



An optimized Identification System by using Shark Smell algorithm for Biometric Images Crossing

N. A. Majeed alhammadi*, K. Hameed Zaboon, A. Abdulhadi Abdullah

Department of computer sciences, shatt al-arab University college, Al Basrah, 61001, Iraq

Emails: Nafeaalhamadi@yahoo.com; Khalid.Hameed842@gmail.com;
ammarabdulhadiabdullah@sa-uc.edu.iq

*Corresponding Author: Nafeaalhamadi@yahoo.com

Abstract

The security and privacy fields and multimedia biometrics have been widely used today for personal authentication. Sclera and Palm-print of humans are one of the fastest, accurate, reliable, and secure biometric techniques for identification and verification based on unique features. The majority of the biometric systems are based on the global features, which may lead to weak performance in cases of poor-quality biometric images, therefore, swarm intelligence techniques are used to improve recognition accuracy, reliability, and quickness. In this paper, an enhancement shark smell optimization (ESSO) is proposed to build an efficient hybrid identification system depend on the sclera and palm-print images. The SIFT algorithm used to extract features from the biometric images. The optimal key-points from this feature are obtained using ESSO and chaotic map, and finally, generation digital signature using a 256-MD5 algorithm for each user. The Package of the NIST tests proves that the generated keys are random, unpredictable, uncorrelated, and robust against different kinds of attacks.

Received: March 17, 2023 Revised: June 09, 2023 Accepted: September 05, 2023

Keywords: SIFT algorithm; Feature Selection; shark smell optimization SSO algorithm; 1d logistic chaotic function.

1. Introduction

The growth in computer technology and data processing that always need to access control to sensitive or personal data. Biometric technologies can control any unauthorized access. Therefore, the identification of biometric systems has more interest [1]. The multimodal biometrics are combining more than one modality of biometrics to improve recognition accuracy. Biometric systems are becoming popular as a measure to identify human beings by measuring one's physiological or behavioral characteristics [2]. There are many kinds of research to develop an identification system through metaheuristic algorithms by conducting an identification system with an optimization algorithm [3], [4]. Froba B. et.al [5] introduced a multi-biometric system using Palm-print and Iris, texture parameters are extracted based on Gabor filters. However, both of the palm print features and iris features fusion are designed based on the wavelets. The decision is obtained using the KNN classifier. Recognition accuracy is 99.2% and FRR = 1.6%. Bhaskar B. et.al [6] presented a feature extraction method for palm-print is monogenic binary coding; for inner knuckle print recognition, two algorithms named ridgelet transform and SIFT are proposed. The extracted feature vectors are classified using SVM. Bokade GU and Sapkal AM [7], used PCA to extract features of palm and face images. Fusion technique concatenated the feature vectors of the face and palm modalities into one fused vector, and feature selection is performed. This paper generates a variable length of stream key based on hybrid identification systems and enhancement shark smell optimization algorithm (ESSO) such as: In section 1 shown introduced of this work, section 2 reviews the background theory that used in this work. Also, the design of the proposed

system is presented in section 3. Section 4 illustrated the implementation, test results, and a discussion of their meaning. Section 5 presents the conclusions.

2. Background Theory

In this section review the basic concept that related to proposed works.

• Biometric

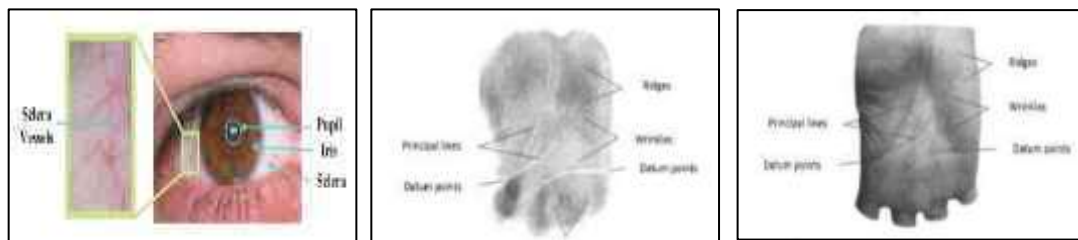
Biometric is referring to the science which involves the statistical analysis that is related to the individual. The security applications analyzing the characteristics of individuals for verifications and identifications of identities [9]. Biometrics has been a reliable solution for protecting the identity and rights of individuals because they recognize the unique characteristics of people [10].

