

(A)



(B)

Figure (10) The chain code direction (A) the pixel (x, y) and its 8- neighbors; (B) the order of chain code.

From the above figure (10),we could started the following direction sequence 1,2,3,4,5,6,7,0;or it could be started from any direction and transfer points (clockwise or counter clockwise).

3.4 Feature Extraction

Previous research has shown that different systems have different numbers of extracted characteristics. These characteristics are often expressed by measurements of the hand breadth, finger width, and finger length at various places along the finger. The landmark points of the hand, which are indicated by peaks and troughs between neighboring fingers, determine the characteristics of hand geometry. Additionally, additional points might be deduced from fundamental landmark points, which are represented by the center points of the fingers. Geometric human hands serve as keys in a system of hand authentication. Hand geometry-based biometric systems use the numerous properties retrieved from hand images to accomplish personal authentication [17]. In the proposed system, thirty-five meaningful features of hand geometry are extracted for person identification as shown in figure. 11. Before matching, different hand geometry parameters such finger lengths/widths, the palm, and the perimeter are extracted and discretized. This results in 35 features all together. Local Maxima of the curve correspond to finger tips and minima are associated to finger valleys. Depending on the hand acquisition, first maxima will correspond to the thumb. These features are:

- Finger lengths (5 features).
- Finger widths (20 features).
- Perimeter (5 feature).
- Palm Inter-point Distance (5 feature).

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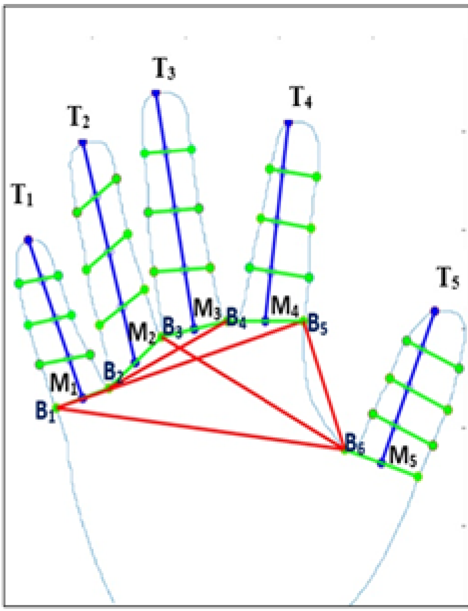

1.Thumb Perimeter	2. Index Finger Perimeter
3. Middle Finger Perimeter	4. Ring Finger Perimeter
5. Pinkie Finger Perimeter	6. Thumb Length
7. Index Finger Length	8. Middle Finger Length
9. Ring Finger Length	10. Pinkie Finger Length
11. Thumb Width 1	12. Thumb Width 2
13. Thumb Width 3	14. Thumb Width 4
15. Index Finger Width 1	16. Index Finger Width 2
17. Index Finger Width 3	18. Index Finger Width 4
19. Middle Finger Width 1	20. Middle Finger Width 2
21. Middle Finger Width 3	22. Middle Finger Width 4
23. Ring Finger Width 1	24. Ring Finger Width 2
25. Ring Finger Width 3	26. Ring Finger Width 4
27. Pinkie Finger Width 1	28. Pinkie Finger Width 2
29. Pinkie Finger Width 3	30 Pinkie Finger Width 4
31. Palm Inter-point Distance 1	32. Palm Inter-point Distance 2
33. Palm Inter-point Distance 3	34. Palm Inter-point Distance 4
35. Palm Inter-point Distance 5	

Figure 11 Set of features studied in the proposed hand geometry system

First, it must be calculate maximum and minimum to find finger tips position and between fingers points position. T points and B points used to calculate M points by finding the mid points between B points.

- Finger length can be calculated by using distance formula written as:

$$finger\ length = \sqrt{(T_x - M_x)^2 + (T_y - M_y)^2} \quad (6)$$

Also, slope can be calculated by using formula written as:

$$slope = \frac{T_y - M_y}{T_x - M_x} \quad (7)$$

Where, T_x,T_y,M_x,M_y are coordinates.

- Finger baseline length can be calculated by using distance formula written as:

$$finger\ baseline\ length = \sqrt{(B_{1_x} - B_{2_x})^2 + (B_{1_y} - B_{2_y})^2} \quad (8)$$

Also, slope can be calculated by using formula written as:

$$slope = \frac{B_{1_y} - B_{2_y}}{B_{1_x} - B_{2_x}} \quad (9)$$

Where, B1x,B1y, B2x,B2y are coordinates.

