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Research Article

Neural Gen Feature Selection for Supervised Learning Classifier

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Abstract: Face recognition has recently received significant attention, especially during the past few years. Many face recognition techniques were developed such as PSO-SVM and LDA-SVM However, inefficient features in the face recognition may lead to inadequate in the recognition results. Hence, a new face recognition system based on Genetic Algorithm and FFBNN technique is proposed. Our proposed face recognition system initially performs the feature extraction and these optimal features are promoted to the recognition process. In the feature extraction, the optimal features are extracted from the face image database by Genetic Algorithm (GA) with FFBNN and the computed optimal features are given to the FFBNN technique to carry out the training and testing process. The optimal features from the feature database are fed to the FFBNN for accomplishing the training process. The well trained FFBNN with the optimal features provide the recognition result. The optimal features in FFBNN by GA efficiently perform the face recognition process. The human face dataset called YALE is utilized to analyze the performance of our proposed GA-FFNN technique and also this GA-FFBNN is compared with standard SVM and PSO-SVM techniques.

Keywords: Face recognition, FFBNN, GA, PCA, SVM

INTRODUCTION

Face recognition is one of the dynamic research fields for computer and machine vision researchers (Reza *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. A face recognition system, which routinely identifies a human face from database images, is a computer vision. The challenging problem of face recognition is to take into consideration of all possible appearance variation caused by change in lighting, facial features, occlusions, etc., (Sudhir and Banerji, 2011). One of the most important biometric is face recognition, which seems to be having excellent cooperation between actuality and social reception and balances security and privacy well (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. Face recognition method applied in some areas like 1.identification at front door for home security, recognition at ATM or in conjunction with a smart card for authentication and also in video surveillance for security (Anil and Kumar, 2010; Jennifer *et al*., 2003). In biometric based identification methods the face recognition system are very natural and the people using these system does not show any negative response. This system is also has higher reliability than token based systems (card, key and etc.). Therefore this system in biometric areas is under several research efforts (Sanghoon *et al*., 2007). The reason for the nonintrusive in face recognition method is due to the fact that it is based on images recorded by a distant camera and it can be very effective because the presence of face recognition system is unknown to the person. This method is used in common and user friendly for the reason that human face is the simple and powerful identification used by the humans to detect the other humans (Hussein, 2011).

There are two categories in face recognition are Verification and identification. First, the face verification means to compare a face image with

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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. They are face localization, feature extraction and modeling (Mini and Chhabra, 2011). The task of face recognition has been found out by several researchers. The geometry of key points (like the eyes, nose and mouth) and their geometric relationships (angles, length, ratios, etc.) have been used by the prior face recognition methods (Gordon, 1992). Recently many face recognition techniques have been proposed such as PSO-SVM (Jin *et al*., 2011); SVM-NDA (Khan *et al*., 2012) and MOUD-SVM (Li *et al*., 2011). However, the extracted features play an important role in the recognition stages. In this study, a face recognition system based on genetic algorithm and Feed Forward back Propagation Neural Network is proposed. The rest of the study is organized as follows. a brief review is made about the recent research works, the proposed technique namely GA based FFBNN with necessary mathematical formulations, the implementation results and comparative results and concludes the study.

MATERIALS AND METHODS

Genetic algorithm: John Holland-university of Michigan proposed a genetic algorithm (Holland, 1992) which is the technique used in our study. This technique is used for optimization and machine learning applications in the way of the principles of evolutionary biology to computer science.

First generation pool is the first step done in this algorithm. This means that the chromosomes are generated randomly or heuristically to form an initial pool of possible solutions. Each organism is evaluated in each one of the region. Then the fitness function returns the value of fitness or goodness. Selection, crossover (or recombination) and mutation are the genetic operators used or any one of these genetic operators are used for the generation of second generation pool of organisms in the second step. Based on elements of the initial generation having better fitness the pair of organisms is selected for to survive. Following the selection process the crossover operation is performed. According to some probability of crossover, the crossover (or recombination) operation is performed on the selected chromosomes. Two new child chromosomes are added to the second generation pool as the result of cross over. Swapping a portion of the underlying data structure of the chromosomes of the parents is the operation of crossover. Until reaching the solution that is good enough, the same process should be applied for more number of generations. Hence obtained optimal features by GA procedure are selected and used to train FFBNN to acquire remarkable recognition outcome. The basic structure of Genetic Algorithm (GA) is illustrated in Fig. 1.