• Sclera Biometric

Sclera blood vessels are presently effective biometric traits. The sclera is the white regions around the eyeball containing blood vessel patterns which might be utilized for personal identification, also it might be defined as the opaque and white areas of connective tissue and blood vessels in the eyes, such part of the eyes is surrounding the iris that is defined as a colored tissue around the pupil as shown in figure (1-A), it has a rich pattern of blood vessels that has various layers and orientations. The sclera's veins might be imaged in the case when an individual is glancing to either side, offering 4 pattern regions: one for each of the eye's sides [11].

• Palm Biometric

The palm print-based individual identifications can be defined as an efficient approach to identify individuals with high effectiveness. The palm prints are specified to have a lot of features: minutiae points, wrinkles, principal lines, singular points, and ridges, as can be seen in the figure (1-B and C). The surface area of palm prints is large in comparison to a fingertip, yet it is covered with some type of skin related to the fingers [12]. The data set is a palm dataset version 1-0 of 100 subjects [13].



A. Sclera vessels and eye structure

B. inked palm print

C. inked less palm print

Figure 1: Different biometric image [10] and [11]

the biometric systems are generally operating in one of the two modes: identification or verification. **In verification mode**, the system will be validating the identity of an individual through putting to comparison the obtained biometric features with the biometric template of the person [14], while **Identification mode**, systems are recognizing individuals through attempting to find a match in the whole template database [15].

• Pre-processing

The preprocessing of an image represents several steps such as remove noise Eliminating image noises is of high importance in image processing [16]. **Median Filter** is considered to be a simple implementation related to non-linear filters concerning noise removal [17], **Fill Flood Algorithm** used to find the connection as well as the shortest path between 2 points [18]. It is considered as a major region filling algorithm that has been typically based on the notion of 4-connectivity or 8-connectivity. **Morphology Operations** used for formulating operation which is based upon the selection of structuring elements (SEs), which is a small group of sets or sub-images, and it's utilized for examining an image for the relevant characteristics [19].

• Feature Extraction

The first method used is **2D maximum entropy threshold** in the image. The first step of 2D entropy thresholding segmentation is to build a 2D histogram through computing the frequency occurrence of each pair of grey level of every one of the pixels and the neighborhood's mean grey-level value then, compute 2D entropy [20].

- **Scale Invariant Feature Transform (SIFT)**

solved the issues of image rotation, intensity, affine transformations, and view-point changes in the matching of the features. SIFT includes four main steps [21]: **First step**, estimation of scale-space extrema with the use of Difference of Gaussian (DoG). Every set of same-size images is referred to as the octave, **Second Step**: a detailed fit is performed to nearby data to find the precise location, ratio, and scale of the principal curvatures, **Third Step** for every one of the key-points, one or several orientation values are assigned based on the directions of the local image gradient. This is a beneficial step towards the achievement of the invariance to the rotations as a descriptor of the key-points may be characterized based on that orientation and as a result, achieved the invariance to the rotations of the image. **Fourth Step** for a sample of the image $L(x, y)$ at the scale σ , orientation $\theta(x, y)$, and gradient magnitude $m(x, y)$, are pre-computed with the use of the pixel differences.

- **Shark Small Optimization SSO Algorithm**

The shark smell optimization algorithm is a meta-heuristic algorithm which has been developed by Abedinia et al. (2014) that has obtained inspiration from the sharks' superior hunting behaviors and their capability in sensing the prey's odor even from massive distances that can reach miles that explain in following steps [22]:

- **Initializing**

An initial solution's population will be haphazardly produced in the potential environment of the seeking. Every one of them responds represents a potential shark position. The vector of the starting position has been given by [23]:

$$X_i = [X_1^1, X_2^1, \dots, X_{NP}^1] \text{ and } NP = \text{size of the population} \quad (13)$$

X_i^i represents i -th starting location vector, i^{th} initial potential solution. The speed of every one of the individuals of the populations is represented by:

$$SP_i = [SP_{i,1}^1, SP_{i,2}^1, \dots, SP_{i,ND}^1], i=1, \dots, NP \quad (1)$$

Where $SP_{i,j}^1$ is j -th dimension of shark's i -th position or j -th decision variable of the i -th position of shark X_i^1 ; and ND = number of the decision variables in the issue of the optimization.

