Swarm intelligent hyperdization biometric

Israa Mohammed Khudher, Yahya Ismail Ibrahim

College of Education for Pure Sciences, Department of Computer ScienceUniversity of Mosul, Iraq

Article Info

ABSTRACT

From the last ancient the significance of biometrics has been truly configured due to its important in the every day lifestyles that begins from civilian functions to military actions as well as commercial applications. A Footprint cognizance is a one type of the excellent personal identity based totally on biometric measures. The intention of this research is to sketch a desirable and reliable left foot tip biometric system entitled (LFBS). This paper provides a robust varied technique which connects between two important technology techniques they are Image Processing and Artificial Intelligent technique via Bird Swarm Optimization Algorithm (BSA) to apprehend the human footprint. The use of (BSA) enhances the overall performance and the quality of the outcomes produced from the proposed biometric application via function selection. The chosen facets were once handled as the top of the line attribute set in places of characteristic collection size. The visual database was once developed through capturing life RGB footprint images [1]. Freeman chain code was used with footprint template (black and white image), then statistical values which represent the footprint features was extracted. These aspects have been extracted from every image and saved in Excel file to be entered into the Bird Swarm Algorithm. The experimental effects exhibit that our algorithm estimates, terrific consequences with a tiny feature set in evaluation with different algorithms. On the other hand experimental about 100% accuracy in relation with different papers on the same field. Results show that our algorithm achieves well-organized and precise result.

Corresponding Author:

Israa Mohammed Khudher,
Department of Computer Sciences,
University of Mosul, Mosul, Iraq.
Email: esramk65@gmail.com

1. INTRODUCTION

The main the reliable personal authentication methods requires automatic identification of persons that meet the increasing demand for security in applications such as ID cards, border checkpoints, gate control and forensic. Biometric features such as iris, face, DNA, voice, dental tissue , fingerprint, and footprint have proved to be sole to each person and constant all its lifetime. Biometrics system used to distinguish and detect individual based on biological and behavioral characteristics [2]. Footprint biometrics is an identity that could be applied usefully in crossing points at airport. Individual recognition, baby identification to guard them from missing. Indeed, in holy faith where shoes uninvolved essentially due to holy manner [3]. Vast number of features complicates the search and computational time, as well as considered data poor. This problem leads to the so-called cruse of dimensionality. To overwhelmed difficulties stand up from the vast data, researchers procedure chiefly two solutions. The first one is feature extraction that contains the making of a new feature with minimum space. The second one is feature selection (FS) that configure at first on removing of unrelated, noisy and dismissed features of the original set. This process selects the related features in a small subset that essentially affects the results [4]. The Particle Swarm Optimization (PSO) is an exploration procedure in a Meta exploratory form, physically stimulated from the Mother Nature's society actions, actions and announcements of fish, insects and birds. This method was explored by the American psychologists since the last century and is

often addressed on the name of Swarm-intelligence (SI). It is a populace transfer in a collection penetrating for food arbitrarily in multi directions. PSO has been effectively applied to numerous areas including Estimate Analysis, Feature Fusion, Pattern Recognition, Data mining, Image Processing and Biometric Recognition. Frequently, to reach perfect presentation, a PSO is joint with various techniques to figure a hybridization model [5-7]. At the beginning the two known Swarm Optimization were the Particle Swarm Optimization and Ant Colony Optimization methods. Bird Swarm Algorithm (BSA) was classified under Particle Swarm Optimization (PSO). Recently, a huge number of new swarm-inspired algorithms have appeared [8].

For the significance of footprint authentication from last ancient and it is seldom used in countless establishment. We propose to create a biometric system for which concerned in left footprint. The original knowledge with this approach was the connection between image and intellectual analysis methods thru Bird Swarm Algorithm (BSA). We use (BSA) because it selects features in Meta heuristic form which eliminate the enormous amount of features extracted. New consequences on image information collection addressed that the suggested procedure consumes higher presentation over other surviving paper, our paper show perfect precision through a reduced feature collection. The creation of the suggested paper as in below: Section 2 the related papers this segment converse the works survey and the major distributions with biometric system footprint recognition systems. Section 3 discuss swarm intelligence. Section 4 describes the idea about bird swarm optimization. Section 5 translates the behavior of bird flocks to a mathematical process in bird swarm algorithm. Section 6 discuss in brief the chain code. In section 7 we discussed the proposed work which designed into two stages. The first one involved the foot tip preprocessing; foot tip features extraction. The second stage show the footprint recognition stage. Section 8 discuss the experimental outcomes. Indeed, the conclusion and future work is drawn in section 9. At last the references.