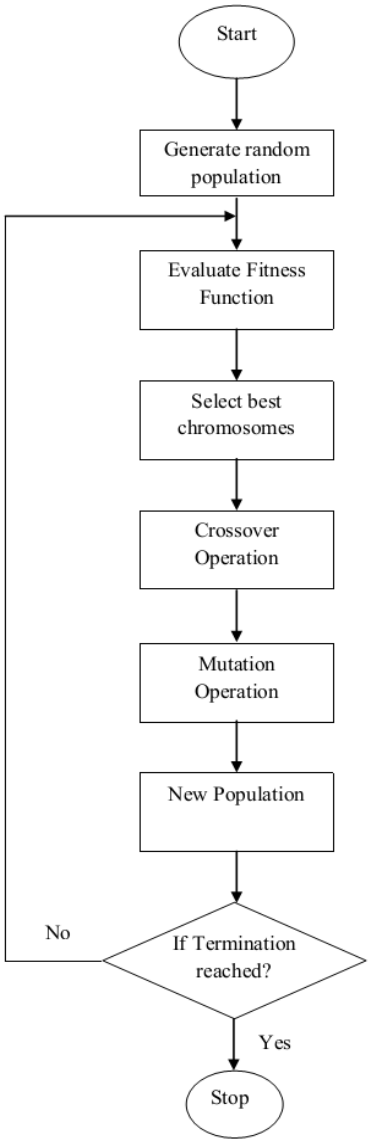

Fig. 1: Basic structure of GA

State of the art: Recently developed face recognition process based literature works are reviewed below.

Belghini *et al*. (2012) have developed a color face recognition system to identify human faces using back propagation neural network and compared how the algorithm converges using the mean square error and the Bhattacharyya distance. Another face recognition method has been proposed (Guillaumin *et al*., 2011), performed the face recognition process by using a collection of images with captions. Here, they consider two tasks: retrieving all faces of a particular person in a data set and establishing the correct association

between the names in the captions and the faces in the images. Balcoh *et al*. (2012) have proposed a method for biometric attendance. That proposed work described the efficient algorithm that automatically marks the attendance without human intervention. Whereas, Kekre *et al*. (2012) have proposed Multilevel Block Truncation Coding based Face Recognition on BTC-Intermediate 4 and BTC-Intermediate-9 techniques. For experiment analysis they have used two face databases, one was "Face Database" and the second one was "Our Own Database.". One of recent face recognition technique has been proposed by Hirdesh and Padmavati (2012) using Scale Invariant Feature Transform (SIFT) for extracting the distinctive invariant feature from images. They have analyzed the performance of SIFT using Euclidean distance as a similar algorithm. This proposed method, face recognition under various distance calculation methods like Correlation and Cosine.

The problem statement: The previous section reviews the recent works related to our face recognition process. These existing techniques perform the face recognition process by utilizing different classifiers and distance measures. But these techniques not attain high level performance in face recognition process, because those techniques not focus on the feature extraction process. More accurate features from the face images automatically increase the recognition results. But these techniques lacks in their feature extraction process. The inefficient features in the face recognition have introduced an inadequacy recognition result. Hence to avoid this drawback, a face recognition method with optimal feature extraction is proposed in this study. To avoid such drawback in the existing method, here we proposed a GA with FFBNN (GA-FFBNN).

Proposed face recognition system: Our proposed method develops a recognition technique to recognize the human face images from the face database. The face recognition process is attained by the Genetic Algorithm (GA) with FFBNN techniques. The proposed system mainly comprised of three stages namely:

- Feature Extraction using PCA
- Feed Forward Back propagation Neural Network (FFBNN)
- Optimal features selection by GA with FFBNN

These three stages are consecutively performed and the face images are recognized more efficiently. The Structure of our proposed face recognition system is illustrated in Fig. 2.

Feature extraction by PCA: Extraction of the feature vectors or information which represents the face is the purpose of the feature extraction. Principal Component Analysis (PCA) (Vaseghi and Jetelova, 2006) is the feature extraction algorithm. Based on the information theory approach, PCA is to be used in face recognition. This is efficiently and easily encoded by extracting the relevant information in a face image. The subspace of the image space spanned by the training face image data is identified and decor relates the pixel values. By projecting the face image to the coordinate system defined by the principal components the classical representation of a face image is obtained. Information compression, decor relation and dimensionality reduction are used for decision making in the projection of face images into the principal component subspace. Treating an image as a vector in a very high dimensional face space sought the principal components of the distribution of faces or the eigenvectors of the covariance matrix of the set of face images in mathematical terms.