- **Shark Movement Toward the Prey**

The shark's moving towards the prey, the movement comprises in forward movement and rotational one that the odor concentrated and computed from:

$$SP_{i,j}^m = \mu_m \cdot R1 \cdot \frac{\partial(OF)}{\partial X_j} [X_{i,j}^m + \alpha m \cdot R2 \cdot SP_{i,j}^{m-1}] \quad (2)$$

Where, $i = 1, \dots, NP$, $m = 1, \dots, M$, $j = 1, \dots, ND$, μ_m represents the coefficient of the gradient, $\nabla(OF)$ represents the objective function's gradient, m represents the number of stages, M represents maximal numbers of stages in the shark's forward movement, μ_m , and αm belongs to the interval of $(0, 1]$, and $R1$ & $R2$ are constants that have been generated randomly in the $[0, 1]$ interval [24].

There is a constraint for the speed of the shark, represented in the following form:

$$|SP_{i,j}^m| = \left[\mu_m \cdot R1 \cdot \frac{\partial(OF)}{\partial X_j} |X_{i,j}^m + \alpha m \cdot r2 \cdot SP_{i,j}^{m-1}|, |\gamma_m \cdot SP_{i,j}^{m-1}| \right] \quad (3)$$

Where, $i = 1, \dots, NP$, $m = 1, \dots, M$, $j = 1, \dots, ND$, Parameter γ_m indicates the higher current speed boundary concerning the previous speed. Every one of the constituents $SP_{i,j}^m$ of SP_i^m will be calculated based on (4). The updated position may be represented by:

$$GY_i^{m+1} = X_i^m + SP_i^m \cdot \Delta tm \quad (4)$$

The m -th time interval stage is denoted by Δtm . Therefore, the shark's local seeking may be characterized by:

$$NX_i^{m+1,l} = GY_i^{m+1} + R3 \cdot \Delta GY_i^{m+1} \quad (5)$$

Where, $l = 1, \dots, L$, $R3$ represents a constant which has been randomly generated in the interval of $(-1, +1)$; and L represents the number of points in every stage's local seek. The optimum values of points, the local search is selected by the shark and then modeled in the approaches of shark smell optimizations in the following form [24]:

$$X_i^{K+1} = \text{org max} \{OF(GY_i^{m+1}), OF(NX_i^{m+1,1}), \dots, OF(NX_i^{m+1,L})\} \quad (6)$$

$i = 1, 2, NP$

- **The Chaotic Maps Algorithm**

This algorithm has a several of applicable features that could be employed in discrete time, also, it is a dynamic system in that generate complicated sequence which behaves randomly easily and simply, its signal is not random but it is deterministic, it has a high sensitivity of initial condition so any change in initial condition creates another sequence, and finally, it has random behavior in the specific space [24]. The 3D Logistic Formulation logistic map that the formula as given in equation (7, 8, and 9) as follows [24]:

$$x_{i+1} = \lambda x_i(1-x_i) + \beta y_i^2 + x_i + az_i^3 \quad (7)$$

$$y_{i+1} = \lambda x_i(1-x_i) + \beta z_i^2 + x_i + ax_i^3 \quad (8)$$

$$z_{i+1} = \lambda x_i(1-x_i) + \beta x_i^2 + x_i + ay_i^3 \quad (9)$$

Three quadratic coupling constant features are obtainable to strengthen the difficulty and security of the 3D Logistic map. The system offers chaotic behavior for $3.53 < \lambda < 3.81$, $0 < \beta < 0.022$, $0 < \alpha < 0.015$ and generates chaotic sequences X and Z in the range [0, 1].

- **The Digital Signature**

It is considered as a one the greatest and secure type of cryptography techniques. It has similar properties of a handwritten signature [25]. Furthermore, MD 5 algorithms is one of the message-digest which has been developed by Ron Rivest in 1991. The function of MD5 is creating large amounts of information to be compressed into a confidential format and then the private key is signed by the digital signature. MD5 algorithm consists of five main steps illustrated in [25, 26].

3. Methodology

The proposed method used firstly the sclera and palm images as input from the database and then the digital signature will be extracted based on three main stages, figure (3) shown the overall a multi-biometric for digital signature generation using enhancement shark smell optimization (ESSO) algorithm.

