INDIVIDUAL BIOMETRICS PATTERN BASED ARTIFICIAL IMAGE ANALYSIS TECHNIQUES

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ABSTRACT. Biometric characteristics have been used since antiquated decades, particularly in the detection of crimes and investigations. The rapid development in image processing made great progress in biometric features recognition that is used in all life directions, especially when these features recognition is constructed as a computer system. The target of this research is to set up a left foot biometric system by hybridization between image processing and artificial bee colony (ABC) for feature choice that is addressed within artificial image processing. The algorithm is new because of the rare availability of hybridization algorithms in the literature of footprint recognition with the artificial bee colony assessment. The suggested system is tested on a live-captured ninety colored footprint images that composed the visual database. Then the constructed database was classified into nine clusters and normalized to be used at the advanced stages. Features database is constructed from the visual database off-line. The system starts with a comparison operation between the foot-tip image features extracted on-line and the visual database features. The outcome from this process is either a reject or an acceptance message. The results of the proposed work reflect the accuracy and integrity of the output. That is affected by the perfect choice of features as well as the use of artificial bee colony and data clustering which decreased the complexity and later raised the recognition rate to 100%. Our outcomes show the precision of our proposed procedures over others’ methods in the field of biometric acknowledgment.

1. Introduction. In the last 30 years, the need for a security system becomes insisted through biometric machines. The first biometric appliance mounted and utilized by fingertip. The development continued until these styles of structures approximate to two thousand systems. Biometric elements like deoxyribonucleic acid, ear tip, and fingertip have evidenced to be sole to all and sundry and steady all its lifespan that is entitled bodily and social characteristics [39]. Foot-tip identification is defined as the dimension of footprint functions for recognizing the identity of a user has surfaced currently [31]. Feature selection (FS) has been used to reduce the problems of the processing operation and calculation time that produced a vast
The artificial bee colony is an investigation method, adapted and developed by users, it is a computational optimization well-defined by way of Karaboga in 2005, it concerned in the intelligent behavior of honeybee [11][23]. An artificial bee colony is made more robust, it changed via merged with a few classical and evolutionary diverse algorithms this technique is named hybridization [17]. A paper shows a hybridization technique of a multi-objective fuzzy method and artificial fish swarm algorithm (SAAFSA) then the method is implemented to offer top of the line solutions. The technique offers a solution to the problem of flow scheduling manufacturing establishment. The acquired consequences display the usefulness and excessive performance of the cautioned method is an assessment with different works [36].

A paper by Tirkolaee E. B. et al. [37] shows strategies to clear up the trouble of city unused collection to minimize total cost the authors used mixed-integer linear programming. Then, to develop the solution a hybrid set of rules used as the Taguchi constraint layout technique become evolved primarily based on stepped forward improved max-min ant scheme. Computational consequence displays excessive performance for the suggested set of rules. Another research by Tirkolaee E. B. et al. [38] provides a solution to the problem of city hard waste control which used the fuzzy principle for the multi-tour arc routing problem. Hybridization between that was used to reduce ant colony optimization based totally on advanced max-min and a simulated strengthening algorithm. The use of ant colony optimization amplified the overall performance. The procedure is examined in a real-world study and reflects perfect results. In the following section, we will discuss the typical research for footprint authentication. As well as, another research that merges between artificial bee colony and other type of biometrics characteristics such as ear print, fingerprint. Table 1 shows a summary of biometric related papers. This paper aims to build an original, intelligent, and effectual image processing appliance for foot-tip biometric. After the survey and read in the footprint biometric papers, it is clear that the methodology of the suggested paper is original because of the intelligent image processing evaluated via an artificial bee colony to produce artificial foot-tip image evaluation. In addition to the deduction of the extensive number of features to a small set, this in turn, optimized the outcome. The gadget is applied to ninety RGB live foot-tip image databases. The procedure of this work is as follows; the foot template changed to chain code. Five attributes are extracted and stored in an excel file. This file represents the feature database as a requirement of the application. The created consequences produced from this paper displays the remarkable overall performance and development of this work over the other’s paper on the same field. The rest of this paper is prepared as follows: Section 2 suggests the Swarm Intelligent notions that discuss the organic and mathematical evaluation of the artificial bee colony. Section three discusses the proposed method it’s specially constructed employing phases. The first phase is the visual database enhancement approach which incorporates the footprint function mining. The second phase shows the recognition assessment. Section 4 fully discusses system enhancement through outcome analysis. Section five the conclusion and future outlook. Indeed, the references.