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- Divide finger into four parts by finding the inner three points on the finger using finger slope and length of the three points position, can be calculated as:

$$finger\ slope = \frac{\Delta y_1}{\Delta x_1} \tag{10}$$

$$finger\ length\ = \sqrt{{\Delta y_1}^2 + {\Delta x_1}^2} \tag{11}$$

Then, after calculate the equations above can find the first point position coordinates, do the same for all three points through each point we calculate line length has same slope of the finger baseline and within in the finger perimeter.

- Calculate each finger perimeter by using all coordinates of the hand. Then, calculate distance between those coordinates, for the range between B points. For example, first finger perimeter is calculated from B_1 to B_2 by using all coordinates between B_1 to B_2.

Finally, we can calculate 5 features which is the distance between using distance formula. [(B_1 , B_6), (B_1 , B_5), (B_2 , B_4), (B_3 , B_6), (B_5 , B_6)].

Table (1) The extracted features of some samples.

Samples	Feature extracted
person 1	193 251 269 252 185 86 116 125 116 85 41 37 37 34 45 42 38 31 40 37 34 27 44 35 31 26 32 29 25 22 153 177 82 131 72
Person 2	149 256 284 276 185 63 119 131 126 81 31 29 30 27 37 31 29 28 36 31 27 27 46 33 27 26 27 25 25 23 141 145 81 99 63
Person 3	158 238 273 255 190 69 110 126 118 88 32 33 34 30 38 34 32 28 38 33 33 28 37 32 28 26 30 29 26 24 138 148 73 102 58
Person 4	166 198 218 199 145 73 92 101 92 66 36 31 29 27 34 32 28 24 34 27 25 23 38 27 24 22 28 26 21 19 127 145 69 104 65
Person 5	150 204 235 220 167 65 95 109 101 71 29 29 28 26 30 28 25 24 32 27 25 23 36 25 23 22 26 26 23 19 122 125 67

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3.4 Feature Selection

Reducing the number of resources needed to explain a huge quantity of data is what feature selection entails. PSO is a potent heuristic optimization method that has been successful in a range of difficult optimization problems. PSO was employed in this study to minimize the number of features[18]. Twenty-five that represent the most discriminating features in this proposed work.

Table (2) Examples of the most discriminant features of some samples.

Samples	Most discriminating features
person 1	269 252 86 116 125 116 85 41 37 37 45 42 31 40 34 27 44 35 31 26 25 22 177 82 131 72
Person 2	284 276 63 119 131 126 81 31 29 30 37 31 28 36 27 27 46 33 27 26 25 141 145 81 99 63
Person 3	273 255 69 110 126 118 88 32 33 34 38 34 28 38 33 28 37 32 28 26 26 24 148 73 10 258
Person 4	218 199 73 92101 9266 36 31 29 34 32 24 34 25 23 38 27 24 22 21 19 145 69 104 65
Person 5	235 220 65 95109 101 71 29 29 28 30 28 24 32 25 23 36 25 23 22 23 19 125 67 83 53

4.Artificial Neural Network (ANN) Matching

The ANN is used in this stage to identify the characteristics that have been extracted and saved in a database. The proposed ANN is the supervised learning neural network that is utilized the most frequently. A categorization system called an Artificial Neural Network (ANN) imitates the workings of the human brain. It processes information utilizing the phenomena of the human brain. Because it is hard to comprehend how artificial neural networks function, they are frequently called "black boxes." In our experiment, the neural network trained the test set using feed-forward back-propagation [19].

4.1 Feed Forward Back-Propagation Neural (FFBPN)

Back-Propagation Neural Network is the only type of neural network. The FFBPN is a multilayered neural network that employs feed forward architecture and supervised learning. It is by far the network that receives the greatest usage. One of the most popular neural network methods for classification and prediction is the FFBPN. By internally modifying the weight values, the FFBPN approximates the non-linear connection between the input and the output. The neural modeling is created using a back propagation supervised learning technique. A supervised approach for neural network training

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is called FFBPN. owing to its simplicity and excellent efficiency. The proportions method is employed by this algorithm to minimize neural system faults. Weights and biases are put up in the network with a random number at the start of the training phase [20].

4.2Neural network architecture

Simple computational neuron cells coupled by weighted connections make up the neural network. An input layer, hidden layers, and an output layer are all parts of the neural network structure. The amounts of features determine the input layer. The number of classes determines the output layer. In this study, there are 100 output layers, representing the number of classes, and 26 input layers, representing the 26 most discriminative characteristics. The number of hidden layers is crucial while building the network's architecture. The lengthening of the network's training period is something that could be useful. Determining the appropriate number of neurons in the buried layer is crucial to determining the entire neural network. Each buried layer's neuron count needs to be carefully chosen. Underfitting is the effect of using insufficient neurons in the hidden layer. On the other hand, utilizing an excessive number of neurons in the buried layer might have a number of negative effects. First, it can cause "over fitting," as the term is known.

