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A Proposed Framework for Optimum Feature Selection using Improved Chicken Swarm Optimization Algorithm for Face Recognition system

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Abstract

Feature selection is a significant assignment in data mining and pattern detection as it lessens the largeness of the data sets and at the same time preserves the classification exploit. Standard Chicken Swarm Optimization (CSO) has been universally employed for feature selection considering its efficacy. The standard CSO algorithm, however, experiences the challenges of falling at local optima and high computational cost due mainly to the large search space. The study proposed a framework to increase the accuracy of a face recognition system. The Improved Chicken Swarm Optimization technique will be formulated from standard CSO and chaotic map by introducing chaotic gauss map and chaotic tent map equations into the rooster and hens update equations of CSO respectively and will be employed for feature selection. Local binary pattern (LBP) will be used for feature extraction. Finally, the classification of individual images based on input images will be recognized using a Support Vector Machine (SVM) classifier. The evaluation will be done by comparing the combination of the ICSO-LBP technique with the combination of CSO-LBP technique based on recognition accuracy and will serve as our performance metrics. Based on the proposed evaluation, this study believed that the ICSO-LBP technique would have a high recognition accuracy than the CSO-LBP and would also avoid being trapped at the local optimum and improve the convergence speed of the algorithm.

Keywords: *Face Recognition, Feature Selection, Improved Chicken Swarm Optimization, Support Vector Machine.*

1. Introduction

Face recognition has influenced a great deal of attention in this present-day [1]. Discussing machine learning, machine vision, and pattern recognition, face recognition has become one of the key areas of study. In face recognition, the scheme selects a face that is almost similar to the desired face in accordance with the trained faces and regards it as the ultimate answer. It can be known or unknown, in other words, it could be defined as recognizing the person who is from an enrolled user database [2].

Feature selection is an important process used in data mining that is responsible for the selected subset of features from the original set of features that gives the same meaning without losing its information [3]. Nowadays, there is an urgent need for applying feature selection methods in discovering, and exploring more accurate features because of the huge amounts of generated data through online profiles, over social networks, blogs and shared text. Feature selection aims to select a subset of relevant features that are necessary and sufficient to describe the target concept, by reducing the irrelevant and redundant features. Examples of feature selection techniques are Particle Swarm

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Optimization and Chicken Swarm Optimization [4].

Swarm intelligence is an artificial intelligence (AI) discipline, inspiration from the collective behaviour of animals including flocks of birds or schools of swarm intelligence (SI) or social insects including ants, termites, bees, and wasps is inspired by the collective intelligence of decentralized, self-organized systems [5]. Swarm intelligence algorithm (SI) is a simulation to realize the optimal search of targets according to the living habits, behaviour, patterns, physical laws, and hidden rules of various group creatures in the natural world, that is, a random optimization algorithm based on group construction [6].

Chicken Swarm Optimization Algorithm (CSO) is one of the bio-inspired meta-heuristic algorithms imitating the behaviour of the chicken swarm [7]. CSO has the characteristics of a simple mathematical model, fast convergence speed, high optimization accuracy, it has been applied to many applications, such as microgrid optimization, reservoir optimization schedule, and image recognition processing [7], [9].

However, there are two seeming issues with the standard CSO algorithm, the likes of slow convergence speed causing a long execution time and difficult to achieve global optimal solutions [10]. And since feature selection is a challenging task with a complex search space, standard CSO algorithm quickly falls into the local optimum in optimization which makes it hard to produce a general optimal solution [3], [5], [9]. The proposed framework aims to develop an Improved Chicken Swarm Optimization (ICSO) by modifying update equation of the rooster and the update equation of the chicks of standard CSO with the chaotic tent and chaotic map as follows:

i. formulate an Improved CSO from standard CSO to optimize the feature selection of facial images to increase accuracy.
ii. develop an improved recognition system using formulated ICSO
iii. implement the developed algorithm ICSO with Matrix Laboratory (MATLAB R2016a) software that employs the chaotic tent map and Gauss map algorithm's into CSO update equation to increase population diversity and increase the chance of escaping from local optimum solutions.
iv. evaluate the performance of the developed technique by comparing the ICSO-LBP and CSO-LBP on the developed system to prove that ICSO-LBP would outperform the existing standard CSO-LBP technique based on recognition accuracy.