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Table 1. Summary of biometric features related papers

| Biometric Type | Technique                                      | Performance | Version |
|----------------|-----------------------------------------------|-------------|---------|
| Foot-tip       | Morphology, statistical                        | 83.38 - 89.52 | 2019 [13] |
| Foot-tip       | Modified Sequential Haar Energy Transform (MSHET) | 92.37       | 2019 [19] |
| Foot-tip       | texture and shape                              | 99          | 2016 [26] |
| Foot-tip       | Modified Haar Energy (MHE)                     | 93          | 2016 [36] |
| Foot-tip       | (ABC) Algorithm for finding the curve fitting  | 97.15       | 2010 [14] |
| Lung image     | (ABC) to segment clinical                      | 99.2        | 2016 [12] |
| Ear print      | Extracting the most discriminant key-points    | 99.6        | 2010 [17] |
| Foot-tip       | Fuzzy neural network                           | 90-92.80    | 2010 [36] |
| Foot-tip       | Suggested work Statistical Chain code-based (ABC) | 100         | 2020    |

from this paper displays the remarkable overall performance and development of this work over the other’s paper on the same field. The rest of this paper is prepared as follows: Section two suggests the Swarm Intelligent notions that discuss the organic and mathematical evaluation of the artificial bee colony. Section three discusses the proposed method it’s specially constructed employing phases. The first phase is the visual database enhancement approach which incorporates the footprint function mining. The second phase shows the recognition assessment. Section four fully discusses system enhancement through outcome analysis. Section five the conclusion and outlook. Indeed, the references.

2. Swarm Intelligent. The behavior of animals and insects was investigated and translated to mathematical algorithms and especially used for many applications [29][6]. Swarm intelligence is defined as any effort to design procedures or spread problem solution strategies enthused by the collective actions of insect colonies and other animal societies. Also, swarm intelligence is a fixed of particles, which might be reliable to communicate immediately, or performing on their close by an environment with all, and which mutually carry out a disbursed hassle solving [41].

2.1. Artificial Bee Colony. It is a recursive elegance used recently based on population and the hassle solution is the food source (nectar). Nectar fitting represents fitness. The colony consists of three types of bee they are: scout bee, onlooker bee, and hired bee. At the start point, the bee frequency number is divided into two halves the first half for the hired bee and the second for the onlooker bee. The following operations repeated until the perfect answer reached [9] [5]:

- Employed (active) bee work, look for the meals sources and replace the meals when the nectar quantity is richer in the new source.
- The onlooker (observer) bee selects the place of the meal.
- Determine the scout bee when the meals positions are expired, the employed bee turn into a scout. Figure 1 describes this procedure.
2.1.1. *ABC.* The (ABC) method starts by initializing NS nectar source. Each food source is a D is a one-dimensional array holding the parameter factors to be optimized between which are arbitrarily and regularly distributed between the predetermined initial values $X_{ij}^{high}$, $X_{ij}^{low}$ bound as in equation 1

$$X_{ij} = X_{ij}^{low} + \text{rand}(0, 1)(X_{ij}^{high} - X_{ij}^{low})$$

for $j = [1, D]$ and $i = [1, NS]$ with $i$ and $j$ being the individual and parameter indexes correspondingly. The fitness of each source is valued.

2.1.2. *Active Bee.* The active bee looks for the nearest food location and the original food position is calculated using equation 2

$$V_{ij} = X_{ij} + \psi(X_{ij} - X_{kj})$$

$i \in [1, NS]$, $j \in [1, D]$ and $k \in [1, m]$, where is a randomly selected j-th factor of the i-th individual index and k is a member of NS number of food source. Fulfill the condition that k is different from i and j. $\psi$ is a random number within $[-1,1]$.

