Optimization based Neural Network for face Recognition

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Abstract: Intelligent face recognition remains a challenging task when offering uncooperative users as well as in uncontrolled conditions and so received a great deal of attention by the computer perspective research community. In this proposed work, the face with its expression and various movements is recognized. The proposed method includes three phases particularly, pre-processing phase, feature extraction phase and finally classification phase. The feature extraction phase is carried out with the GLCM feature extraction and is followed by the NN classification phase. Moreover, for accurate prediction the Cuckoo Search optimization is included along with the classification phase. The whole proposed methodology is implemented in the working platform of MATLAB and the results were analyzed.

Keywords: GLCM Features, Face recognition, Neural Network, Cuckoo Search Algorithm

INTRODUCTION

Facial image is the important biometric characteristics used for personal identification and hence the evolution of techniques of face recognition (FR) becomes an active field of research in recent years [1]. Face recognition is a very challenging research area due to variations in facial expressions, poses and illumination. Researchers have done on the problem of face recognition for many years still several challenges need to be solved [2].

Local-DNN model identify gender images it deal with images with this kind of registration and where some prior knowledge can be applied in order to select the most informative parts of the images [3]. Improve the face recognition rate by handling the image of enhanced facial features through the multi-dimensional data pre-processing technologies (PCA combined with ASM) and DE-based P-RBF NNs [4].

The ICA model is to separate the independent component of a surface normal on each point of an image [5]. Frequency domain correlation filters (CFs) for face recognition have shown use correlation filters are to exhibit some tolerance in distortions and occlusions and can accommodate certain degree of variations in illumination conditions in face [6].

The major drawback such as optimization, slow convergence, local minima problem, and very poor sensitivity to the learning rate setting can be overcome by cuckoo search optimization based neural networks.

The face recognition approach generally uses a minimum distance classifier for classification of facial image. Therefore there is a strong need to use optimal principal components for a better classification [7].

Cuckoo search algorithm has emerged a promising metaheuristic algorithm and has been utilized as successful optimization method in various optimization problems. The Cuckoo search (CS) is an optimization algorithm evolved due to the captivating reproduction policy of certain Cuckoo species. They lay eggs other bird’s nest and even remove host eggs to increase the probability of their eggs getting hatched [8].

Artificial neural network is a branch of artificial intelligence which has fast emerged with wide range of applications in pattern recognition and data processing. It is
popular because of its adaptive learning, self organizing, real time operations and fault tolerance via redundant information coding [9]. It uses convolutional neural networks, radial basis neural networks, and other types of neural networks. In several of these works, the neural networks act as classifiers. Separate feature extraction algorithms extract relevant features that are fed to the neural network classifiers. They provide better classification efficiency for discriminant facial features [10].

LITERATURE SURVEY

A lots of investigations make their way in the domain of literature, which area dedicated to the Face recognition. Given below is a concise account of some of the research works in this regard.

Z. Huang, S. Shan et al [11] have proposed a benchmarking and comparative study based on a newly collected still/video face database. It could be used for V2S/S2V face recognition on COX Face DB. Video based face recognition needs more efforts; COX Face DB was a good benchmark database for evaluation.

S. Pang et al. [12] have stated a FME for face recognition. A score fusion scheme was used to predict the label of the original unknown sample then mirror images of all original face images obtained and views both mirror images and original face images as available samples. It performed very well in face recognition.

Kuang-Jui Hsu et al. [13] have explained a augmented multiple instance regression (AMIR) method. It performed selection as the problem of multiple instance regression (MIR), and augments information derived from the object contours to guide and regularize the training process of MIR. In that way, a bounding box was treated as a bag with its contour hypotheses as instances, and the positive instances refer to the hypotheses close to the ground truth. AMIR provided effective alternatives to manually labelled contours for semantic segmentation.

Yong Xu et al. [14] have stated a sparse representation to improve the face recognition accuracy and reduce the uncertainty. The uncertainty of the face representation was reduced by synthesizing the virtual training samples. Finally face recognition performed by representation approach based on the selected useful training samples.

