Face Recognition using PCA and SVM with Surf Technique

Shilpa Sharma
Indo Global College of Engineering
Abhipur, Mohali, India

Kumud Sachdeva
Asstt.Prof. Indo Global College of Engineering
Abhipur, Mohali, India

ABSTRACT
Face Recognition is a biometric application which can be controlled through hybrid systems instead of a solitary procedure. This paper focus at Principal Component Analysis system alongside SVM and SURF for Face Recognition. Preprocessing abrogates improper, superflous and unnecessary information. PCA naturally decreases dimensionality and Feature extraction to minimize highlights. Furthermore, after element extraction, the recognition is performed on these elements to perceive the person. SVM classifier is a classifier which is utilized as a part of this paper for performing the recognition capacity and SURF is utilized for matching the source image with the database. This outcomes in an adequate error rate and accuracy furthermore this gives better MSE and PSNR results. In this paper, a novel facial methodology is used to hunt the element space down the ideal component subset where elements are extricated by PCA , while matching and recognition is done utilizing SVM classifier and SURF Technique. For the usage of this proposed work we utilize Image Processing Toolbox under the MATLAB programming.

Keywords
Face Recognition, Principal component Analysis, Support Vector Machine, SURF.

1. INTRODUCTION
Face recognition is a biometric software application. Biometric can be defined as the set of procedures which are used to measure the physical and behavioural traits of a person for identification and verification. A biometrics is, " An automated method of recognizing unique physical or behavioral characteristics of an individual". Face Recognition basically figure out an individual in a digital image or video by analysing and comparing patterns. It is widely used in security systems like other biometrics procedures like eye iris or fingerprint recognition system . Face recognition a promising and popular research field in the pattern recognition and computer vision. Face Recognition supportes security systems, surveillance, credit cards, passport, etc. Numerous methods have been suggested in the last few decades. The dimension of the facial images are higher and thus need considerable amount of computing time for assortation. The classification and recognition time can be reduced by reducing dimensions of the image data.

The facial recognition methodology infers mechanized systems to characterize facial segments that are the fundamental components of isolation. The mechanized strategies for facial recognition, despite the fact that seek after extremely well however don't watch subjects in the same way as a human cerebrum. The way people connect with other individuals solidly underpins the ability to remember them.

Contrasted and distinctive biometric methodologies, facial recognition may not be the most solid and productive. Then again, one key point is that it doesn't seek the test's collaboration subject to satisfy. Appropriately outlined frameworks introduced in airplane terminals, multiplexes, and other open spots can distinguish people in group, without the attention to the passer in the framework. Different biometrics like fingerprints, iris sweeps, and discourse recognition can't perform this sort of recognizable proof. Be that as it may, inquiries arised on the adequacy of facial recognition programming in the instances of railway, road and air terminal security.

One of the primary parts of face distinguishing proof is its vigour. In contrast with different biometrics, a face recognition framework would permit a passer to be recognized by just strolling in front of a reconnaissance camera.

2. LITERATURE REVIEW
Gheorghita Ghinea, Rrajkumar Kannan, and Suresh Kannaiyan in 2014 suggested a peculiar approach to recognize faces. In this work schurfaces are introduced as a face recognition method. Schurfaces is a robust itnterpretation of conventional PCA. Schurfaces frequently surpass the regular Face Recognition procedure that have immense discriminant potential. The Hausdorff distance is used with the closest neighbor classifier to examine the similarity or resemblance between distinct faces. Experiments are conducted on Yale face database and ORL face database which shows that the introduced approach is highly segregated and gained a promising accuracy for face recognition.

Hossein Sahoolizadeh, Zargham Heidari, and Hamid Dehghani in 2013 investigated a method which assemble PCA and LDA . The capability of LDA is upgraded when exigous images are used and neural classifier reduces misclassifications caused by non linear separable classes. YALE B database supporting simulation shows the adequacy of the peculiar method for face recognition with fewer misclassifications. YALE face datasets validates the capability of the suggested method for ideal facial elements extraction and adequate face classification. Simulation reteive 10 individual image and considered 40 training image and 20 test image for each human (totally 400 training and 200 test face images).