2.1.3. *Observer Bee.* Observer bee chooses a food position by estimating the evidence established from the employed bee. The probability of nectar amount $p_i$ is based on the fitness value $fit_i$ of the food source i, as calculate in equation 3:

$$fit_i = \begin{cases} 
\frac{1}{1 + f_i}, & \text{if } f_i \geq 0, \\
1 + \text{abs}(f_i), & \text{if } f_i < 0.
\end{cases}$$

(3)

where $f_i$ is the objective function. $p_i$ is calculated as in equation 4:

$$p_i = \frac{fit_i}{\sum_{j=1}^{N} fit_i}$$

(4)

where $fit_i$ is the fitness value of the food positions i.
2.1.4. **Foot Place.** If the food place could not be improved for more the food source considers expired and the employed bee considered as a scout. In the (ABC) procedure, the scheduled several attempts to run out food place is called limit, and only one employed bee changes to a scout at each loop.

2.1.5. **Stop Algorithm.** The algorithm is stopped if a satisfied condition is met and the top nectar home is informed; else the procedure back to 2[22][4][10].

We used ABC aside from Swarm Intelligence (SI) algorithms commonly used that include ant colony optimization (ACO) and particle swarm optimization (PSO). Due to the easiness of implementation, robust and extremely versatile, quick convergence, and robust strength. It is measured as a very flexible since it needs two control factors only of extreme cycle quantity and colony size. Indeed, it requires minimum management parameters compared with different search techniques. ant colony optimization has a disadvantage that has a lack while it used with vast seek space as well as, it couldnt enhance the answer when all ants converge to the same path. On the other hand, the drawback of particle swarm optimization is that it is slow in the process.

3. **The Proposed Method.** The proposed paper-based software and requirements, which are rigidity, accuracy, clarity, and possibility of usage to distinguish with hundreds of persons. The natural residences of the footprint image have been translated as statistical functions extracted from the template chain code [34][23][14] and statistical moments from chain code histogram [27]. The system is sturdy and improves the enactment. Figure 2 indicates the proposed work. All the methods are applied in MATLAB2018b software.

3.1. **Visual Database Enhancement Method.** The RGB foot-tip images were captured by a digital scanner. Figure 2 shows a number of these images. The database is arranged in cluster form with many angles ten-foot-tip image each. At first, the foot-tip colored images are converted to the intensity form then to the monochrome form. To find the foot template the binary image was treated by a successive morphological operation. Then a segmentation operation was performed to isolate the background from the foreground to get the foot-tip.

3.1.1. **Footprint Feature Mining Phase.** Feature mining is the main phase in any biometric system. The statistical moment has been used as the most perfect attributes selected by analysis. Moments were evaluated for recognition in the system.
due to the following reasons. They offer memory storage space, robustness, computational speed, and correct outcomes [13]. Table 2 describes the features illustrated in this work as shown in equations (5-7).

The binary image was used to extract five types of features. These features are the mean, standard deviation of the chain code histogram, orientation (angle), the standard deviation as well as the chain code mean. The illustrated values of these features entitled the feature database and stored in excel file "footdb.xls".

3.2. Recognition Evaluation. This stage is an essential step inside any biometric application. The technique is that once a query image is entered into the system its on-line analyzed. Its features were extracted and compared with the feature database through the artificial bee colony algorithm. The comparison operation is performed between the query image and all the 9 clusters image through (ABC)
### Table 2. Features description

| Moment title      | Equation | Parameter                                      |
|-------------------|----------|------------------------------------------------|
| **Mean**          | \[ M_i = \frac{1}{N} \sum_{j=1}^{N} f_{ij} \] (5) | Where \( f_{ij} \) is the value of the feature and \( N \) Denotes features frequency [27]. |
| **Description**   | This factor is directly proportional to brightness. | The big value the more brightness and vice versa [27]. |
| **Standard Deviation (STD)** | \[ \sigma = \left( \frac{1}{N} \sum_{j=1}^{n} (f_i - M_i)^2 \right)^{\frac{1}{2}} \] (6) | Where \( M_i \) represents the average of the image, \( f_{ij} \) denotes the value of the feature and \( N \) reflects the observation size [27]. |
| **Description**   | This factor is inversely proportional to image contrast. The big value the small contrast and vice versa [27]. |
| **Center-Angle**  | \[ \Theta = \frac{\tan^{-1}(y,x)}{\pi/180} \] (7) | \( y,x \) are convoluted images with specific masks[27]. |
| **Description**   | This factor describes the direction of the chain code. |
| **Mean, Std of Histogram of the Chain Code** | = | = |
| **Description**   | These factors describe the intensity and contrast of the Chain Code [22]. |