2. RELATED PAPERS

Due to the lack of footprint biometric systems with the Bird Swarm algorithm on the corresponding literature. In this section we will discuss the traditional hybridization techniques with footprint recognition. As well as the merge between PSO with other biometrics measures. First biometric recognition system performed in the 1940s as semi-automated for talker recognition system. The associated researches with altered and several algorithms are discussed in follows. A traditional techniques the Sequential Modified Haar transform is processed the resized footprint image to obtain Modified Haar Energy (MHE) feature. Euclidean Distance was used as a similarity measure to compare the MHE feature with the database feature [9]. The recognition rate approximate to 92.375% from proposed MHE feature. Jin-Woo Jung et. al. suggest a new person recognition method depends on both overlain foot form and COP (Center Of Pressure) path throughout one-step walking. The recognition rate obtained was 98.6% [10]. This paper segment the person foot tip image, used threshold to identify and detect person by determining value [11]. Another paper merges fuzzy logic and neural network to extract features [12]. Authors record the foot core individualities. These individualities founded with geometrical also smoothness values [13]. Authors in this paper obtained geometrical morphology operations to detect footprint shape variant of about 84 women [14]. Chabbra and Singh constructed biometric system for physical biometric identity hand, eye, face, fingerprint and voice. A swarm intelligence classification tactic for biometrics authentication problems was used. With the merger of biometric features and swarm intelligence the system faults were reduced [15].

3. SWARM INTELLIGENCE (SI) [15, 4]

Natural surroundings have been given that an endless inspiration for human to think and design new Meta heuristic procedures. Swarm intelligence is an up-to-date artificial intelligence discipline which is involved by the plan of various mediator schemes with applications. The project pattern for the schemes is essential totally altered from more old-style techniques. As a substitute of a superior control mechanism that directs a universal action of the organization, the swarm intelligence basic idea is essentially contained many simple units that work so as to indicate a looked-for conduct. Creativeness of such systems is collected from the combination social actions of insects such as ants, bees, termites, and wasps, in addition from the rules of other animal in the world such as flocks of birds. Even though the one member of such societies is innocent individuals, they are able to succeed complicated tasks in cooperation.

The advantage of this method is very simple, easily finished and it requires fewer factors, which made it fully advanced. Despite the advantages shown, PSO also has a drawback which is if all the velocity becomes equal to maximum velocity the particle will continue to manner searches within a hypercube and will probably stay in the top but will not touch in the local area. When the algorithm converges, the stable values of the factors

might cause the unnecessary variation of particles. Higher amount more stylish finite element formulations, higher precision [16]. Typical SI-based computation algorithms including ACO, PSO, ABC, BA, SFLA, AFSA and PIO. These algorithms have different operators and control parameters. SI is used for feature selection and classification. The effectiveness of classification results for Particle swarm Intelligent , Artificial Bee Colony (ABC) and random feature were compared with small feature sets show best results for (PSO) than other two types as shown in Table 1.

Table 1. Classification Results Comparison between SI Methods [17]

No. Features	PSO	ABC	Random
50-5	91.10%	90.18%	83.70%
200-10	95.64%	98.01%	88.64%
200-40	91.87%	97.90%	90.26%
300-10	93.77%	94.06%	85.24%
300-20	91.37%	93.71%	85.71%

4. BIRD SWARM OPTIMIZATION

Bird Swarm Algorithm (BSA) is a modren metaheuristic algorithm recently proposed by Meng et al. For continuous optimization problems. BSA depends on the swarm intelligence extracted from the sociable behaviors and communications in bird swarms. In contrast to a number of metaheuristic technique such as PSO, BSA has the attribute of fast merging and high affluence accuracy. Due to their excellent performance, BSA and its alternatives have recently been practical in a various program, such as optimization of standard functions, edge detection [18-19]. The main principles of the collective behavior as presented:

a. Homogeneousness: Every bird in the swarm behaves in a same manner. Despite that the flock moves without leader, the short-term leaders were appearing.
b. Area: The sign of each bird is inclined by its adjacent flock mates. Visualization is considered as the important senses for flock organization.
c. Crash Escaping: Escape with close flock mates.
d. Speed Matching : Try to match speed with near flock mates.
e. Flock Centring: Try to stay near to the close flock mates. This combined intelligence seems to occur from what are rare huge collections of relatively simple mediators. The agents use easy local rules to manage their movements and via the connections of the entire group, the swarm performs its targets [4, 20]. Figure 1(a) and Figure 1(b) describe these concepts.