2. Related Works

2.1 Chicken Swarm Optimization Algorithm.

Chicken swarm optimization (CSO) is a bio-inspired metaheuristic optimization algorithm proposed by Meng, X.B. et al. [8]. The chicken swarm optimization (CSO) algorithm is a nature-inspired algorithm that consists of three main actors: the chicks, roosters, and hens based on the fitness value the actor holds its positions such as the best fitness value are for rooster while the worst fitness value is for the chicks. CSO has a set of groups each group consists of one rooster as a leader and two hens, and the rest of the groups are chicks [10].

Nursyiva [9] propose An Adaptive Fuzzy Chicken Swarm Optimization Algorithm (FCSO) Targeting at attacking the two problems of CSO. FCSO uses the fuzzy system to adaptively alter the number of chickens and random factors of the CSO algorithm and achieves an optimal balance of exploitation and exploration capabilities of the algorithm.

Khaled, Aboul, and Siddhartha [3] introduce a Novel Chaotic Chicken Swarm Optimization Algorithm (CCSO) for Feature Selection, aims at improving the CSO probing skill by applying logistic and tent chaotic maps to assist the CSO swarm in exploring the search space better.

Mohamed [11] proposed Chicken swarm foraging algorithm for big data classification using the deep belief network classifier, the big data classification is enabled using the Map-Reduce framework, which utilizes the proposed optimization algorithm, named chicken-based bacterial foraging (CBF) algorithm. The planned algorithm is generated by integrating the bacterial foraging optimization (BFO) algorithm with the cat swarm optimization (CSO) algorithm.

Zhenwu *et. al.* [13] presented "Enhancing the Performance of the Greedy Algorithm Using Chicken Swarm Optimization" for solving the exam timetabling problem by enhancing the performance of the greedy algorithm by modifying the chicken swarm optimization (CSO).

2.1.1. Basic of Chicken Swarm Optimization.

As described by Yamamoto and Tomizawa [12]. There are at least four laws in chicken behavior, as follows: (1) the chicken swarm is divided into several groups. The group comprises a dominant rooster, a couple of hens, and chicks. (ii) The division of the chicken swarm into several groups and determination of the identity of the chickens (roosters, hens, and chicks), all aforementioned depends on the fitness values of the chickens themselves. The best several fitness values chicken would be acted as roosters and would be the head rooster in a group. The worst several fitness values chicken would be designated as chicks while others will be the hens. The hens randomly pick which group to live in. The hens and the chick's mother-child relationship are also randomly established. (iii) The hierarchal order, dominance relationship, and mother-child relationship in a group remain unchanged. These statuses only update every several (G) steps. (iv) Chickens follow their group-mate rooster to search for food, while they may prevent the ones from eating their own food. Undertake chickens would randomly steal the good food already found by others. The chicks search for food around their mother (a hen). The dominant individuals have the advantage in the competition for food. Based on the four rules, the basic steps of the CSO can be summarized by the pseudo-code as in algorithm 1 Deb, Gao, Tammi. *et al.* [10].

Algorithm 1: Chicken Swarm Optimization

Input: Set of initial feature parameters W= $\{w_1, w, \ldots\ w_p\}$
Predefined swarm size: $\boldsymbol{N_c}$
Number of dimensions of a chicken: $\boldsymbol{D=q}$
Output: Optimal feature parameters $\{wopt_I, wopt_H, wopt_c\}$

1. Initialize chickens Ck= [RN=CN =MN=HN] $\forall \boldsymbol{i,j},\ \boldsymbol{1 \leq i \leq\ N_c},\ \ \boldsymbol{1 \leq j \leq D = q}$, number of CHs, G (maximum generation)
   $\boldsymbol{x_{i,j}(0) = (x_{i,j}(0), y_{i,j}(0))}$ /* *position of the features* */
2. Evaluate the N chickens' fitness values (Ck).
3. t=0;
4. ***While*** (t < G)

i. ***If*** $(\boldsymbol{t\ mod\ G = 0})$

a. Rank the chickens' fitness values and establish a hierarchal order in the swarm;
Fitness values = $\boldsymbol{f(x)} =$
$$\sum_{i=1}^{m}\sum_{j=1}^{n}\Delta\left(W_{i,j}^{m,n}\right)\left((x_i) - (x_j)\right)$$