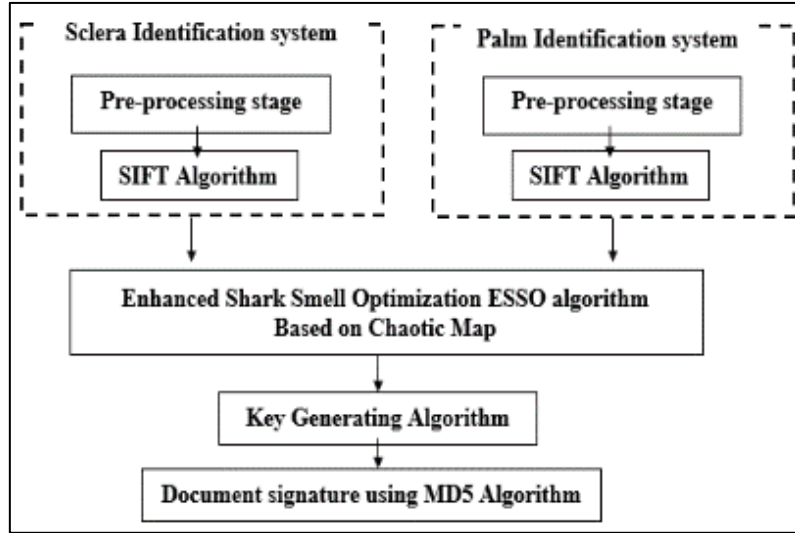


Figure 3: The Block Diagram of the Proposed Method.

- **Preprocessing Stage**

The preprocessing of the proposed method consists of two proposed identification system (sclera and palm) which illustrated in details as following: *Sclera identification system* as shown in figure (4) a block diagram of the sclera identification system:

- **Preprocessing sclera image**

it is preprocessed using *Morphology dilation operation* that makes an object (white area) more visible and fills the small holes in objects, *Convert Sclera Image to Binary Image* using threshold method that is produced a binary image, *Binary Morphology Octagonal Structure Step* using octagonal structure element with size 5×5 to enhancement the edges of the sclera image, create a harmonious, and gap-free object, and *Remove Noise Step* that specified by edges of the cropped image are not important for the white's area of the eye, Furthermore to fill the area outside the given boundary using (flood fill algorithm).

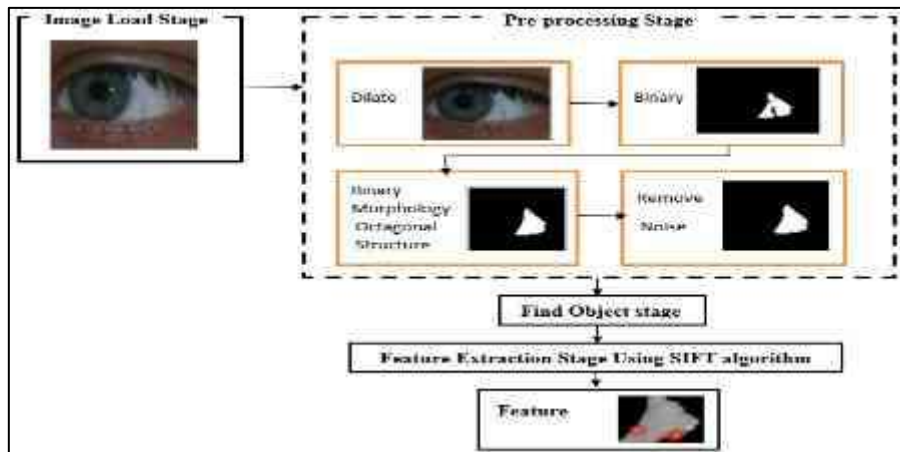
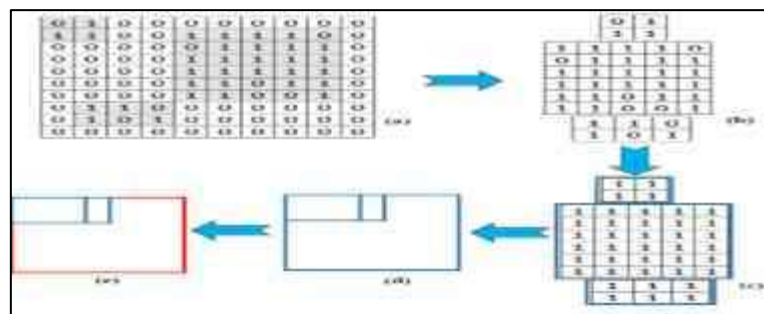


Figure 4: The Sclera identification steps.