(a). Concept of BSA behaviors   (b) the bird flocks
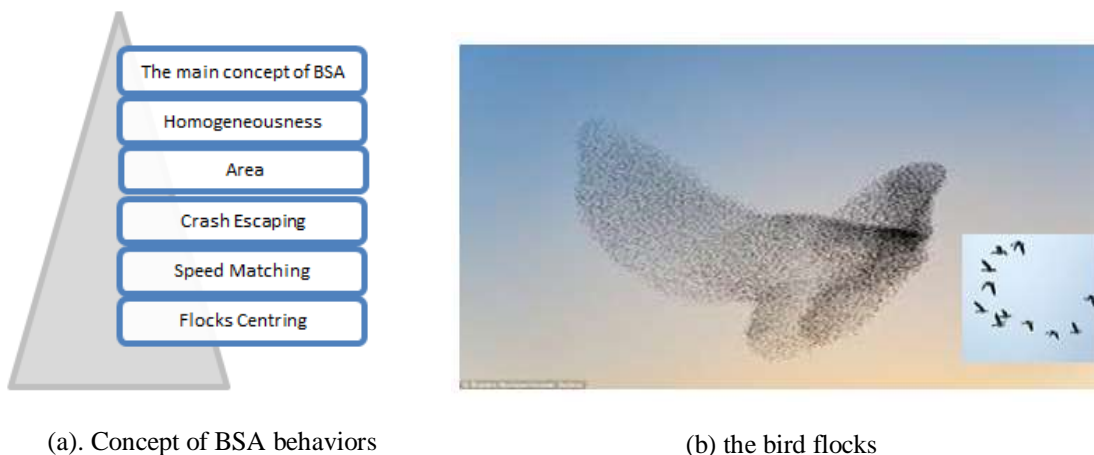
Figure 1. Bird swarm optimization

BSA has recently been joint to standard and useful methods to form a hybrid. The good thing about creating a hybridization is that both techniques can balance each other's drawback and enhance the overall performance as well as gain hence results [5]. Table 2 shows the merge betweenthe related work of (PSO) techniques with other techniques.

Table 2. Merge between (PSO) with other Techniques

Author , Year	Purpose	Method	Details
De Falco 2007 [21]	Classification	ANN	Proposed Particle Swarm Optimization to avoid the problem of classification of situation in DB.
Qi Shen et al. 2007 [22]	Classification	Support Vector machine (SVM)	Proposed work merges between (PSO) and Support vector machines (SVM) For tumor classification.
Qi Shen et al.2008 [23]	Classification	Pure Tabu Search (TS) & Hybride PSO	A hybrid PSO and TS (HPSOTS) Approach for gene choice.
Li-Yeh Chuang et al. 2008 [24]	F Selection	Binary PSO, K-NN, BPNN and PNN	Combined binary particle swarm optimization and K-NN Method for gene expression data and grouping problems.
Alper Unler et.al.2011 [25]	F Selection	SVM	A hybrid filter wrapper feature subset selection Algorithm based on PSO and SVM
Bing Xue, et. Al 2014 [26]	F Selection	LDA, KNN, PSO	Proposed a PSO based FS aproach for better classification performance
Subhajit Kar et al. 2015 [27]	Classification	SVM, KNN, PSO	Proposed a hybride approach for the diseases dignosis .
Yong Zhang Dunwei Gong et.al. 2015 [28]	F Selection	PSO, NN	Proposed binary BPSO method to find optimal Feature subset.

5. BIRDS SWARM AlGORITHM (BSA)

Explaining the social behaviors of birds are simplified on the following described rules:

a. All particle alteration between observance and foraging behaviors.

b. In foraging, each flying creature may record and refresh its best past involvement to look for sustenance. The social data is shared quickly between the whole swarm.

c. While carefulness is kept up, each fowl endeavors to move to the focal point of the swarm a challenge in the swarm is exists. Feathered creatures that require advanced arrangements could be bound to situate nearer to the middle than winged animals with small arrangements of nourishment.

d. While watchfulness is kept up, each feathered creature attempts to move to the focal point of the swarm a challenge in the swarm is exists. Feathered creatures that have higher arrangements would be bound to situated closer to the center than fowls with low arrangements of foodstuff [29].

e. Birds may normally travel to other position; after this event, they spread delivering, searching observance is continued, every particle attempts to travel to the swarm core a struggle in the nest is exists. Birds that have higher foods would be the most positioned nearby the nest core than birds with little food amount [29].

f. Particle can regularly change its position; then, they can spread amongst producing, scrounging and intermediate. Producer are birds with the highest keeps of food, scrounger those that have the lowest supplies. Intermediate are birds with randomly select to be a producer or scrounger.

g. Creators in active find nutrition but scrounger randomly follow Producers to search for food. The Pseudo-code of BSA is shown in Figure 2 [7-8].

6. CHAIN CODE

The Chain Code algorithm requires the process of converting the gray image to a binary image (black and white) and by scanning from left to right and from top to bottom, then the background information is separated from the foreground. Attributes are taken for the location, angle, direction and actual value of the dots [30-31]. A series of figures that simply represent the shape of the eight directions (east, 0 north-east, north-west, (7)) as showed in Figure 3 and the work of the series clockwise. The important thing is the direction to connect Pixel points from point-to-point. Chain Code requires 8-connected or 4-connected [30]. Chains can signify the borders or contours of any discrete object composed of regular cells. Binary image array with the background represented by the value 0 and foreground represented by the value 1. The aim of boarder extraction is to find the pixels that are on the edge of shapes in the image [30-31]. The string code when (K> 8) is called (chain codes) [32-33]. Figure 3 shows the details of chain code method where 3(a) represents the eight symbol chain style (K = 8)[34]. In Figure 3(b) the direction graph in clockwise manner represents the symbolic of edge starting from the black mark 3(c) Describes of the scheme (b) Indeed Figure 3(d) shows the Histogram representation of the figurative sequence [33].