The precision is improved via the (ABC) which primarily based on a feature algorithm that reduces the large function set. The goal of the ABC is to discover a global optimized summation of the squared Euclidean measure between each object and the centroid of the cluster. The (ABC) works repeatedly and calculates the fitness function as shown in the following application section that normalized the fitness value. The employed bee’s replaced the old food position by a new applicant food source position that holds a better fitness value. So, the continuation of this function returns the pleasant route and best index which denotes the matched image and cluster number within the database.

```plaintext
FitEmp=calculateFit(\[Employed.Cost\]) // calculateFit is a function calculates fitness value as shown in equation (3-a)
pro1=FitEmp/ sum(FitEmp) // to finds the probability of the fitness value as shown in equation (3)
pro2=(0.9.*FitEmp./max(FitEmp))+0.1 //if the fitness value did not improved its the scout bee replaced it by a new one
NormFit=max (prob1, prob2) //the better fitness value is selected
```

4. **Outcome Analysis.** The outcome produced from this proposed application varies between Figures and calculation values saved in tables. Figure 4 shows these results in the case of acceptance after the query image enters the system. This acceptance is represented as a Figure of the matched foot-tip image with its frequency and its cluster number within the visual database. Otherwise, a message of rejection regards that the comparison process did not match. The experimental results are described in the res matrix which is shown in Table 3, the rows represent the query image entered to the system. The columns arranged as follows: the
Figure 4. The system outcome for acceptance message

first column is the Bestsolution. The second column is the query image number. The third column displays the cluster number and the last is the time elapsed for recognition operation.

Table 3. The experimental results

| Query name | Bestsolution | Image number | Cluster | Time in sec |
|------------|--------------|--------------|---------|-------------|
| Qry1       | 0            | 4            | 1       | 0.2888      |
| Qry2       | 0.0740       | 13           | 2       | 0.1215      |
| Qry3       | 0.2932       | 28           | 3       | 0.1318      |
| Qry4       | 0            | 31           | 4       | 0.1261      |
| Qry5       | 0.0765       | 42           | 5       | 0.1196      |
| Qry6       | 1.6607       | 52           | 6       | 0.1215      |
| Qry7       | 0            | 61           | 7       | 0.1222      |
| Qry8       | 0            | 71           | 8       | 0.1204      |
| Qry9       | 0            | 82           | 9       | 0.1207      |
| Qry10      | 0            | 83           | 9       | 0.1210      |

From the results shown in Table 3 Bestsolution parameter represents the fitness function its value was compared with a threshold value equal to 4.5. This value was denoted through tests and analysis. If the fitness value is less than the threshold a choice of acceptance is performed as shown in Figure 4. Otherwise, a choice of reject is produced via a rejection message. Table 3 shows that Qry1 entered the system the successive processes as discussed are performed, the results illustrated are a matched image is four and its cluster is one inside the database. Qry2 entered to be compared the matched image is thirteen and its cluster is two inside the database and so on. These results reflect the progress of the suggested research in the speed of convergence, exact evidence access, and recognition time reduction. This time varies from (0.1190) to (0.2888) recursively. To check the system improvement, enhancement metrics had been computed which describes the strength of the system.
at all. These metrics are the accuracy that has calculated as in equation 5 [30].

\[
\text{Accuracy} = \frac{tpo + tng}{n}
\]  

(5)

where tpo represents the true positive number of images correctly identified and tng denotes the incorrectly identified images, while n is the number of images within the database. The other measure is the confidence it is calculated as in equation 6

\[
\text{Confidence} = \frac{tpo}{(tpo + fpo)}
\]  

(6)

where tpo represents the true positive number of images correctly identified and (fpo + tng) is the total number of correctly and incorrectly identified images. Enhancement metrics were calculated based on the results displayed in Table 3 for ten queries images entered by the system. The shown rates in Table 4 were computed to the clusters composed the whole database.