In this study, several trials were used to determine the ideal topology for the neural network design. Additionally, two widely used words are crucial for ANN learning algorithms [21].

- Momentum: It represents the influence of the motion through the weight space. It deals with large areas in the weights space where the convergence is slow, and it avoids oscillation of the gradient. The momentum term forces the update of the gradient in the direction of the mean gradient and speeds up the convergence.
- Learning rate: It regulates the rate at which learning occurs. The selection of the learning rate parameter determines how quickly a neural network learns. If a high value is selected, the weight values will require a significant amount of adjustment, which causes oscillation (i.e., back and forth) across all feasible weight values and prevents the ideal value from ever being obtained. The learning process may sluggish if the learning rate is too low.

As indicated in the table (3), we tweaked the parameters of this study's neural network to get good performance (3). For the test of six spectrums, this neural network back propagation architecture was used. Figure (12) shows the construction of a neural network.

Figure (12)Neural network architecture for each spectrum.

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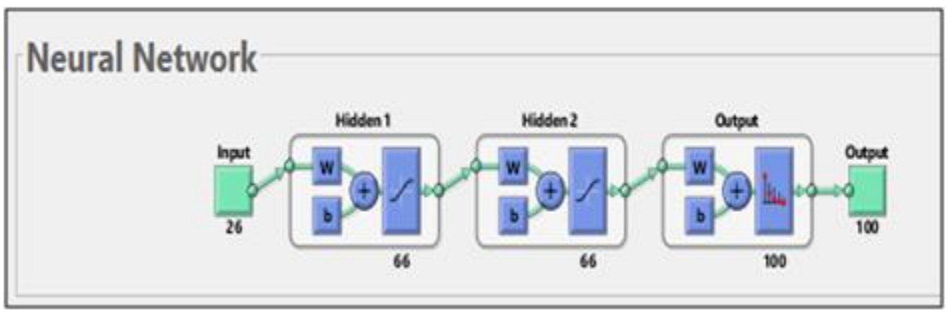
Table (3) The default values of parameters for each spectrum after make setup for neural

ParameterName	Default value
Learning Rate	0.01
Momentum	0.99
Epoch	2000
Hidden layer	2
Iterations	30
Neurons	[66,66]
Transfer function	tansig

The neural network back propagation setup was used in table (4) to test the entire database at once. Not every parameter from the initial experiment has been altered. Because the amount of the data has changed and the parameters used in the first experiment were inappropriate for use in the second experiment, which resulted in low accuracy, we have created a new configuration for the neural network. Figure (13) displays the construction of a neural network.



Figure(13)Neural network architecture for all data.

Table (4) The default values of parameters for all samples after make setup for neural.

Parameter Name	Default value
Learning Rate	0.2218
Momentum	0.8275
Epoch	2000
Hidden layer	2
Iterations	50
Neurons	[117,117]
Transfer function	tansig

5. Experimental Results

The following experiments show the results of the tests conductedon the proposed system an artificial neural network in MATLAB environment. The conducted test scenario in this project has passed through the following experiments:

5.1 FirstExperiment

The first experiment is to test the accuracy of each spectrum separately to find out the best spectrum. Table. 5 shows the performance parameters of this experiment with table multiply *2 when each spectrum has been trained and tested separately. The highest accuracy was for the white light spectrum with 100% recognition rates. The number of samples that were identified was 1200 samples and the number of unspecified samples was zero samples out of 1200 samples with 0.0.09 time. This paper presents and discusses the findings of a few tests run to assess the established system's performance.

Table (5) The performance parameters for default configuration

Spectrum Name	Batch size	Accuracy (%)	Time	Identified Samples	Unidentified Samples
460	1200	**98**	0.0.08	1,170	26
630	1200	**99.50**	0.0.10	1,177	10
700	1200	**99.75**	0.0.07	1,174	8
850	1200	**99.25**	0.0.09	1,176	12
940	1200	**99**	0.0.08	1,179	14
WHT	1200	**100**	0.0.09	1,200	0

5.2 second Experiment

The second experiment employs an artificial neural network to evaluate all spectrum together after setting up the network to produce correct findings. The outcomes of this experiment are shown in Table (6) was achieved about 99.58 recognition rates. Out of 7,192 samples, which were recognized, there were 8 unidentified samples, taking up 0.0.27 of the total sample count.

