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An Efficient Face Feature selection Based on Principle Component Analysis and Genetic Algorithm

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Abstract: The number of features in the face recognition has an important impact in the recognition stage. Hence, such important issue in the face recognition methods need to be solved by choosing accurate features. Here, a new face feature extraction method with optimal features extraction via. PCA and Genetic algorithm techniques is proposed. The proposed method primarily performs features extraction using PCA and the Genetic algorithm is used to obtain the optimal features. The optimal features from PCA+GA is used efficiently to perform the face recognition process. To validate the proposed feature selection mechanism, the neural network Feed forward back propagation neural network has been used for the recognition purpose. The human face dataset called CASIA is used to examine the performance of our proposed PCA+GA technique. The results showed the proposed method is very effective in choosing the optimal features and has been reflected that in the recognition process.

INTRODUCTION

Face recognition is one of the dynamic research fields for computer and machine vision researchers (Ebrahimpour *et al*., 2011) today. In today's world, face recognition has turn out to be more and more appropriate within computer vision. The new interest in face recognition can be ascribed to the rise of commercial interest and the progress of feasible technologies to sustain the development of face recognition (Patil *et al*., 2010). There are five major areas of commercial interest namely including biometrics, law enforcement and surveillance, smart cards and access control. Face recognition is one form of user-friendly and non- intrusive method dissimilar to the identification methods like fingerprint analysis and iris scans (Huang *et al*., 2003). There are two categories in face recognition are Verification and identification. First, the face verification means to compare a face image with template image in a 1:1 match so that, the identity can be claimed. Second, the face identification means to compare a query face image against all image templates. This is a 1: N method done in the face database. There are some major issues in automatic facial recognition. One of these important issues is feature extraction process (Ahuja and Chhabra, 2011). However, the selection of the optimal features has a heavy impact on the performance of any face recognition technique. The inefficient features in the face recognition have introduced an inadequacy recognition result. Hence, to avoid this drawback, a face feature selection method with optimal feature extraction is proposed in this study.

Literature review: In the previous research, several studies have been applied different face feature extraction methods for example: a face recognition method based on "DLA (Dynamic Link Architecture)" is proposed by Laddes *et al*. (1993) which was used Gabor filters in order to recognize faces. An expansion of DLA has been made by Wiskott *et al*. (1997) which is called "EBGM (Elastic Base Graph)" method based on a wavelet transform to distinguish the face images. However, both of these techniques are computationally very high. Kumar and Padmavati (2012) have proposed face recognition

technique based on "Scale Invariant Feature Transform (SIFT)" in order to extract the unique features from images. They have analyzed the performance of SIFT using Euclidean distance as a similar algorithm. Particle swarm optimization has been used as a feature selection algorithm along with feature extraction methods Seal *et al*., 2015). Have presented a feature selection method via. Particle Swarm Optimization (PSO) in order to be used for thermal face recognition. Abdulameer *et al*. (2014a, b) have proposed two face recognition techniques and they utilized PCA algorithm as a feature extraction method in their two techniques. However, in their studies PCA was not accurate enough to achieve optimal features and that lead to some drawbacks in the recognition stage. In this study, a new feature selection technique called PCA+GA is introduced where Genetic Algorithm (GA) is used as a feature selection algorithm to get the optimal feature from Principle Component Analysis (PCA).

MATERIALS AND METHODS

Genetic algorithm: A Genetic Algorithm (GA) is a method for solving both constrained and unconstrained optimization problems based on a natural selection process that mimics biological evolution (Semanco *et al*., 2011). The algorithm repeatedly modifies a population of individual solutions. At each step, the Genetic algorithm randomly selects individuals from the current population and uses them as parents to produce the children for the next generation. Over successive generations, the population "evolves" toward an optimal solution. You can apply the Genetic algorithm to solve problems that are not well suited for standard optimization algorithms including problems in which the objective function is discontinuous, non-differentiable, stochastic or Algorithm 1 highly nonlinear. Five phases are considered in a Genetic algorithm:

- Initial population
- Fitness function
- Selection
- Crossover
- Mutation

Algorithm 1; The pseudocode of Genetic algorithm:

START
Generate the initial population
Compute fitness
REPEAT
  Selection
  Crossover
  Mutation
  Compute fitness
UNTIL population has converged
STOP

The proposed technique: The proposed technique is attained by the PCA and Genetic Algorithm (GA) techniques. The proposed system mainly consists of two stages which are: feature extraction using PCA and optimal features selection by GA. The structure of the proposed face feature selection is explained in Fig. 1.