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

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

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

The training and testing images with the size of $X \times Y$ whereas m, n is the number of training. These numbers of training images are given to the PCA technique for feature extraction and these extracted features are given to optimal feature selection by GA

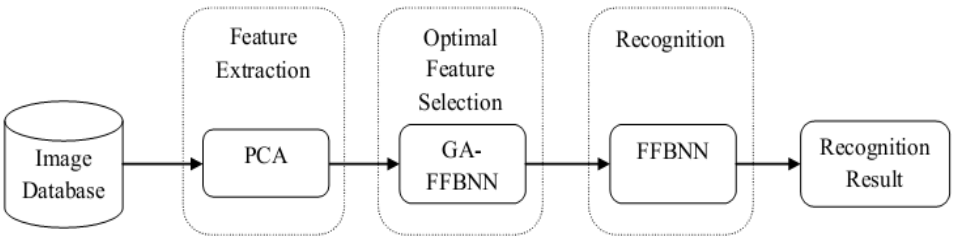

Fig. 2: Structure of proposed face recognition system based on GA-FFBNN

Table 1: GA optimal features

	Optimal features from GA	
Number of persons	Pose	Illumination
1	27, 29, 5, 30, 21, 4, 9, 18, 31, 31	10, 21, 18, 16, 9, 24, 27, 9, 17, 1
2	7, 22, 20, 32, 3, 20, 25, 9, 1, 4	30, 23, 23, 31, 30, 16, 16, 10, 10, 28
3	30, 1, 25, 21, 25, 24, 22, 16, 24, 25	28, 18, 28, 2, 9, 31, 10, 27, 19, 3
4	9, 25, 9, 2, 12, 18, 27, 30, 20, 3	13, 13, 15, 16, 20, 18, 14, 25, 11, 15
5	5, 21, 17, 23, 27, 19, 8, 14, 32, 5	16, 26, 7, 32, 14, 4, 17, 29, 1, 4
6	19, 20, 17, 13, 2, 10, 20, 32, 9, 14	31, 5, 32, 14, 29, 2, 26, 23, 7, 32
7	31, 7, 28, 29, 32, 24, 1, 2, 31, 7	10, 8, 15, 20, 1, 23, 30, 27, 20, 18
8	29, 29, 27, 15, 20, 22, 10, 21, 17, 28	30, 9, 20, 9, 30, 32, 26, 7, 20, 3
9	13, 17, 24, 14, 6, 32, 22, 31, 8, 4	20, 14, 12, 23, 7, 26, 29, 19, 26, 14
10	22, 31, 18, 13, 22, 15, 5, 15, 18, 13	1, 11, 9, 26, 20, 16, 14, 18, 4, 17

with FFBNN process. The steps involved in the PCA are given below:

- The mean value $M(I_m(a, b))$, $M(I_n(a, b))$ of the given training dataset $I_m(a, b)$, is found
- Subtract the mean value from $I_m(a, b)$, $I_n(a, b)$ and obtained new matrixes A and B
- The covariance is obtained from the matrix A and B i.e., $C_1 = AA^T$, $C_2 = BB^T$ and also computes its Eigen vectors. Eigen values are obtained from the covariance matrix which is represented as e_1, e_2, e_3, … e_E
- Sort Eigen values in ascending order
- Project the principal component vectors

The optimal features from the GA for 10 persons with different pose and illumination results are given in Table 1.

Feed Forward Back propagation Neural Network (FFBNN): A computational structure motivated by the study of biological neural processing is a neural network. Similar to varieties of neural networks, there are also many theories on the working of biological neural networks and branch out to other paradigm later. There are layers of sub-groups of processing elements in a layered feed forward networks. Another layer receives the result by a layer of processing elements which makes independent computation or data that it receives. This process is repeated till a sub-group of one is more processing elements determine the output from the network. Based on the weighted sum of inputs, each processing elements makes its calculations. The input layer is defined as the first and the last is defined as the output layer.