BSA Algorithm Psudo-code

Initiliazation put N: the number of individuals (birds) contained by the population
M: the most extreme number of cycles
FQ: the recurrence of winged birds' flight practices
P: the liklihood of foraging for food
C, S, a1, a2, FL: five consistent parameters
t=0; Initialize the population and characterize the related parameters
Assess the N people's wellness esteem, and locate the best arrangement
While (t < M)
If (t % FQ ≠ 0)
For i = 1 : N
On the off chance that rand (0,1) < P
Birds forage for food
Else Birds keep vigilance
End if, End for
Else
Separation the swarm into two sections: makers and scroungers.
For i = 1 : N
in the event that I is a maker
Making
Else Rummaging
End if, End For
End If Evaluate new arrangements
on the off chance that the new arrangements are superior to anything their past ones, update at that point
Locate the best arrangements
t=t+1; End while

Output: the individual with the best target work an incentive in the populace
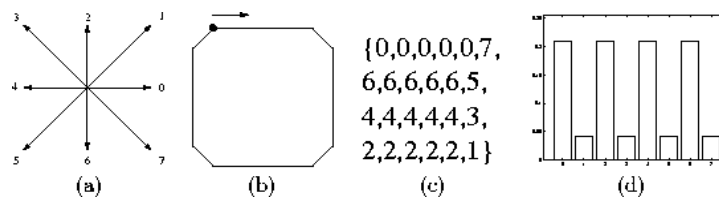
Figure 2. Pseudo-code for BSA (BSA)

Figure 3. The Chain Code method [33]

7. THE PROPOSED WORK

The aim of this paper is to design left footprint biometric system the foot image is obtained from a scanner to authenticate people. The biological properties were represented as statistical features extracted form footprint tip chain code. We enhance the system and improve the presentation by integration between image processing and Bird Swarm Algorithm. The outline of this paper is displayed in Figure 4.

7.1. Stage One
7.1.1. Visual Database Acquisition

At first the visual database images were normalized and preprocessed Figure 5 show a section from the database foot tip. The colored images were renewed toward the intensity scale then to the monochrome formula. Image is treated by successive operations such as canny filter and morphology operations to detect the footprint template. Background is isolated to gain footprint tip. The segmentation process was illustrated for recognition stages. The description of the proposed work is processed into two stages. Stage one and stage two.
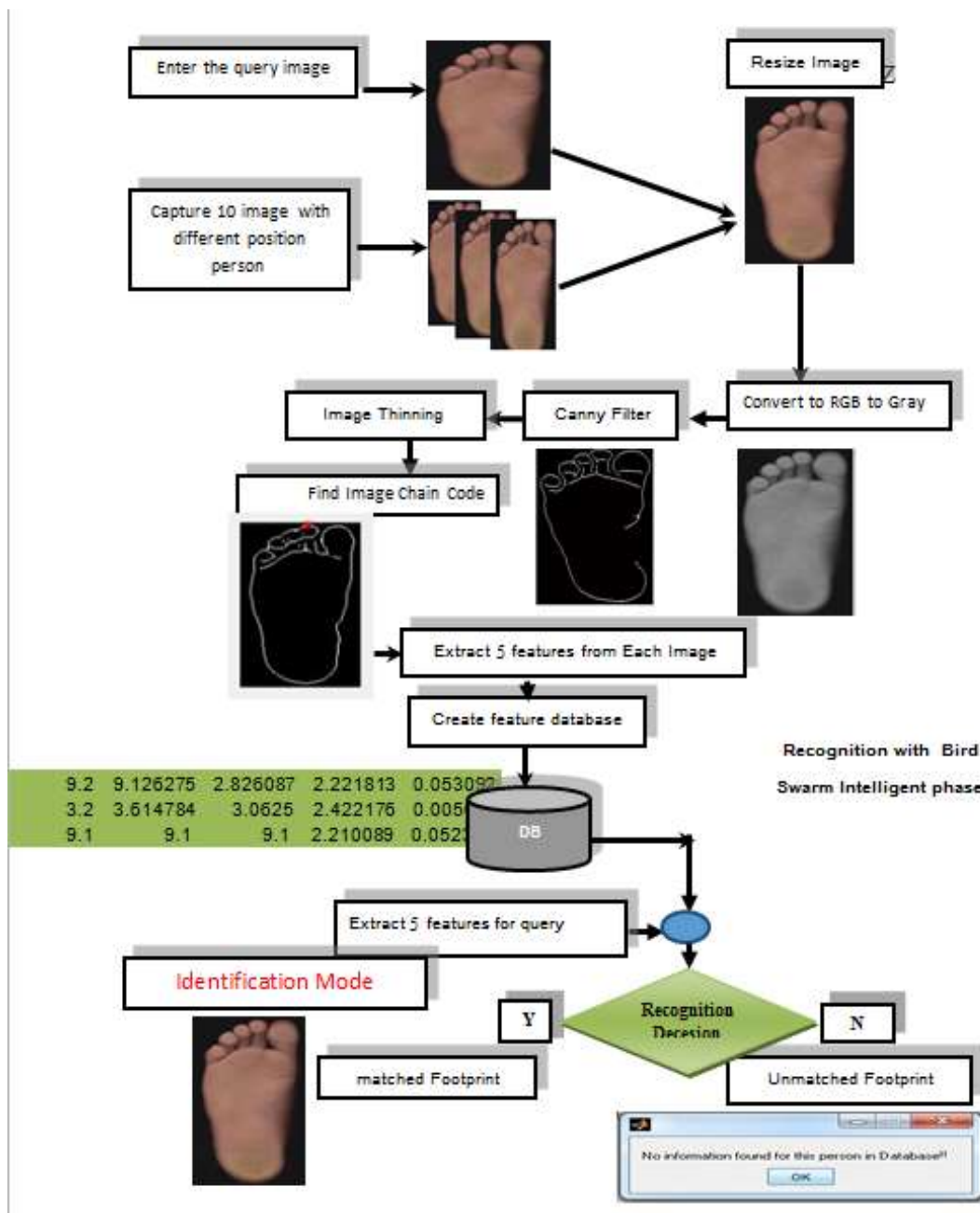
Figure 4. The outline of the work