Dong Hui, Han Dian Yuan in 2012 recommend SURF method to disclose and descript the interest points and match the interest positions supported by high time- adequate KD-tree closest position searching criteria. The experimental result shows high time efficiency and excellent robustness. The facial characterstics are extorted by SURF method even on rotation of scale in an image. The utilization of KD-tree searching method properly utilizes the efficacy of locating exact same position pairs. In this suggested work, pairs of images with distinct pivot angles were accomplised.

Avinash Kaushal, J P S Raina in 2010 presented the classifications of the facial components of a face identification supported by Gabor filter feature extortion technique in image processing. The facial component vector supported by Gabor filters employed as the input of the classifier, known as Feed Forward Neural Network (FFNN) on a feature reduction

subspace examined by an procedure transparent than Principal Component Analysis (PCA).

R.Gowthamam, C. Sathish in 2014 investigates a procedure of calculating eye position co-ordinates or locus points to abolish face image instead of key position descriptors. A new process named Partial face recognition is introduced which identifies or examines a face from its partial image. Multi-Keypoint Descriptors (MKD) is a image representation technique for partial FR where the descriptor content of a face is resolved by the substantial measure of the image. A new keyposition descriptor called Gabor Ternary Pattern (GTP) is also refined for face recognition. It employs new appearences in Grey Level Cooccurrence Matrix (GLCM) to raise accuracy in identifying evident results. This paper introduced an approach to solve the problem of accuracy in identification result, and suggested an alignment-free method known as MKD-SRC.

Rabab M. Ramadan and Rehab F. Abdel – Kader in 2009 defines a peculiar feature selection algorithm supported by particle swarm optimization (PSO). This technique is supported by coefficients derived from two feature extraction techniques: Discrete wavelet transform (DWT) and the Discrete cosine transforms (DCT). PSO is a estimating prototype supporting the idea of synergetic behaviour inspired by the social demeanour of fish schooling or bird flocking. The suggested feature selection innovation supported by PSO is resorted to search the component space for the ideal facial components subset. Transformation is induced by an adequate function processed for enlarging the class separation (scatter index). The length and the performance of the classifier of preferred facial component vectors are considered for performance estimation using the ORL face database.

3. METHODOLOGY

The idea of suggested approach is to create a low spatial subspace that better performs the original images with reduced facial components. It is achieved through PCA which reduces the dimensionality of the images and SURF descriptors to accomplish informative facial component vectors and SVM is used as a classifier to evaluate the similarity between images.

Step 1:
Firstly a code is developed for the loading of face image in the database of the Matlab. This is done for the loading the face image value in the workspace of the Matlab.

Step 2:
After that a code is developed for applying Preprocessing Techniques to the loaded image. Code is developed to generate the formula for preprocessing like RGB to GRAY, img to binary and Edge Detection in the Matlab.

Step 3:
After that a code is developed for the Principal Component Analysis (PCA). Code is developed to generate the formula of the PCA in the Matlab. Code is developed for dimensionality Reduction and applying the feature extraction technique to extract the feature of the image.

Step 4:
After that code is developed for the recognition of the loaded face image using SVM and SURF Technique.

Step 5:
At last code is developed to analyze our result using parameters like PSNR, MSE, Error Rate and Accuracy and compare with previous base paper.

The block diagram of the proposed approach is shown in figure 1.

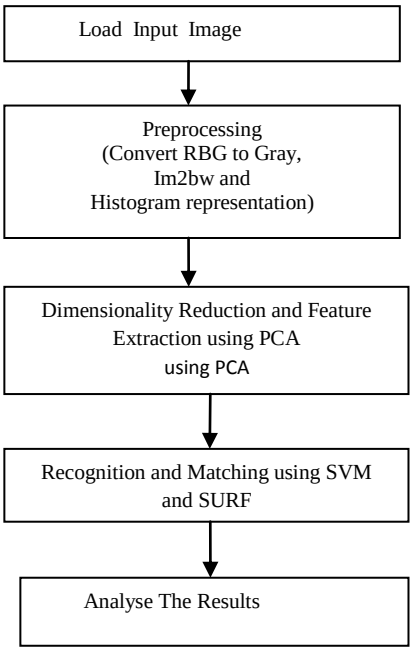

Figure 1. Flow Chart .

4. TECHNIQUES USED

(a) Feature Extraction

Feature extraction accord with is limited in particular facial segments of the face in the image. PCA strategy is utilized for the extraction of facial segments for picture.