Table (6) The performance parameters for default configuration

Spectrum Name	Batch size	Accuracy	Time	Identified Samples	Unidentified Samples
All Data	1200x6	**99.58**	0.0.27	7,192	8

6. Hash Hand Features

The hashing method offers great security for preserving the hand image's extracted properties. The term "signature" refers to a hash value. In this study, the hash value of the person's characteristics was created using the base64 approach. Base64 encoding converts binary data into an ASCII string format by converting it into a 6-bit character representation. The term Base64 comes from the fact that it uses 64 distinct possible values to represent binary data. This shows that six bits are needed to represent a single Base64 character (26 = 64). all capital and lowercase letters, as well as the three-digit numbers 0 through 9. Capital and lowercase letters, the

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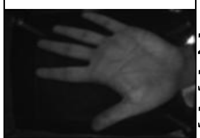
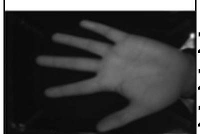
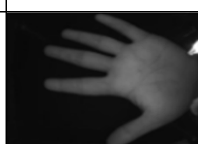
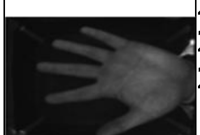
digits 0 through 9, the "+" and "/" marks, and the digits 0 through 9 make up the values [22].The hashed results of most discriminating features are shown in the table (7).

Table (7) Hash hand Feature.

Samples	Hand Image	Most Discriminating Features	Hash Value
Person1		269 252 86 116 125 116 85 41 37 37 45 42 31 40 34 27 44 35 31 26 25 22 177 82 131 72	Ed Es Eh Dm D3 EM Ek EP DT Do Ba BD BJ BN BF B4 B7 By Bg Bj CF CL CG Bp Bx B4
Person2		284 276 63 119 131 126 81 31 29 30 37 31 28 36 27 27 46 33 27 26 25 141 145 81 99 63	CG B6 Bg Bp BZ BV Bc BG BL Ap Af Ag Ak Ad Al Ad Ah Af Ad Al Ae Ai Ad Ac At Al
Person3		273 255 69 110 126 118 88 32 33 34 38 34 28 38 33 28 37 32 28 26 26 24 148 73 10 258	Am Ai Ae Aq Af Ai Ag Ac Af Ac Ac AY AY Ao Ak Am Ai Ag Ai Ab Ah AZ AZ Ab Ab Ac
Person4		218 199 73 92 101 92 66 3631 29 34 32 24 34 25 23 38 27 24 22 21 19 145 69 104 65	AX As Au Al Am Ak Aj Ah Ag Ab AZ Af Ab Ac AY AX Aa Aa Aa AW AW AZ AZ Aa AV
Person5		235 220 65 95 109 101 71 29 29 28 30 28 24 32 25 23 36 25 23 22 23 19 125 67 83 53	AX AW AX AY AT AT C5 CZ Cc CZ CF BW BV BN BJ BH CL Bn Bq Bs BX BM BD A6 BF A1

7. Conclusion and Future Work

The proposed work shows how to utilize the shape of the palm to extract features using very simple algorithms for defining hand fingers points and valleys, then features like figure length, width, palm distances are extracted. Details of the preprocessing and feature extraction steps have been reported. The original 35 features were reduced to 26 features based on PSO. The images used for enrolment and testing are acquired from 100 subject. There been many tested of neural network backpropagation algorithm. By applying an artificial neural network (ANN) in hand geometric recognition system for recognition a result with high performance and high accuracy obtained. The proposed system to protect the authenticity of hand features by Adding a base64 method to the features to get a hash value. The results presented in the above tables show that the best spectrum of database was white light spectrum in firstexperiment that implemented in this studywith recognition rate of 100%; this result indicate that this spectrum is a promising one. In the second experiment, the suggested system gives 99.58 % accurate results of recognition rate when all the spectra were tested.

In the following a number of the future work suggestions are laid out:

- The 2D geometrical features employed in the proposed work can be upgraded to 3D geometrical features in the future.
- Other features that exist in the hand, such as (skin color, wrinkles and folds on the skin, etc.), need to be researched. The suggested method depends on the lengths, perimeter, widths of fingers, and palm inter-point distance as features.
- Another encryption technique, such SHA-256, is an option.
- A mobile biometric authentication system based on hand geometry and the hash function may be used in the future.
- Deep learning techniques can be applied as a classification technique.
- In order to create a multi-modal biometric system, efforts will be undertaken to connect the hand geometry pattern biometrics with other forms of biometrics.

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