7.1.2. Foot tip Features Extraction

Features extraction is the imperative phase in any biometric application. We obtained the statistical moment that denotes to the foot tip features the best precise features were chosen. The moment was used in the research because they are important in providing storage space in memory because they give a very high representation compared with other characteristics. It also gives faster and more accurate results [35].

The first moment is the Mean and the second moment is the standard deviation (STD). Mean gives a clear idea of the brilliance of the image. The splendid image has a high mean and the low mean reflects the dark image as shown in (1) [35].

$$Mi = \frac{1}{N} \sum_{j=1}^{N} f_{ij}$$

(1)

Where fij is the attributes value and N is the number attributes.

The standard deviation STD represents the contrast and distribution of the image. The higher the contrast value, the low STD value, and if the value of the contradiction is low, the value of the STD is high. The value of STD is mathematically defined as shown in (2).

$$\delta = \left(\frac{1}{N} \sum_{j=1}^{n} (f_{ij} - M_j)^2\right)^{1/2}$$

(2)

Where Mj represents mean of i, fij represents the attributes value of the image, and N represents the number of attributes in the image database [35].

Figure 5. Sample from visual database

The Chain Code Histogram (CCH) feature extraction method gets guiding data from the pixels of the mined character shape [33]. Here we represented the histogram of an image as the number of pixels in each direction as a count instead of intensity values. When the binary image is obtained, the vertical, horizontal, right and left diagonal histogram of the image is calculated and it is denoted as a feature vector. Then all the four guiding histogram sequences are collective into a single integer sequence as feature vector of the digital image. The collective integer sequence is characterized as a chain code of the digital image. Five features from the binary image were extracted. These features are the angle of chain code, mean and STD as well as the mean and STD of a histogram was also extracted. The values were stored on EXCEL file were the features' database is constructed. A sample of these features is shown in Table 3.

Table 3. Sample from EXCEL File for Features Database

Img N0.	Angle	Mean	STD	Mean Hist	STD Hist
1	.1	9.631545	2.78022	2.210089	0.052355
11	9.9	14.43337	5.10101	1.956126	0
21	3.3	3.093003	2.818182	2.324523	0.035508
31	11.2	17.89351	4.964286	2.241816	0.054831
41	8.4	13.08264	5.345238	2.079701	0.046116
71	11.6	21.75725	5.387931	1.753365	0.004548
81	5.2	8.966605	2.596154	3.18858	0.053669

7.2. Stage Two-The Recognition Techniques

We calculate and extract features for the 90 images; there values were saved on an EXCEL file. The query image was entered to the system its characteristics were mined online for the duration of the system action. Comparison operation is performed between the query features and all the database features by means of Bird Swarm Algorithm (BSA). BSA helps to estimate the fitness task which concerned to the least dissimilarity (min) between inquiry and dataset attributes. Our suggested approach application segment as shown in Figure 6, the entry is the BSA parameters. The result was the accorded image as well as its identification number in the databank else a note of reject is displayed. Excel file nwfoot hold image foot tip attributes which pass into BSA

function. This task outlays the preeminent solution and the top path from 100 compared addresses corresponding to the footprint designated from one to ten.