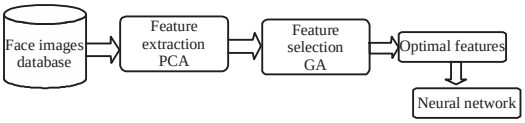

Fig. 1: The structure of proposed face feature selection PCA+GA

Feature extraction by PCA: "Principal Component Analysis (PCA)" (Lankin *et al*., 2017) is a well-known feature extraction algorithm. Depends on the information theory approach, PCA is to be used in face recognition as a feature extraction method. This is professionally and simply determined by extracting the appropriate information from the face image.

Algorithm 2; The main steps of PCA is shown below:

i) Determine $\overline{I_i(x,y)}$ and $\overline{I_j(x,y)}$ mean of $I_i(x, y)$ and $I_j(x, y)$
ii) Compute covariance matrix and its eigenvectors
iii) Sort eigenvectors in descending order of eigenvalues
iv) Project eigenvectors in order
v) Determine $A = I_i(x, y)- \overline{I_i(x,y)}$, $B = I_j(x, y)- \overline{I_j(x,y)}$
vi) Compute covariance matrix C_i, C_j
vii) If mean is centered, $C_i = A^TA$, $C_j = B^TB$
viii) Find eigenvectors and corresponding eigenvalues (V_i, E_i), (V_j, E_j) of C_i, C_j
ix) Sort eigenvalues such that $e_1 \geq e_2 \geq, ..., \geq e_n$
x) Project step-by-step into the principal components $\vec{v}_1, \vec{v}_2, ...,$ etc.

We apply PCA on the face images and get the unique one dimension feature vectors. Let us consider the given set of training and testing images as:

$$I_m(a,b); m = 1,2, ..., M \quad (1)$$

$$I_n(a,b); n = 1, 2, \cdots, N \quad (2)$$

The training and testing images with the size of whereas is the number of training and testing images. These numbers of training and testing images are given to the PCA technique for feature extraction and these extracted features are given to optimal feature selection by GA. The optimal features from the GA for 15 persons with different posture and lighting results are given in Table 1.

Optimal features selection by GA: The optimal features by GA is selected from PCA features. The optimal feature selection is described in the following process:

Initialization: Initially the chromosomes are generated by using the feature vectors. The generated chromosomes are composed of genes which are randomly generated between the interval [1, k] where k is an index value of

Table 1: The Optimal features

Optimal features from GA		
No. of persons	Different posture	Different lighting
P1	11, 23, 28, 7, 9, 14, 18, 19,3, 21	7, 21, 10, 15, 7, 28, 31, 21, 2, 8
P2	17, 12, 23, 25, 9, 21, 23, 1, 8, 1 5	21, 34, 10, 18, 3, 33, 13, 19, 3, 35
P3	22, 3, 16, 19, 31, 14, 11, 10, 36, 22	22, 10, 8, 16, 16, 18, 13, 27, 5, 8
P4	2, 14, 17, 19, 11, 8, 15, 11, 21, 1	20, 3, 5, 19, 33, 21, 11, 3, 6, 22
P5	15, 16, 18, 11, 10, 21, 17, 10, 34, 21	11, 10, 31, 6, 7, 5, 22, 21, 21, 10
P6	16, 6, 31, 15, 32, 18, 18, 9, 20, 7	31, 2, 16, 20, 10, 21, 31, 2, 18, 17
P7	27, 22, 33, 21, 17, 8, 11, 18, 17, 33	9, 22, 31, 30, 16, 7, 18, 19, 11, 10
P8	1, 25, 35, 22, 9, 15, 21, 8, 2, 35	31, 8, 21, 22, 25, 33, 18, 16, 22, 8
P9	10, 23, 7, 18, 17, 11, 15, 16, 9, 34	2, 8, 10, 6, 13, 16, 18, 11, 10, 5
P10	15, 21, 6, 8, 8, 33, 21, 17, 10, 16	10, 18, 12, 22, 20, 16, 11, 18, 18, 33
P11	14, 20, 15, 33, 18, 17, 25, 22, 11, 15	10, 16, 15, 19, 21, 30, 31, 17, 12, 18
P12	8, 11, 19, 22, 16, 13, 33, 38, 17, 10	6, 34, 19, 16, 24, 18, 30, 17, 9, 13
P13	31, 16, 19, 13, 34, 35, 21, 16, 7, 21	18, 21, 17, 9, 27, 5, 31, 13, 8, 10
P14	19, 18, 22, 31, 6, 33, 22, 18, 11, 23	11, 17, 19, 37, 25, 9, 30, 8, 17, 12
P15	20, 30, 17, 19, 10, 12, 34, 35, 18, 34	20, 23, 8, 21, 24, 17, 33, 17, 9, 18