Principle Component Analysis

In this technique, principal components are first concluded and then these components are used as transformation matrix for the transformation of training set images and test images to PCA space.

PCA Algorithm

Listed below are the points of PCA approach:

- dataset consisting of d-dimensional samples are contained except class labels.
- Figure out the d-dimensional mean vector (i.e., mean of every dimension in the whole dataset).
- Enumerate the covariance matrix (alternatively, the Scatter matrix) of the whole data set.
- Then , compute eigenvectors ($e_1,e_2,...,e_d$) and corresponding eigenvalues ($\lambda_1,\lambda_2,...,\lambda_d$).
- arrange the eigenvectors by declining their values and choose k eigenvector having largest value to form a d×k dimensional matrix W.
- Employ W to transform the sample elements into new subspace using equation: $y= W^T \times x$ (where x represents a element, and y is the transformed sample element in the new subspace).

Every individual pixels of a picture are taken through and through and after that they again changed to line vector which incorporates the intensity values or grey components of that picture. These column vectors a solitary or single matrix is changed by connection. Every picture is arranged by line in that matrix. Two unmistakable networks are changed over for

test picture set and training picture set. Both the training and test pictures are handled under same system.

Covariance matrix is then calculated for training set images in which image is categorised by each row and pixel position is categorised by columns. Covariance will be positive if both the variables vary in the range expected value but if one variable varies overhead its expected value and second diversify under its expected value then there will be negative covariance.

$$Cov(x_i, x_j) = E\left[(x_i - \mu_i)\left(x_j \mu_j\right)\right]$$

$$(for\ i\ and\ j = 1,2,3 \ldots \ldots n)$$

This is the expression for calculating the covariance.

where E is the mathematical expression and $\mu_i = Ex_i$, and x is training image matrix. If the order of matrix x is (m x n), where n represents columns and m represents rows to represents number of pixels per image. Then the order of new resulted covariance matrix is (n x n).

Dimensionality reduction: The extent of eigenvector matrix is (n x n), it is accepted that there are n eigenvectors (where n is the quantity of pixel per picture) and by change to PCA space we pick up a n dimensional space. To pack that space, its dimensionality must be decreased and for this , take the top k eigenvectors relating to top k most astounding eigen values which will help in changing matrix A_k. Transformation matrix can be figured as:

$$K = \lfloor number\ of\ pixel/2 \rfloor$$

For instance, assume the measure of a picture in the database is 80×40 that arrives are 3200 pixels for each picture. After the change to PCA space and the diminishment in dimensionality, the picture's extent of new decreased change lattice, will approx 1600 pixel for every picture which is 50% of 3200.

This is the primary process that is prescribed in each of the results in which change in PCA is essential.

Transformation to the PCA space: The matrix *A* that is formed by arranging the eigenvectors used as a transformation matrix to modify the images to the PCA space. This is done by replacing the elements in the expression given below;

$$Y = A(p - m_x)^t$$

Where P defines a vector representing image and m_x describes the mean value of individual pixel position of all training set images. The computed vector *y* is the image which is converted to PCA space. That is defined as *principal component transform.* Now each images determined in the training set remodelled into the PCA space. A new test image *t* is considered which is formed after transforming it into a space which guides in the identification of training set. Same transformation is applied to test image.

$$r = A(T - m_x)^t$$

The vector *r* is mapping such image to the PCA space.

(b) Recognition

It involves using the set of features that were extracted and comparing them to the database to determine which image matches the closest to it. Recognition is done using support vector machine (SVM).

Support Vector Machine (SVM)

SVM is a classification procedure which was illustrated by Vapnik in 1992. This classifier is mainly applied in bioinformatics and other applications due to its many characterstics like high accuracy, process the high-dimensional data such as gene expression. It is associated to the regular category of kernel procedure. A kernel procedure implies the data obtained through dot-products. In this case, kernel function calculates a dot product in possibly high dimensional facial components space.

The primary characteristics of SVM is the capacity to develop non-linear classifier utilizing systems connected on linear classifiers. The utilization of portion capacities in SVM permits the clients to dole out a classifier to the information that don't alter dimensional vector space representation. The sample of SVM in bioinformatics are protein Structure and arrangement either DNA or protein.