- **Object Detection**

In this step, each small object should be eliminated as shown in Figure (5). The values in this matrix can be obtained from true and false. Next, the white color pixels will be neighbored to each other in a separate layer as a group. These pixels configure non-uniformly, they may take place most left or right and top and bottom in each layer once they are set to true. The splitting process can be achieved depending on the whiteness and the darkness in targeted images.



(a) detected object, (b) the separated layers of object, (c) the corrected object, (d) the redrawn objects, and (e) the largest object represents a sclera image.

Figure 5: Schematic Structure for the Identifying Process.

- **Feature extraction**

SIFT is used to detect energy points (key points) in the important area (object) that founded in the previous step, and “characterize/describe” of tiny image areas around the energy point.

- **Palm identification System**

The palm image converts to Grayscale color space applies a Median filter to removes the noise present in the image, applying 2D Maximum Entropy Threshold to extract few significant features from the palm image that is shown in figure (6).

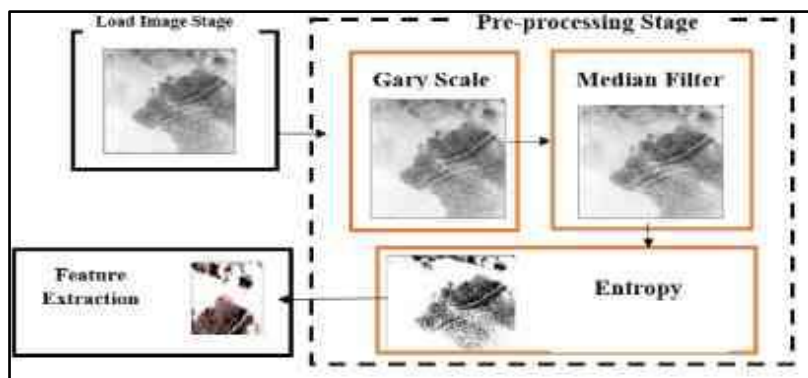


Figure 6: The proposed Palm Identification method.

The final stage in the proposed Palm identification system is feature extraction using Scale-Invariant Feature Transform (SIFT). which are [No, location of key points [x, y], size, angle, octaves].

• **Enhancement Shark Smell Optimization ESSO Algorithm**

Figure (7) illustrated block diagram the proposed enhancement shark smell optimization algorithm (ESSO) using chaotic maps.

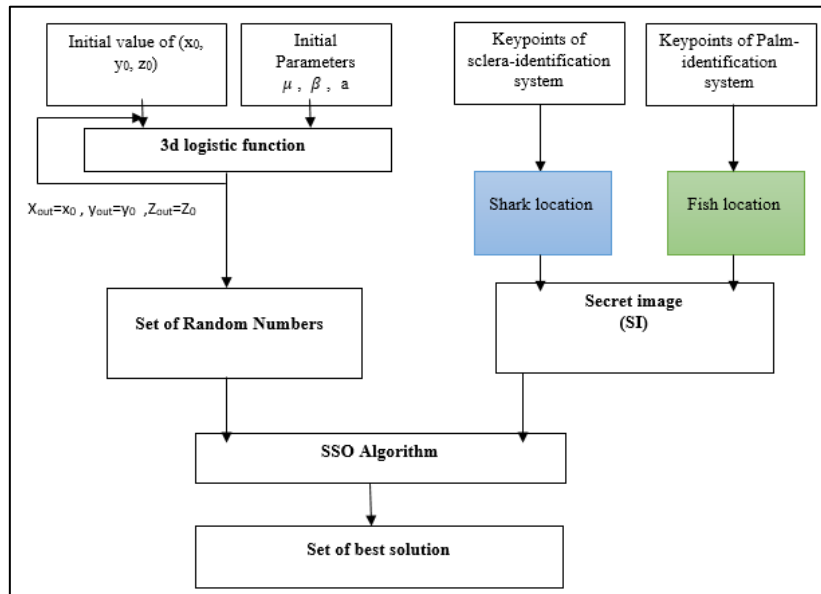


Figure 7: Block Diagrams of the Enhancement Shark Smell Optimization Algorithm (ESSO).

The key points extracted from the sclera identification system are completely different from the key points extracted from the palm identification system to joint between them all key points are projected on an image called secret image (SI). The best location in the secret image is identified using ESSO. In ESSO using 3D Logistic chaotic function as shown in equation (7,8, and 9) to generate random numbers using these numbers to seed random parameter of shark smell algorithm to increase the random behavior of the original algorithm and increased the execution time.