M. Jian et al. [15] have proposed singular value decomposition (SVD) for simultaneous face hallucination and face recognition. In that each face image was represented by using SVD. For each LR input face, the corresponding LR and high-resolution (HR) face-image pairs could be selected from the face gallery. Based on these selected LR-HR pairs, the mapping functions for interpolating the two matrices in the SVD representation for the reconstruction of HR face images could be learned more accurately. Therefore face images were become more reliable and effective.

B. Klare et al. [16] have stated a Dynamic face matcher selection, where multiple face recognition algorithms (each trained on different demographic cohorts) were available for a biometric system operator to select based on the demographic information extracted from a probe image. This method improved face recognition accuracy in many intelligence and law enforcement face recognition scenarios.

M. Uzair et al. [17] have proposed a hyper spectral face recognition algorithm using a spatiotemporal covariance for band fusion and partial least square regression for classification. Face recognition techniques, were used for the first time, to perform hyper spectral face recognition then formulate hyperspectral face recognition as an image-set classification problem and evaluate the performance of seven state-of-the-art image-set classification techniques. They also tested six state-of-the-art grayscale and RGB (color) face recognition algorithms after applying fusion techniques on hyperspectral images.

PROPOSED METHODOLOGY

The proposed technique is to detect the face and to distinguish various facial changes. The facial change distinguishing includes the face showing Expression (E), looking Left (L), looking Right (R), Looking Up (LU)and Looking Down (LD). So that, some of the GLCM features were extracted for the images and the extracted features was utilized during the classification phase.

The proposed method is categorized into the following three phases particularly,

- Pre-Processing Phase
  - Bounding Box interface
Feature Extraction Phase
- GLCM features

Classification Phase (Neural Network)
- Weight Optimization (Cuckoo Search)

Each phase involving in the proposed method is detailed in the below sections.

Pre-Processing Phase

In the stage of pre-processing, ’n’ number of face recognition dataset will be gathered initially. The face recognition dataset consists of images showing various factors like Expression(E), looking Left(L), looking Right(R), Looking Up(LU) and Looking Down(LD). Then the images were passed to the bounding box interface in order to segment the face region alone.

Bounding Box Interface

The bounding box interface is to create a single box for bounding the entire object of an image. Normally, some of the shapes like sphere, parabolic, square and rectangular were utilized for creating the bounding boxes. Other shapes like spherical shape, ellipsoid shape and cylindrical shape can also be used as bounding box. Moreover, the proposed architecture is given by the following figure 1.

In order to create bounding box around each object, some of the “region props” features needs to be extracted. The “region props” function gives value of some parameters like area, centroid, four corner details of the bounding box and diameter etc of an image. By using the coordinate’s value of the four points, bounding box can be sketched. The bounding box creation is shown by the following figure 2.

After sketching the bounding box around the input database images, the RGB color image sequence is gray converted. As the RGB color image processing is difficult to process because of the varying intensity values between the image sequences, the image is gray converted during the pre-processing stage.

Feature Extraction Phase

The process of feature extraction will be made in order to recognize the various facial changes. In order to extract such features, the GLCM feature extraction method is utilized. The GLCM features include, the area, perimeter, auto correlation, contrast, cluster prominence, cluster shade, dissimilarity, energy, homogeneity, circularity and entropy were extracted.

**Gray Level Co-occurrence Matrix (GLCM) Algorithm**

In GLCM, the relationship between pixels is considered more. Let us consider a pixel with coordinates \((p_x, q_y)\) is placed at the centre of its neighborhood window, \(N(p_x, q_y)\). The GLCM matrix, \(G_{1,\phi}(p_x, q_y)\) can be formed with elements \((r,s)\) can be defined as the number of occurrence of pixel with gray level \(r\) at distance \(l\) and at direction \(\phi\) of pixel with gray level \(s\). Moreover, all the pixels were in the same neighborhood window \(N(p_x, q_y)\).
Simply, the GLCM can be represented as follows,

\[ x(p_1, q_1) = s, \quad x(p_2, q_2) = r, \quad (1) \]

where,

\[ x(p_2, q_2) = x(p_1, q_1) + (l \cos \phi l \sin \phi) \quad (2) \]

\[ x(p_1, q_1) \text{ and } x(p_2, q_2) \in N(p_g, q_g) \quad (3) \]

Hence, at any \((l, \phi)\), \(N \times N\) GLCM matrix of \(G_{l, \phi, (p_g, q_g)}\) can be obtained. Where, \(N\) denotes the number of gray levels of an image. After obtaining the GLCM matrix for every pixel values, the GLCM feature vectors were determined. Finally, the features of each kind of image are trained and tested through the NN based CS algorithms.