Table 4. Enhancement metrics

| Metric    | Value |
|-----------|-------|
| Accuracy  | 100%  |
| Confidence| 100%  |

A consequence comparison between the suggested work and my preceding paper on ant colony optimization [15] and particle colony optimization [19] is that the suggested work estimates the experimental results to a hundred percent, but approximate to 98.88% and 98.6% recursively. These outcomes display that the success of the ABC is higher than the other two algorithms with the benefit of using fewer control parameters. In addition to its rapid convergence from the most fulfilling solution. Table 5 describes the contrast among our projected work and other studies primarily based on traditional and intelligent techniques via ABC but with other forms of biometrics. These consequences display the role of ABC optimization characteristic preference that it selects the ideal skills in a small and quit right feature set. Our proposed work shaded in Table 5 shows the best recognition rate over other papers which are equal to 100 %. We use various category of recognition but with ABC precept as proven in Table 5 for the following reasons:

Due to the difficulty in obtaining research on the same topic of foot-tip and using recognition hybrid with intelligent methods such as ABC. Therefore, comparative research was used in other recognition subjects except for the first search in the table, but ABC is also used, which obtained excellent results.

We were unable to obtain the practical part of the paper of researchers whose names are in the table to apply to our proposed research data so that the evaluation is fair. So, the research results that were presented in a valuable form recorded at tables or drawn on Figures within the paper.

5. Conclusion And Future Outlook. We have concisely reviewed strategies for fixing biometric recognition problems, paying unique devotion to intelligent techniques. An interest turned into given to dispose of and develop the issues raised with the biometric authentication such as consuming time and error in the authentication. We finish our solution and observations to assist authors to check and apprehend the typical and unique study. Our concluded observation and notes are:

1. We proposed a hybrid method that comes together between image processing and ABC. From the outcomes shown, merging is better than the separation
Table 5. Enhancement analysis of related work

| Moment title                                      | Equation                      | Parameter          |
|--------------------------------------------------|-------------------------------|--------------------|
| Technique                                       | Author                        | Accuracy Rate %    |
| (ABC) Algorithm for finding the curve fitting and Euclidean distance for foot-tip | K. K. Nagwanshi and S. Dubey [14] | 97.15              |
|                                                  | K. K. Nagwanshi and S. Dubey [15] | 85                 |
| Fuzzy Neural Networks + Geometrical Characteristics | W. Rong et al. [40]           | 90-92.80           |
| (ABC) for Area Allocation                        | L. Yang et al. [18]           | 67.4-67.7          |
| (ABC) for object recognition                     | C. Chidambaram and H. S. Lopes [3] | 88-99              |
| (ABC)+Fuzzy C Mean                               | M. Shokouhifar and G. S. Abkenar [24] | 98.38              |
| (ABC) for Handwritten recognition                | S. Nebti and A. Boukerram [29] | 99.82              |
| The suggested paper                              | Israa M. Kh., et.al.          | 100                |

of every of the proposed approach because we gain a great answer to the popularity scenario and intelligent image processing.

2. We evaluate the ABC technique for attribute decision on a mainly based metaheuristic search manner for feature selection.

3. The experimental software of the image processing and ABC strategies hybridization reflects robustness in ideal result over other works at the biometric authentication field. The discrimination ratios are equals to 100.

4. The outcomes show that the ABC technique decorates accuracy by reducing the variety of fired functions in the statistics set. Besides, it reduces the processing complexity from the time factor of view. For the near future we will discover the following idea:

- The combination of traditional and new algorithms. We will think to use parallelization to make the algorithm even extra beneficial in practice. Besides, with big data observation.
- The usefulness of the practicality of algorithms is the capacity to clear up an extensive variety of issues, especially extensive, real-world problems. We will develop our method of numerous optimization issues such as science, IT, enterprise, and business applications.
- We will adapt to accelerate and develop our method by ABC-k-modes which provide supervised learning via classification and regression.
- As we mentioned earlier, the tuning of algorithm dependent parameters is a challenging task. The control of parameters is also a difficult task. Ideally, a truly useful algorithm should be able to self-tune and self-adapt to suit for different types of problems.

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