Support Vector Machines (SVM) have accomplished incredibleness in the field of machine learning and example classification. Classification is acquired by understanding a linear or non-linear partition surface in the information space. It stacks the set with the closest combine of focuses from inverse classes like the Direct SVM calculation.

SVM Algorithm

- Identify a violating point in the dataset.
- If there is a Violater point is identified in the dataset then it will be greedily added to the candidate set.
- It may take place if adjoining of the violating point as a Support Vector may be impeded by other candidate Support Vectors that are already present in the set.
- Steps Repeated if the Violating points are eliminated.

Curve Fitting Tool

Curve Fitting Toolbox is an application that are connected on fitting curves and surfaces to information. This tool performs information investigation, preprocessing and post-handling of information, looking at competitor models, furthermore to evacuate anomalies. Relapse investigation can likewise be performed utilizing the library of direct and nonlinear models giving custom comparisons.. This toolbox additionally supports nonparametric displaying strategies, for example, insertion, smoothing and splines. It Selects fits and information sets that are shown in the tool.

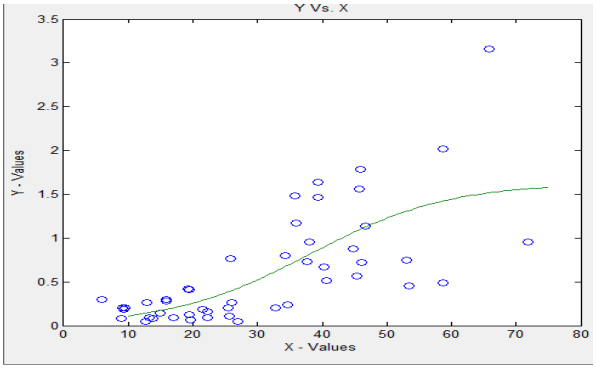

Fig 2 shows the graph as non linear classifier of input image

Fig 2 shows the graph as non linear classifier of input image which is obtained by SVM. This graph represents the X and Yvalues from respective file which is represented by Curve Fitting Tool.

c) Matching

Speed up Robust Features (SURF)

SURF algorithm is a feature point extraction algorithm. It is purposed by Bay H,Tuytelaars T,Gool L V in 2006. SURF algorithm works in two parts:

- Feature Point Detection .
- Feature Invariant Point Descriptor.

SURF (Speeded Up Robust Features) algorithm is the quickened adaptation of SIFT (Scale-Invariant Feature Transform), having a more noteworthy advancement continuously . SURF is utilized for object acknowledgment and target following. SURF descriptors are utilized to create instructive component vectors. One of the fundamental points of interest of SURF is that it rapidly processes unmistakable descriptors. SURF descriptors is invariant to some basic picture changes like picture pivot, perspective, change in scale, light illumination. Surf is utilized as a part of different frameworks for performing coordinating operation. It is a hearty nearby component finder and is great at taking care of pictures with revolution and obscuring. Various Experiments demonstrates that SIFT is three times slower than SURF. It approximates the plans which are already proposed as for uniqueness, repeatability, and power but then can be registered and contrasted much quicker as looked at and other coordinating strategies.

Also, SURF depends on totals of 2D Haar wavelet equations and makes an effective utilization of integral images. This uses a whole number rough guess to the determinant of Hessian blob detector; which can be figured to a great degree rapidly with an integral picture (3 number operations). This uses the whole of the Haar wavelet reaction around the purpose of hobby. These can be registered with the integral's guide image. SURF utilized as a part of this way to deal with concentrate applicable elements and descriptors from images. This methodology is favoured over its ancestor because of its concise descriptor length i.e. 64 skimming point values. In SURF, a descriptor vector of length 64 is built utilizing a histogram of inclination introductions in the nearby neighbourhood around every key point.

combination of novel detection; description; and matching steps. At last it is achieved by;

- Relying on integral images for picture convolutions
- Building on the main's qualities existing detectors and descriptors (utilizing a Hessian framework based measure for the finder; and an appropriation based descriptor).
- Simplifying these strategies to the key. Subsequently this prompts a blend of novel detection; description; and matching .