The aim is similar with most neural networks, to train the network to achieve a balance between the network's capability to react and the capacity to give a sensible answer to the input that is similar, but not identical to the one used in the training. The feed forward of the input training pattern, the calculation and the back propagation of the associated error and the weighted adjustment are the three stages of training of a back propagation network. After the network has been trained, its function involves only the feed forward phase. All through feed forward, each input neuron receives an input a signal and broadcasts it to the each hidden neuron, which in turn computes the commencement and passes it on to its output unit, which again computes the activation to obtain the net output. During training, the net output is compared with the objective value and the proper error is calculated, from the error, the error factor is obtained which is used to give out the error back to the hidden layer. The weights are updated accordingly. In the same way the error factor is calculated, after the error factors are obtained and the weights are updated simultaneously. The structure of FFBNN (Anna and Saro, 2008) for the face recognition process is shown in Fig. 3.

The FFBNN include g number of input units, one output units and H_d hidden units. The number of input units based on the length of the chromosome, the input values of i[th] chromosome gene values is represented as G_g^i. The main functions of the FFBNN are bias function, activation function and learning error rate. The bias function is used to calculate a hidden layer input value, H_d and the activation function, η is calculated in the output layer, which is given in Eq. (3) and (4):

$$B^i = \lambda + \sum_{h=1}^{H_d} w_{gH_d} G_g^i \tag{3}$$

where, parameter λ is called bias:

$$\eta = \frac{1}{1+e^{-B^i}} \tag{4}$$

Subsequently, the learning error rate is calculated by comparing the output values with the target values:

$$\partial = \frac{1}{H_d} \sum_{h=1}^{H_d} E_h^i - T_h^i \tag{5}$$

The error between the nodes is transmitted back towards the hidden layer and the minimization of error is performed by the back propagation algorithm.

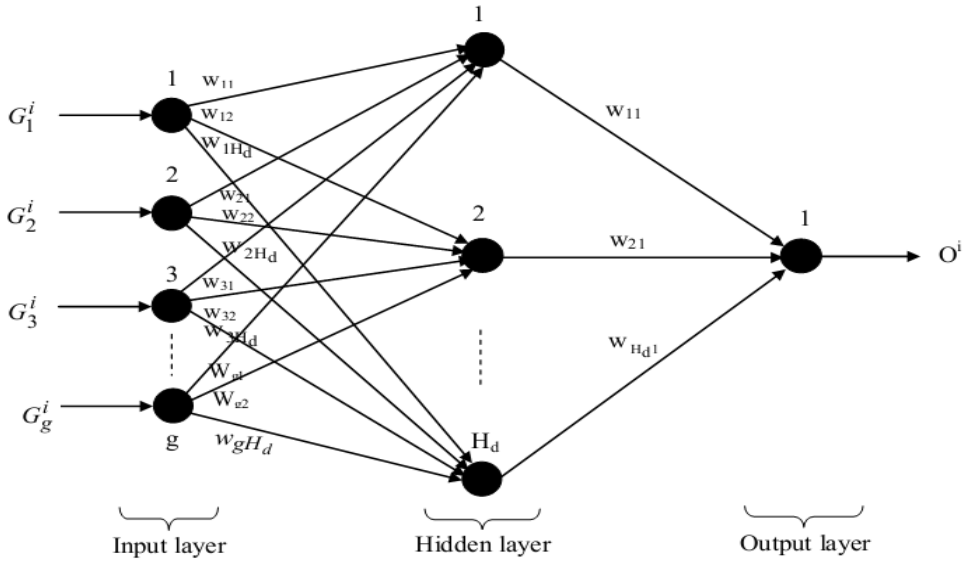

Fig. 3: Structure of FFBNN

Training: During the training process the FFBNN takes the training image I_m (a, b) feature vectors corresponding generated chromosomes are given to the input. The FFBNN is well trained by the training images feature vectors.

Testing: In testing phase, the well trained FFBNN acquire a testing image I_n (a, b) feature vectors corresponding chromosomes. Here, the chromosome genes values are corresponding training image chromosome gene values.

Optimal features selection by GA with FFBNN: The optimal features by GA Ephzibah (2011) is selected and trained with the FFBNN technique. 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, L), where L is an index value of the feature vector. These chromosomes values are given to the FFBNN.
- **Fitness:** Fitness value is calculated by comparing the FFBNN output value of training and testing images respectively. Each chromosomes fitness is calculated by the formula:

$$F = \min\left(O^i_{I_m(a,b)} - O^i_{I_n(a,b)} \right)$$

where $O^i_{Im(a,b)}$ and $O^i_{In(a,b)}$ is the training and testing images output values from FFBNN 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.

EXPERIMENTAL RESULTS

The proposed face recognition system is implemented in the working platform of MATLAB (version 7.12) with machine configuration and SVM configuration as given in Table 2 and 3.