Where $\boldsymbol{x_i^t}$ represent the s at i=1,2, …, n and k=2,3, …, m

Where $\boldsymbol{\Delta\left(W_{i,j}^{m,n}\right)((x_i) - (x_j))}$ is the change in feature of input, hidden and output layers x along the row *n* and column *m*

b. Divide the swarm into different groups, and determine the relationship between the chicks and mother hens in a group;
End if

ii. For i = 1:N
a. If i = rooster Update its solution/location
$$\boldsymbol{x_{i,j}^{t+1} = x_{i,j}^{t} * (1 + Randn(0, \sigma^2))}$$

$$\boldsymbol{\sigma^2 = \begin{cases} 1, & if\ f_i \leq\ f_k \\ e^{\left(\frac{f_k - f_i}{|f_i| + \varepsilon}\right)}, & otherwise,\ \ k\ \in\ [1, N], k \neq i \end{cases}}$$

Where $\boldsymbol{Randn(0, \sigma^2)}$ is a gaussian distribution with mean 0 and standard deviation $\boldsymbol{\sigma^2}$. $\boldsymbol{\varepsilon}$ is used to avoid zero-division-error. *k* is a rooster's index, $\boldsymbol{f}$ is the fitness value of the corresponding $\boldsymbol{x}$.
End if

c. If *i = hen* Update its solution/location using equation (3.15);
$$\boldsymbol{x_{i,j}^{t+1} = x_{i,j}^{t} + S1 \times Rand\left(x_{r1,j}^{t} - x_{i,j}^{t}\right) + S2 \times Rand(x_{r2,j}^{t} - x_{i,j}^{t})} \quad (3.15)$$
$$\boldsymbol{S1 = e^{\left(\frac{f_i - f_{r1}}{|f_i| + \varepsilon}\right)}},\quad \boldsymbol{S2 = e^{(f_{r2} - f_i)}}$$

Where *Rand* is a uniform random number over $\boldsymbol{[0, 1]}$. $\boldsymbol{r1 \in [1, \ldots, N]}$ is an index of the rooster, $\boldsymbol{r2} \in [\mathbf{1}, \dots, \boldsymbol{N}]$ is an index of the chicken (rooster or hen)

End if

d. If *i* = *chick* Update its solution/location

$$\boldsymbol{x_{i,j}^{t+1}} = \boldsymbol{x_{i,j}^{t}} + \boldsymbol{FL}(\boldsymbol{x_{m,j}^{t}} - \boldsymbol{x_{i,j}^{t}})$$

Where $\boldsymbol{x_{m,j}^{t}}$ stands for the position of the *ith* chick's mother ($m \in [1, N]$). $FL(FL \in (0, 2))$ is a parameter

End if

d. Evaluate the new solution;

If the new solution is better than its previous one, update it;

End for

End while

2.2 Local Binary Pattern

According to Ahmed *et al*.[13]. The LBP operator is used to express a contrast information in relation to its neighbour's pixel. In the 3*3 window, the original LBP operator is defined. It compares the gray value of the next 8 pixels to the median pixel value as the window's threshold. The value of pixel position is indicated as 1 if the neighbouring pixel value is greater or equal to the median pixel value, otherwise it is marked as (0) [14]. Aftab Ahmed *et al*.[13] define the function as given in equation 1.

$$S(x) = \begin{cases} 1, & x \geq 0 \\ 0, & x < 0 \end{cases} \qquad (1)$$

3. Proposed Methodology

3.1 Research Proposed Framework

The proposed framework for the research as shown in figure 1, the image will be acquired into the local dataset (KWASU (Kwara State University) database). The face image will be captured by a digital camera into the system for classification. Noise and other unwanted elements will be removed from the image by conversion of face images into grayscale, application of local histogram equalization for contrast enhancement, and image cropping. Local Binary Pattern algorithm will be applied for feature extraction and dimensionality reduction. Improved Chicken Swarm Optimization technique will be formulated from the standard CSO and will be employed for feature selection. Finally, the classification of individual images based on input images will be recognized using the Support Vector Machine (SVM) classifier. Performance metrics such as accuracy, sensitivity, false-positive rate, specificity, precision computation time will be used to evaluate the system. The scheme of the Face Recognition System and schematic diagram of Face Recognition Process were presented in the figure 1 and Figure 2 respectively.