Suggested paper program-code

Involvement: BSA's attributes

Production: correct foot image and its identification

```
[per, header]=xlread('nwfoot')
[bstindx, gbest]=BSA(per, data)
chain=cha3(m,s,t,posit); % chain code length, start, end,
 direction h=1;
feat(h,1)=th(2,2);
feat(h,2)=std((chain)); feat(h,3)=mean((chain));
feat(h,4)=std(hist((chain))); feat(h,5)=mean(hist((chain))) ;
[per1,
header]=xlsread('nwfoot.xlsx');
for j=1:size(per1,1)
% pso Function
[bestIndeX,gbest]=PSO_Count_General(per
 1,data(i,:)); i41=10; % . no.of image to
 every person ttt(j,1)=gbst;
ttt(j,2)=bestIndeX;
ttt(i,3)=ceil(bestIndeX/i41); if (gbst<4.5)
 bestIndeX/i4; sq=ceil(bestIndeX/i4); % to identify person no.
 else sq=0;
end if sq~=0 msg1
"acceptance message"
 else msg1 "rejected message";
end
```

Figure 6. Proposed work program segment

8.   EXPERIMENTAL OUTCOMES

The system were subjected to the visual database which was constructed from Ten images per person so that the database contain 90 images. There features were extracted via chain code and compared with query image features. The effectiveness and the improvement of our work were estimated, by a number of trials on the image features. The application were evaluated and run on Matlab2018b. The appreciation results was gained via comparing the query image features entered to the system with the features' database. Another nine trails for testing were evaluated on nine images, these images features were extracted on line and compared with the features database. The system succeed to recognize the footprint as shown in Figure 7, the image on the left shows the starting point with red mark for the chain code method. As well as, a message of reject or acceptance with the corresponding footprint were shown. We magnitude the value of the consequence by two measures, that is, recall and precision they are definite as in (3) and (4) correspondingly [36].

$$Recall = TRU(i)/K (i) \tag{3}$$

$$Precision=TRU(i)/TRU(i)+FFA(i) \tag{4}$$

Where, $K(i)$ denotes the database size, $TRU(i)$ is the digit of the relevant images, $FFA(i)$ is the counter of irrelevant images. Tabletop 4 records the value Processes for a set of image. Were all the results approximate to 100% precision for Recall and Precision. The total average is 100 for all the visual databases.

Table 4. Value Processes for Feature Database

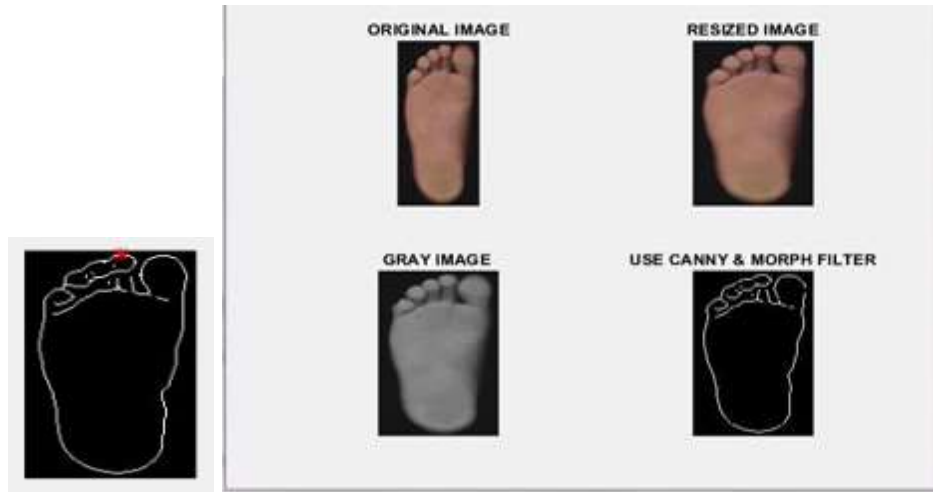| Img ID	Recall	Precision	Img ID	Recall	Precision
Foot 1	100%	100%	Foot 6	100%	100%
foot 2	100%	100%	Foot 7	100%	100%
Foot 3	100%	100%	Foot 8	100%	100%
Foot 4	100%	100%	Foot 9	100%	100%
Foot 5	100%	100%			
			Average	100	100

Figure 7. The matching results of inquiry with DB images

Recall and precision values denotes 100% but 90% for the testing images. There mean are 98.6 and 100 respectively. Since, only one irrelevant image was produced from nine images. The results were recorded in Table 5.

Table 5. The Quality Measures for Testing Images

Img ID	Recall	Precision	Img ID	Recall	Precision
Img 1	100%	100%	Img 6	100%	100%
Img 2	100%	100%	Img 7	100%	100%
Img 3	100%	100%	Img 8	88%	100%
Img 4	100%	100%	Img 9	100%	100%
Img 5	100%	100%			
			Average	98.6	100

The recognition rate value show the superior results gained by our work that reached to 100% for features database. Recognition rate for the nine testing image the is 100% for recall and 88% for precision. Table 6 described the comparison between our proposed work and other research depends on traditional technique as well as intelligent techniques via PSO but not with footprint biometrics. These outcomes show the character of (BSA) optimization that chooses the optimal attributes in a trivial precise set. Our proposed paper describes the best recognition rate that ranged from 98.6 to 100 with many techniques by their results which are ranged between 51 to 92.8.