The performance of the proposed system is evaluated with face dataset YALE and the face images under different circumstances like pose and illumination. In our technique the face images are tested with three conditions as stated as follows:

- Face images with Different pose and same illumination
- Face images with Different illumination and same pose
- Face images with Different pose or illumination

Table 2: Machine configuration

Processor	Intel core i5
Operating system	Windows 7
CPU speed	3.20 GHz
RAM	4 GB

Table 3: SVM configuration

Kernel cache limit	5000
Kernel function	Linear
Method	Sequential minimal optimization

Table 4: Comparison of recognition results by GA-FFBNN and SVM

Conditions	Images	Recognition methods	Face recognition accuracy (%)
1		GA-FFBNN	93
		SVM	83
		PSO-SVM	90
2		GA-FFBNN	92
		SVM	80
		PSO-SVM	85
3		GA-FFBNN	95
		SVM	85
		PSO-SVM	88

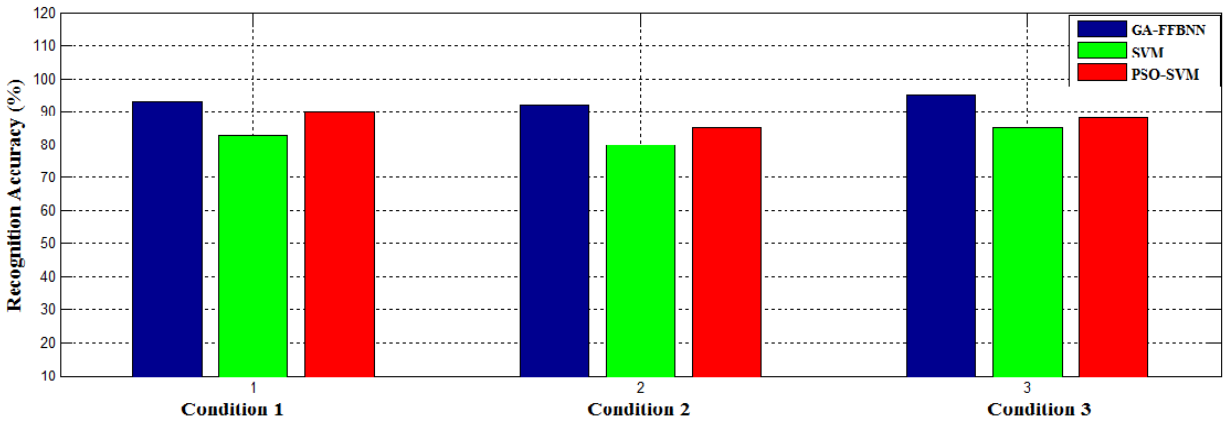

Fig. 4: Recognition results under the three conditions

These different circumstances face images optimal features were given to the FFBNN in the testing process. In each experiment, face images of 20 persons are utilized among these 20 images 10 images under recognized images and 10 images are unrecognized images. In these 20 images, 1st experiment was performed by taking 19 images in the training process and 20th image in the testing process and the 2nd experiment was performed by taking the 19th image in the testing process and the 1 to 18th and 20th image in the training process. This similar procedure is followed for different circumstances. In each experiment 20 images are involved in both training and testing process. These 20 images from different persons are given to the GA-FFBNN. The recognition results for different conditions by the GA-FFBNN, SVM and PSO-SVM are shown in Table 4 and the recognition results of proposed and existing techniques comparison graph is illustrated in Fig. 4.

DISCUSSION

As shown in Fig. 4, the recognition result of our proposed technique gives better results than the SVM and PSO-SVM methods in all three conditions. The recognition results under the different pose or illumination acquires high recognition result than other two conditions. These different conditions results indicate that GA-FFBNN has higher face recognition accuracy than SVM and PSO-SVM methods under the three conditions. Furthermore, we have assessed the proposed method efficiency by using t-test statistical measurement. However, the proposed GA-FFBNN proved to be very statistically significant compared with the standard SVM and PSO-SVM, where the probability-value is less than 0.05 ($p<0.05$, $p = 0.0033$) and ($p<0.05$, $p = 0.0289$), respectively.