Classification Phase (Neural Network)

The Neural Network classification is an Artificial Intelligence based classification method inspired by the biological neural networks. The Neural Network consists of three layers like input layer, hidden layer and the output layer. The features were given as input through the input layer. At the hidden layer, the validation occurs through assigning the weight. Moreover, the weight is optimized by means of CS algorithm.

The computed data at the hidden layer is passed to the output layer. Here, the computation will be made by means of the weighted sum of the inputs.

Let the input features be denoted as, \(F_1, F_2, F_3...F_n\). Also, the output attained will reflect the recognition of various facial changes such as Expression (E), looking Left (L), looking Right (R), Looking Up (LU) and Looking Down (LD). The ANN architecture is given by the below figure 3.

At each layer, the steps taking place are given as below,

**Input Unit:** The input features are of,

\[ P_{\text{input}} = F_1, F_2, F_3...F_n \quad (4) \]

**Hidden Unit:** The weight updation taking place in the hidden unit is given as,

\[ P_{\text{hidden}} = F(b_m + \sum_{m=1}^{M} w_m F_n), \quad \text{where}, \quad n = 1, 2, ...11 \quad (5) \]

Where, \(F(y)\) is the activation function of the hidden layer. The activation function is the tan-sigmoid function as given as below,

\[ F(y) = \frac{2}{1 + e^{-2y}} - 1 \quad (6) \]

**Output Unit:** The calculations taking place in the output unit can be simply given as follows,

\[ Q = \sum_{m=1}^{M} W_m P_{\text{hidden}} \quad (7) \]

In the ANN, the weight updation is made to optimally by means of the Cuckoo Search algorithm.

Moreover, the NN classification algorithm is given as below,

**INPUT (P):** GLCM features of an image;  
**OUTPUT (Q):** Face Recognition (E, L, R, LU, LD, P);  
Where, \(E \rightarrow \text{Expression}; \quad L \rightarrow \text{Left}; \quad R \rightarrow \text{Right}; \quad LU \rightarrow \text{Looking Up}; \quad LD \rightarrow \text{Looking Down} \)

Create network;  
Fix maximum number of iteration;  
Set weights and bias functions of the NN;  
Optimize the weight and the bias function using the Cuckoo Search Algorithm;  
Replicate network;  
\[ Q = \text{Network output (E/L/R/LU/LD/P) with the input as ’P’;} \]

Determine Error

\[
\begin{align*}
\text{Determine Error} & \\
\epsilon &= P - Q; \\
\end{align*}
\]

FIGURE 3. Neural Network classification
Optimization Phase (Cuckoo Search)

The optimization phase is to optimize the weights assigned during the Neural Network based classification phase. The cuckoo search algorithm is a meta-heuristic optimization technique belonging to Swarm Intelligence (SI) family, which was actually inspired by the cuckoo bird breeding behavior. Generally, the cuckoo birds follow an aggressive approach of reproduction. The cuckoo birds lay egg on host nests. The number of host nest is fixed but the chance of discarding eggs by the host bird is different and is calculated by means of the probability of \( P \in [0,1] \).

The steps involving in the cuckoo search optimization procedure is given as follows,

**Objective Function :** \( OF(y) \)

Generate initial population (Host nests)

\[ y_n \ (n=1,2,...,m) \]

while (\( T < \text{Max-Generation} \))

\{
  Obtain Cuckoo s randomly through Levy Flight (say, s) 
  Evaluate Fitness \( OF_s \), 
  Choose a nest from m host nests (say, r) 
  Evaluate Fitness, \( OF_r \) 
  If \( (OF_s < OF_r) \) 
  \{ 
    Replace r by new solution 
  \} 
  End If (When the fraction of probability \( P \) of worst nests are abandoned and the new solution is generated by building up of newer ones) 
  Keep the best solution 
  Perform ranking 
  Find and get ahead of the current best solution/nest to the next generation 
\}

End While

The complete flow of CS optimization algorithm is given by the below flow chart given in figure 4.