Table 6. Comparison Results of the Proposed Work and the Related Work

Author & Year	Technique	Recognition Rate %
Qi Shen et al.2008 [37]	Pure Tabu Search (TS) & Hybride PSO	100%
Nakajima, 2000 [38]	Euclidean distance	85%
Jin-Woo et. Al. ,2003 [10]	Hidden Markov Model	64%
Jaesoek Yun et. Al. 2007 [39]	Neural Network	92%
Jacqueline Domjanic 2013 [40]	The intra class correlation coefficients	95%
	(ICC) for the first four principal	85%
	components	85%, and 88%
Hashem Kadhim m. and Ghali Fatiama 2016 [41]	Foot Shape Geometry and ANN	92.5%
Riti Kushwaha, et. Al. 2017 [42]	Shape descriptors	75.8%.
	Shape segmentation	51 %
	Eigen foot	92.%%
The Proposed Work	Chain Code and BSA	100%

9.   CONCLUSION AND FUTURE WORKS

We proposed in this approach a Hybridization algorithm which merges between image processing techniques for feature mining by binary and morphological applications and BSA for feature selection and reduction based on swarm intelligence strategy. Bird Swarm Algorithm (BSA) chooses exceptional characteristics in rapports of minimum features collection. The experimental products of the system describe the integrity of this process in comparison with other related papers on the field of classical foot tip biometric. The produced recognition rate was 100% for database features but 98.66% for testing (online) features.

REFERENCE

[1] Yahya Ismail Ibrahim and Israa Mohammed Alhamdani, "A hyprid technique for human footprint recognition" , *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 9, no. 5, pp. 4060-4068, October 2019.

[2] R. Kushwaha, et al., "*Detailed Analysis of Footprint Geometry for Person Identification*". 13th International Conference on Signal-Image Technology & Internet-Based Systems (SITIS), 2017.

[3] Lucija Brezočnik., et al., "Swarm "Intelligence Algorithms for Feature Selection:A Review", *Institute of Informatics, Faculty of Electrical Engineering and Computer Science, University of Maribor*, 2018.

[4] Madan Madhaw Shrivas, et al., "A Review of Particle Swarm Optimization: Feature Selection, Classification and Hybridizations"*, International Journal on Recent and Innovation Trends in Computing and ommunication,* ISSN: 23218169, vol. 3, Issue: 4, 2015.

[5] Qinghai Bai, "Analysis of Particle Swarm Optimization Algorithm", *Computer and Information science,* vol.3, no.1, 2010.

[6] B.Gireesha Obaiahnahatti, "A Literature Survey on Artificial Swarm Intelligence based Optimization Techniques", *International Journal of Engineering & Technology,* 7 (4.5) ,2018, pp. 455-458.

[7] Min Lin , et al., "Discrete Bird Swarm Algorithm Based on Information Entropy Matrix for Traveling Salesman Problem", *Mathematical Problems in Engineering,* vol. 2018, DOI: 10.1155/2018/9461861, Oct. 2018, pp. 1-15.

[8] V. D. Ambeth Kumar and M. Ramakrishnan, "Footprint Recognition using Modified Sequential Haar Energy Transform (MSHET)", *IJCSI International Journal of Computer Science,* vol.7, Issue 3, no.5, 2010.

[9] Jin-Woo Jung, et al. , "Person Recognition Method using Sequential Walking Footprintsnvia Overlapped Foot Shape and Center-Of-Pressure Trajectory"*, Systemics, Cybernetics And Informatics,* vol. 11, no.4, 2013.

[10] Kh. A. Al-Dulaimi, "Using Feature Extraction for Human Footprints Recognition", *International Journal of Computer Applications, vol.* 64. no.3, 2013.

[11] K. N. Kumar and S. Dubey "Mathematical modeling of footprint based biometric Recognition", *International of mathematical trends and technology (IJMIT),* vol. 54, no.6, 2018.

[12] A. Uhl and P. Wild, "Footprint-based biometric verification", *Journal of Electronic Imaging,* 2008.

[13] Jacqueline Domjanic, et al.," Geometric morphometric footprint analysis of young women", *Journal of Foot and Ankle Research,* vol. 6, no. 27, 2013.

[14] Sumit Chabbra and Nirmaljit Singh, "Applications of Swarm Intelligence in Biometrics systems", *International Journal of Innovative Research in Computer and Communication Engineering, vol.* 2, Issue 2, 2014.

[15] Mohammad Aizat bin Basir and Faudziah binti Ahmad, "Comparison on Swarm Algorithms for Feature Selections/Reductions", *International Journal of Scientific & Engineering Research,* vol. 5, Issue 8, 2014.

[16] Tao zhang, et al., "A Fast Feature Selection Algorithm Based on Swarm Intelligence in Acoustic Defect Detection", *Digital Object,* 2018.