• **Generation stream key**

The set of the optimal solution found by using ESSO is converted to binary which exhibits a random, where the length of the stream key generation is depending on the number of iterations of the ESSO algorithm.

• **Generation Digital Signature Using the MD5 algorithm**

After generation unique secret key for each user from the previous step, in this step using the MD5 algorithm as shown in section (2.6) to generation signature for each user using its secret key.

4. Experimental Results

The proposed system is implemented on two data-based: firstly *UBIRIS.v1 database* [27] that has 522 color digital iris images with the ratio of gender = Male: 54.4%; Female: 45.6% and simulate less constrained imaging processes and acquire visible wavelength images with several types of data occluding the iris rings (considered noise) and secondly, *THUPALMLAB-DB database* [19] that contains 1,280 grayscale palm print images from 80 subjects (2 palms per person and 8 impressions per palm) captured using a commercial palm print scanner of Hisign.

The results of all steps of the sclera-identification system shown in table (1,2, and 3). In the table (1) the best value is chosen for the filter size is 3*3 for two reasons, firstly is to speed up the operation, secondly is producing image more smoothing by the separated areas are connecting with distances smaller than the structural element size.

Table 1: The results of dilation operation with different size of mask

Load sclera image	Dilation operation			
	3*3	5*5	7*7	9*9

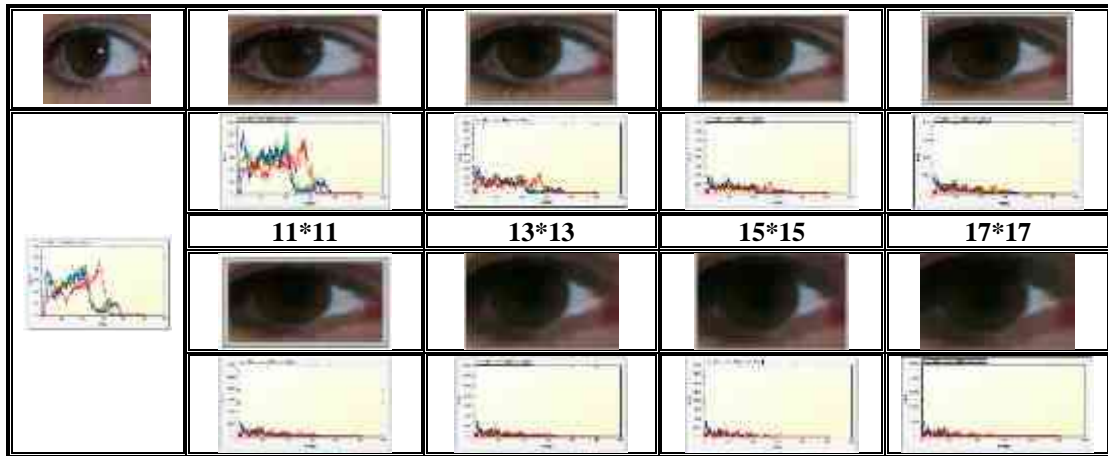



Table 2: The conversion results of dilated Sclera image to Binary and enhancement

Dilation sclera image	Preprocessing		
	Binary with Threshold 128	Erosion operation	Remove Noise

Table 3: The results of detection SIFT key points

NO. Object	Object	SIFT						
		Key Points	Description					
No	X		Y	Size	angle	octaves		
4			0	16.19434	25.7035	4.843551	18.74561	4915712
			1	14.20891	41.32967	10.84168	268.4457	13042177
			3	14.20891	41.32967	10.84168	27.28824	13042177
5			0	74.158	14.23974	3.916359	112.8113	6226176
			1	78.9186	32.63867	6.721629	235.8694	11928320
			2	44.88605	6.944855	5.4487	113.7384	13435392
			----	----	----	----	----	----
			5	12.81202	43.81301	9.582843	39.09009	4129281
6			0	31.09151	6.120071	3.768978	109.4585	3473664
			1	44.70367	10.06152	4.849864	102.0301	4981248

	2	7.050093	12.57722	4.575388	5.584595	786944
	3	6.769567	36.10471	7.115308	265.1006	15991552
	4	52.2459	21.59435	12.53903	246.2173	6882049

The results of all steps of the Palm-identification system shown in tables (4 and 5).