While, the objective function is determined here through the evaluation of minimization function Mean Square Error. The minimization function is given as follows:

\[ OF = \min(MSE) \] (8)

Also, the Levy Flight updation can be performed through the following equation as,

\[ y_n(T + 1) = y_n(T) \oplus \alpha \text{Levy}(\delta) \] (9)

Where,
\( \alpha \)-step size (\( \alpha > 0 \))

Moreover, the Levy Flights were taken from the Levy distribution based on the random walk,

\[ \text{Levy} \ x = T^{-\delta} \] (10)

Where, the value of (\( \delta \)) lies between (1 < \( \delta \) ≤ 3)

The weights assigned during the NN classification phase is optimized using CS algorithm and then it was again transferred to the NN, where the face recognition takes place. The process takes place continuously until the maximum generation is reached.
RESULTS AND DISCUSSION

This section puts in a nutshell the upshots realized together with the CS based NN (Cuckoo Search based Neural Network). The experimental association along with recognition results is colorfully carved out below. The database has been extensively employed for acquiring the productivity from times immemorial. In this case, face image database is used for the face recognition process.

Experimental Set Up and Simulation Results

The innovative method for the face recognition is performed in a system having 8 GB RAM with 32 bit operating system having i5 Processor employing the MATLAB Version 2015a. In the novel technique, for arriving at the efficiency we have employed certain parameters which are shown below.

Description:
The projected method is for face recognition in which some of the facial movements like Expression (E), looking Left (L), looking Right (R), Looking Up (LU) and Looking Down (LD) were recognized. So that two face image datasets were gathered and the images with face is alone segmented from the background by means of bounding box interface. Then certain features particularly, the GLCM features were determined for this prediction. Finally, the input images were classified using CS based NN technique.

The input database image and its bounding box image is given as in the below figure 5 and 6.

Moreover, the system performance for the face Recognition is analyzed by comparing its efficiency with the existing methods. The efficiency of our proposed system is determined through the evaluation of accuracy, specificity and sensitivity measures. The comparison made to show how the proposed method stands forward than the existing method is given through the below tabulations 1 and 2.

From the above tables, it is clear that the accuracy has reached almost 92% for the proposed technique for the dataset 2 and 90% for the dataset 1. Moreover, the sensitivity and specificity values also had reached better values than the existing techniques. In terms of sensitivity measure for the dataset 2, the proposed technique achieves 98% and 97% for existing method. Also for the dataset 1, 97% is attained while determining sensitivity for the proposed technique and 96% for the existing method.

Furthermore, the specificity measure also gives more than 86% for the proposed technique for both the datasets. From the above tabulation, we could conclude that the prediction is more accurate for the dataset 2 while comparing with the dataset 1. Hence it is clear that the proposed technique performs well than the existing method and more appropriately for the dataset 2.

CONCLUSION

In this paper, various movement of a face image is detected and analyzed. In order to evaluate the performance of the proposed method, some performance metrics like accuracy, specificity and the sensitivity measures were evaluated and compared with the existing techniques. Also, the comparison is made here between the proposed CS based NN classification and the existing SVM. Hence, from the
result section we could clearly understand the performance improvement of the proposed method.

Table 1. Accuracy, Sensitivity and Specificity values attained for Dataset 1

<table>
<thead>
<tr>
<th>Technique</th>
<th>Accuracy</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSVM</td>
<td>0.8</td>
<td>0.96</td>
<td>0.85</td>
</tr>
<tr>
<td>CS based NN</td>
<td>0.9</td>
<td>0.97</td>
<td>0.86</td>
</tr>
</tbody>
</table>

Table 2. Accuracy, Sensitivity and Specificity values attained for Dataset 2

<table>
<thead>
<tr>
<th>Technique</th>
<th>Accuracy</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSVM</td>
<td>0.85</td>
<td>0.97</td>
<td>0.86</td>
</tr>
<tr>
<td>CS based NN</td>
<td>0.91</td>
<td>0.98</td>
<td>0.87</td>
</tr>
</tbody>
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REFERENCES