3.2 Database Design

The dataset will contain a total of 600 images, 200 facial images of each person and 3 images will be taken per individual and would be stored in the local dataset called KWASU database. A digital camera will be used to capture a person's frontal face images. The camera will be tilted down at about 25 degrees to point towards the image. To avoid strong shadows, only ambient that is fluorescent room lighting will be used.

The saved pictures will be stored in a folder to form a generated face dataset. At this stage, the dataset will be preprocessed for the feature extraction process. The dataset will be converted into greyscale images for feature extraction, and then normalized those images for good recognition results that would present a new enhanced biometric system that will overcome the problem of slow convergence and stagnation at a local optimum.

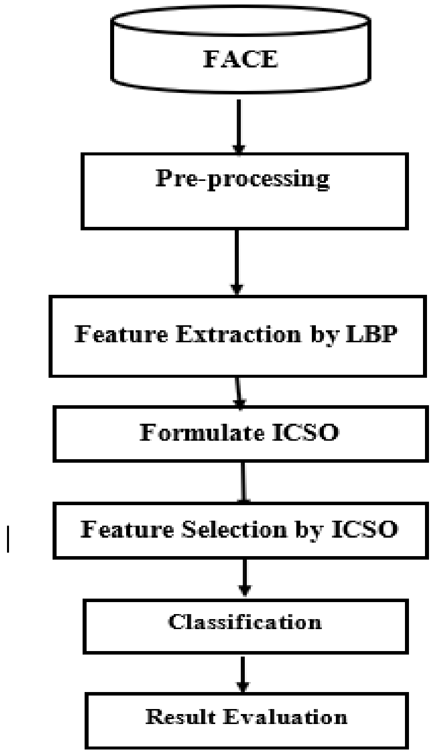

Figure 1: The Scheme of the Face Recognition System

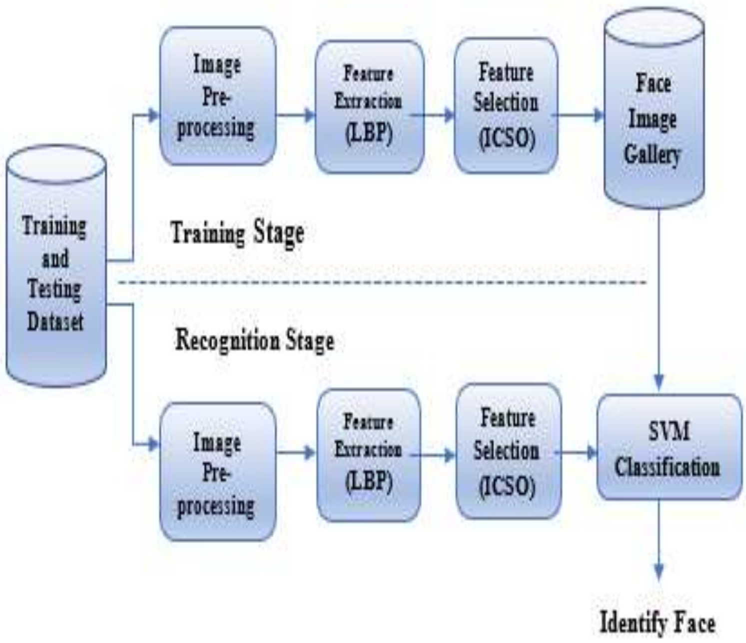

Figure 2: Schematic Diagram of Face Recognition Process

4. Conclusions

Due to its applications in various domains face recognition has received a great deal of attention over the past years. Although, it has some challenging problems in the field of image analysis and computer vision. Developing a suitable program that can be used digitally in recognizing a face is a quite challenging task because human faces are complex and are different from each other in every aspect.

Feature selection aims to select a subset of relevant features that are necessary and sufficient to describe the target concept Chicken Swarm Optimization is an example of a feature selection algorithm, and CSO is known for maintaining a good balance between exploration and exploitation as compared to other algorithms. Nevertheless, falling into local optimum when solving high dimensional problems and slow convergence are some of the problems attributed to CSO.

This paper proposes an Improved Chicken Swarm Optimization algorithm to improve face recognition accuracy by modifying the update equation of the rooster and hen update equation of the chicks of standard CSO with the chaotic tent Map and chaotic Gauss map respectively. As a result of this modification, the new ICSO-LBP technique will have high accuracy than CSO-LBP technique if applied and would fast track the fast convergence speed and strong stability, avoid the problem of premature convergence.

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