Table 4: Results of preprocessing step of the palm –identification system for 3 users

























	Original palm Image	Grayscale	Median filter	Entropy
User1				
Histogram				
User2				
Histogram				
User3				
Histogram				

Table 5: Results of extract key points and its description using the SIFT algorithm from entropy palm image.







Entropy palm image	SIFT						
	Key Points	Description					
		no	X	Y	Size	angle	octaves
		0	24.96943	4.629488	4.186714	97.85382	11075840
		1	275.1685	7.045592	3.753722	183.3679	3211520
		2	275.1685	7.045592	3.753722	73.20776	3211520
		----	-----	-----	-----	-----	-----
		1002	631.3099	115.1744	80.6683	132.4302	7799300
				0	780.8946	5.110248	3.694515
1	793.2253			8.459703	4.20813	231.7866	11469056
2	793.2253			8.459703	4.20813	105.9789	11469056
----	-----			-----	-----	-----	-----
1934	266.4464			270.3456	219.0846	112.4396	13239045
				0	802.2112	5.397834	3.91212
		1	596.2106	5.933159	4.172237	19.42505	10813696
		2	851.9691	7.966488	4.134669	164.5971	10158336
		----	-----	-----	-----	-----	-----
		3901	788.0816	383.8926	158.7486	203.196	6619653

Figure (8) show an example of 3d logistic behaviors, where initial parameters of 3d logistic map are $r=0.7$ and $x_i=0.4$.

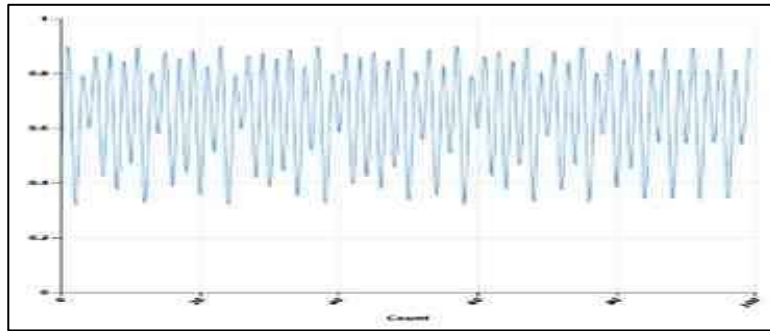


Figure 8: Results of the 3D Logistic Function.

table (7) illustrated randomly behavior of ESSO, where parameters of ESSO algorithm are NP (number of population size) =24336 ,ND (number of decision variables)=50, β_k (the velocity limiter)= 1 , Δk (time interval) =3 , $k=1,0,-1$,and R_1,R_2,R_3 represents random parameter.

Table 7: ESSO algorithm Random behavior-based random parameter

No. of Iteration	The behavior of ESS0 based on Randomly Parameter	
	αk is momentum coefficient [0-1], ηk random value [0-1], R_1, R_2 random value	R_3 Random value
10		
30		
60		
80		

Secret mage								
NIST		P-value						
1	APPROXIMATE ENTROPY	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	pass
2	BLOCK FREQUENCY	0.85968	0.50000	1.00000	0.21592	0.11161	0.21595	pass
3	CUMULATIVE SUMS	0.59251	0.91915	0.31570	0.72994	0.98664	0.86350	pass
4	FFT TEST	0.63817	0.15132	0.15132	0.32872	0.05521	0.34080	pass
5	FREQUENCY	0.71015	0.15787	0.50351	0.15787	0.41357	0.60285	Pass
6	LEMPEL-ZIV	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	Pass
7	RUNS TEST	0.60975	0.59852	0.02096	0.33368	0.14564	0.08657	Pass
8	SERIAL TEST	0.49896	0.15862	0.92175	0.97786	0.92175	0.15862	Pass

5. Conclusion

The sclera portion of the human eye has blood vessel pattern which is unique for each human being and can be manipulated for identifying human. So, the sclera pattern can be used for a useful biometric feature. Palm print is an important biometric technique for personal identification and authentication. In this paper, a new approach to scalar - palm print-based multibiometric identification system. The scalar and palm features are extracted using the SIFT algorithm and proposed method to the combination of these features to create a suitable environment to work on it using the proposed enhancement shark smell optimization algorithm (ESSO). An enhanced version of shark smell optimization (ESSO) was proposed for improving the convergence of this algorithm based on the 3d logistic mapping chaos method. Afterward, the presented algorithm is applied to evaluating all features to find best them to generation stream key in the MD5-256 algorithm to generate a unique user signature.

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