CONCLUSION

In this study, we have proposed a face recognition technique based on GA and FFBNN. The GA has been utilized to select optimal features and these optimal features were utilized in the FFBNN. The FFBNN with optimal feature have been trained for effective face recognition. The proposed GA with FFBNN technique performance has been analyzed by exploiting human face database YALE. The experimental results proved that our proposed GA-FFBNN has given high performance recognition result. Moreover, in comparative analysis, our proposed technique performance is compared with the standard SVM techniques. The comparison result shows that our GA-FFBNN has given more recognition accuracy than the existing methods. Hence, it is proved that our proposed GA with FFBNN technique more precisely recognizes the face images.

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REFERENCES

Anil, K.J. and A. Kumar, 2010. Biometrics of Next Generation: An Overview. Second Generation Biometrics, Springer, Heidelberg.

Anna, D. and A. Saro, 2008. Image compression with back-propagation neural network using cumulative distribution function. World Acad. Sci. Eng. Technol., 17: 1075-1079.

Balcoh, N.K., M.H. Yousaf, W. Ahmad and I. Baig, 2012. Algorithm for efficient attendance management: Face recognition based approach. Int. J. Comput. Sci., 9(4).

Belghini, N., A. Zarghili, J. Kharroubi and A. Majda, 2012. Learning a back propagation neural network with error function based on bhattacharyya distance for face recognition. Int. J. Image Graph. Signal Process., 4(8): 8-14.

Ephzibah, E.P., 2011. Cost effective approach on feature selection using genetic algorithms and fuzzy logic for diabetes diagnosis. Int. J. Soft Comput., 2(1): 1-10.

Gordon, G.G., 1992. Face recognition based on depth and curvature features. Proceedings of IEEE Computer Society Conference on Computer Vision and Pattern Recognition. Champaign, IL, USA, pp: 808-810.

Guillaumin, M., T. Mensink, J. Verbeek and C. Schmid, 2011. Face recognition from caption-based supervision. Int. J. Comput. Vision, 96(1): 64-82.

Hirdesh, K. and Padmavati, 2012. Face recognition using SIFT by varying distance calculation matching method. Int. J. Comput. Appl., 47(3): 20-26.

Holland, J.H., 1992. Adaptation in Natural and Artificial Systems. MIT Press, Cambridge, MA.

Hussein, R., 2011. Face recognition using principle component analysis with different distance classifiers. Int. J. Comput. Sci. Network Secur., 11(10): 134-144.

Jennifer, H., B. Heisele and V. Blanz, 2003. Component-based face recognition with 3D morphable models. Proceedings of the 4th International Conference on Audio-and Video-Based Biometric Person Authentication (AVBPA, 2003). Guildford, UK, pp: 27-34.

Jin, W., J. Zhang and X. Zhang, 2011. Face recognition method based on support vector machine and particle swarm optimization. Expert Syst. Appl., 38: 4390-4393.

Kekre, H.B., S. Thepade, S. Khandelwal, A. Azmi and K. Dhamejani, 2012. Implementation of multilevel block truncation based face recognition on intermediate-4 and intermediate-9 levels. Int. J. Comput. Appl., 50(20): 39-44.

Khan, N.M., R. Ksantini, I.S. Ahmad and B. Boufama, 2012. A novel SVM+NDA model for classification with an application to face recognition. Pattern Recogn., 45(1): 66-79.

Li, W., L. Liu and W. Gong, 2011. Multi-objective uniform design as a SVM model selection tool for face recognition. Expert Syst. Appl., 38(6): 6689-6695.

Mini, S.A. and S. Chhabra, 2011. Effect of distance measures in PCA based face recognition. Int. J. Enterprise Comput. Bus. Syst., 1(2).

Patil, A.M., S.R. Kolhe and P.M. Patil, 2010. 2D face recognition techniques: A survey. Int. J. Mach. Intell., 2(1): 74-83.

Reza, E., A. Jahani, A. Amiri and M. Nazari, 2011. Expression-independent face recognition using biologically inspired features. Indian J. Comput. Sci. Eng., 2(3): 492-499.

Sanghoon, K., S.T. Chung, S. Jung, S. Jeon, J. Kim and S. Cho, 2007. Robust face recognition using AAM and Gabor features. World Acad. Sci. Eng. Technol., 33: 117-121.

Sudhir, K. and S. Banerji, 2011. Face recognition using K2DSPCA. Proceeding of the International Conference on Information and Network Technology. Singapore, pp: 84-88.

Vaseghi, S. and H. Jetelova, 2006. Principal and independent component analysis in image processing. Proceeding of the 14th ACM International Conference on Mobile Computing and Networking. San Francisco, Calif, USA, pp: 1-5.