[17] A. Hugo Perlin, et al.,"Particle Swarm Optimization for Object Recognition in Computer Vision", *Conference Paper in Lecture Notes in Computer Science,* June 2008.

[18] Sara Motamed, et al., "Multimodal Biometric Recognition Using Particle Swarm Optimization-Based Selected Features", *Journal of Information Systems and Telecommunication,* vol. 1, no.2, 2013.

[19] G. H. Mahamed Omran, "Particle Swarm Optimization Methods for Pattern Recognition and Image Processing", *University of Pretoria,* 2005.

[20] I. De Falco, et al., "*Evaluation of Particle Swarm Optimization Effectiveness in Classification*", Fuzzy Logic and Applications, 6th International Workshop, Crema, Italy*,* 2005.

[21] Qi Shen, et al., "A combination of modified particle swarm optimization algorithm and support vector machine for gene selection and tumor classification" ,*Talanta 71*, 2007.

[22] Qi Shen, et al., "Hybrid particle swarm optimization and tabu search approach for selecting genes for tumor classification using gene expression data", *Computational Biology and Chemistry,* 32 , 2008.

[23] Li-Yeh Chuang, et al., "Improved binary PSO for feature selection using gene expression data", *Computational Biology and Chemistry,* 32, 2008.

[24] Alper Unler and Alper Murat, "A discrete particle swarm optimization method for feature selection in binary Classification problems," *European Journal of Operational Research,* 206, 2010.

[25] Bing Xue, et al., "Particle swarm Optimisation for feature selection in classification:Novel initialisation and updating mechanisms", *Applied Soft Computing,* 18, 2014.

[26] Subhajit Kar , et al., "Gene selection from microarray gene expression data for classification of cancer subgroups employing PSO and adaptive K-nearest neighbourhood technique", *Expert Systems with Applications*, 42 , 2015.

[27] Yong Zhang, et al., "Feature selection algorithm based on bare bones particle swarm optimization,Neuro computing", *IEEE transactions on evolutionary computation*, vol. 20, no.4, 2016.

[28] Ivette Miramontes, et al., "Optimal Design of Interval Type-2 Fuzzy Heart Rate Level Classification Systems Using the Bird Swarm Algorithm", *Algorithms*, vol. *11*(12), 206, DOI: 10.3390/a1112020, 2018.

[29] Faiq Baji and Mihai Mocanu , "Chain Code Approach for Shape based Image Retrieval ", *Indian Journal of Science and Technology*, vol. 11(3), DOI: 10.17485/ijst/2018/v11i3/119998, Craiova, Romania; 2018.

[30] Abdel-Badeeh M. Salem, et al., " A Vertex Chain Code Approach for Image Recognition"*, International Journal on Graphics ,Vision and Image Processing* ,www.icgst.com.

[31] Venu Govindaraju, et al., "Feature Extraction Using a Chain coded Contour Representation of Fingerprint Images", *Audio- and Video-Based Biometric Person Authentication*, Springer-Verlag Berlin Heidelberg, 2003.

[32] N. Venkateswara Rao and B. RaveendraBabu, "Combined histogram chain code feature extraction method to recognize handwritten digits with probabilistic neural network", *International Journal of Applied Engineering Research,* ISSN 0973-4562 vol. 9 no.20, 2014.

[33] Israa Hadi Ali, "New Method for Image Features Extracting Based on Enhanced Chain Code*", Oriental Journal of Computer Science & Technolog,* ISSN: 0974-6471, vol. 6, no.(4), 2013.

[34] Rafael C. Gonzalez and Richard E. Woods, "*Digital image processing*". 2nd Ed., prentice-Hall, New Jersey, USA, 2002.

[35] Henning Muller, et al., "Performance Evaluation in CBIR: Overview and Proposals". *A technical report submitted to the Computing Science Center,* University of Geneva, Geneva, Switzerland, 1999.

[36] Qi-Shin, et al., "Hybrid particle swarm optimization and tabu search approach for selecting genes for tumor classification using gene expression data", *Computational Biology and Chemistry*, 32(1), 2008**.**

[37] K. Nakajima, et al., "Foot-Based Personal Recognition", *IEEE: Tr. On Biomedical Engineering*, vol. 47, no.11, 2000.

[38] V. A. Kumar and M. Ramakrishnan, "Legacy of Footprints Recognition- A Review", *International Journal of Computer Applications*, vol. 35, no.11, pp. 9-16, 2011.

[39] Jacqueline Domjanic, et al., "Geometric morphometric footprint analysis of young women", *Journal of Foot and Ankle Research*, 2013, 6:27.

[40] Hashem Kadhim m. and Ghali Fatiama., "Human Identification Using Human Footprint Features", *Engineering and Manufacturing*, vol.4, 2016.

[41] Riti Kushwaha, et al., "*Person identification on the basis of footprint geometry*", 12th International Conference on Signal-Image Technology & Internet-Based Systems, 2017.