the feature vector. These chromosomes values are given to the recognition neural network feed forward back propagation algorithm.

Fitness: Fitness value is calculated by comparing the feed forward back propagation algorithm output value of training and testing images respectively. Each chromosomes fitness is calculated by the formula $F = \min(O^{i}_{Im(a,\ b)}\text{-}O^{i}_{In(a,\ b)})$ where $O^{i}_{Im(a,\ b)}$ and $O^{i}_{In(a,\ b)}$ is the training and testing images output values from feed forward back propagation algorithm and i represents the chromosome. The chromosomes that have minimum fitness value is selected as the best chromosome.

Crossover and mutation: New populations are generated by updating the chromosomes genes values by Genetic crossover and mutation operations at the probability of p_c, p_m.

Termination: The process is repeated until the maximum number of iterations is reached.

RESULTS AND DISCUSSION

The proposed face recognition system is executed using MATLAB platform. The performance of the proposed system is evaluated with face dataset CASIA (Anonymous, 2010) and the face images under different

Table 2: Evaluation of the average recognition performance under three conditions

Conditions	PSO-SVM (Wei *et al*., 2011)	OPSO-SVM (Hasan *et al*., 2013)	Proposed PCA+GA+ neural network
1	90	92	97
2	93	94	96
3	89	97	98

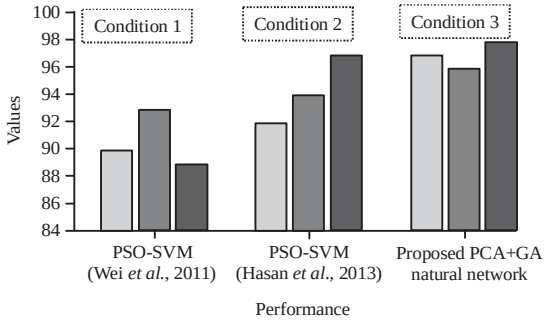

Fig. 2: Average recognition performance for the PSO-SVM, OPSO-SVM and the proposed technique

circumstances like posture and lighting. In our technique the face images are tested with three conditions which are: different pose with same illumination, different illumination with same pose and different pose or illumination.

These different circumstances face images optimal features were given to the feed forward back propagation algorithm in the testing process. In each experiment, face images of 100 persons are utilized among these 100 images 50 images for training and 50 images for testing. This similar procedure is followed for different circumstances. The average recognition accuracy results for different conditions by the proposed technique, PSO-SVM (Wei *et al*., 2011), OPSO-SVM (Hasan *et al*., 2013) are shown in Table 2 and the recognition results of proposed and present techniques assessment is demonstrated in Fig. 2.

CONCLUSION

In this study, a combined face selection technique based on PCA and GA has been proposed. The Genetic algorithm has been used to select the optimal features after applying PCA method and these optimal features were utilized in the recognition process with feed forward back propagation neural network. The performance of the proposed technique has been analyzed by exploiting face database CASIA. The experimental results proved that the proposed PCA+GA with neural network gave high recognition result. Moreover, in comparative analysis, the proposed technique performance is compared with the PSO-SVM and OPSO-SVM techniques. The comparison result shows that our PCA+GA+neural network has gained more recognition accuracy than the existing methods.

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