5. EXPERIMENTAL RESULTS

This section presents the adequacy of the results of the proposed work. The following figures show the result of Face Recognition using PCA and SVM with SURF. After obtaining all the necessary terms Principle Component Analysis, Speed up Robust Features (SURF) and Support Vector Machine (SVM) for a number of images in the database; implemented the results in the final method. This technique gives better results as compared to previous techniques. The comparison of the Error rate, Accuracy, PSNR, MSE is done with the given values to the proposed work.

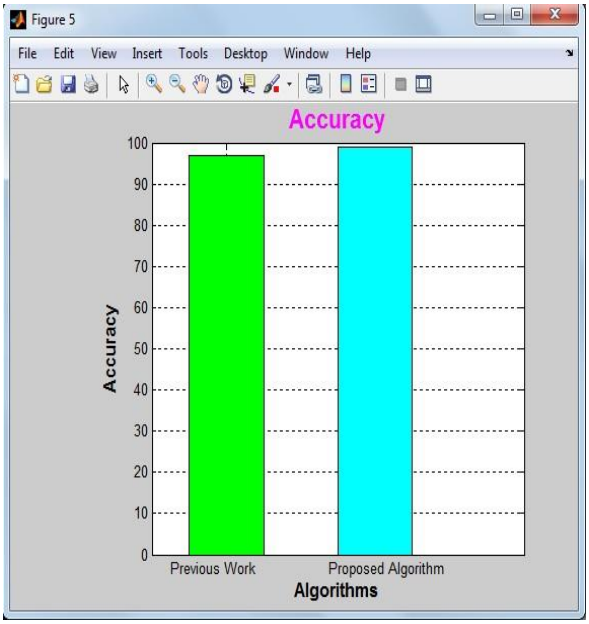

Figure 3: Graph showing accuracy of previous and proposed work.

Fig 3 shows the graphs for estimated Accuracy in the proposed approach. This shows that the proposed system is much efficient as compared with the previous system. All the parameters are calculated just to verify the efficacy of the system.

Table 1 shows the table for comparison of parameters in the proposed approach. The values shows that the proposed approach shows better results than the previous.

Parameters Used	Previous work	Proposed Work
Accuracy	97	98.7696
Error rate	14	13.6810
PSNR	219.3615	228.6025
MSE	9.2155	6.0206

6. CONCLUSION

In this paper, a methodology for face recognition which is invariant to posture, maturing and brightening in particular Principal Component Analysis is utilized. SVM is utilized for arranging the likeness in the middle of pictures and SURF method is utilized for coordinating. This system is utilized to accomplish better Error Rate, Accuracy, MSE and PSNR result.

7. FUTURE SCOPE

This thesis or work is limited to acquiring face recognition from single scanned image .We can extend our research to work on the different scanned images simultaneously. Also in future more parameters like by enhancing the number of pixels quality can be considered. As this work can be extended for the infinite number of users. Further new formulas or algorithms for the enhancement of parameters can be applied

in detection of face and reducing time for execution. The proposed algorithm can be implemented on different tools.

8. REFERENCES

[1] Gheorghita Ghinea, Rajkumar kannan, and Suresh kannaiyan,"Gradient-Orientation-Based PCA Subspace for Novel Face Recognition"in IEEE Access, vol 2,2169-3536, 2014.

[2] Hossein Sahoolizadeh, Zargham Heidari, and Hamid Dehghani," A New Face Recognition Method using PCA, LDA and Neural Network " International Journal of Electrical and Electronics Engineering 2:8, 2008.

[3] Erik Murphy-Chutorian and Mohan Manubhai Trivedi," Head Pose Estimation in Computer Vision: A Survey", IEEE Transactions on Pattern Analysis and Machine Intelligence, 2008.

[4] Ajit P. Gosavi , S.R.Khot," Facial Expression Recognition using Principal Component Analysis with Singular Value Decomposition"in International Journal of Advance Research in Computer Science and Management Studies, Volume 1, Issue 6, November 2013.

[5] Dong Hui, Han Dian Yuan," Research of Image Matching Algorithm Based on SURF Features ",in International Conference on Computer Science and Information Processing (CSIP) ,2012.

[6] S.V.N. Vishwanathan, M. Narasimha Murty," SSVM : A Simple SVM Algorithm".

[7] R.Gowthamam, C. Sathish, "Recognition of Occluded Facial Images Using Texture Features at SURF Keypoints", International Journal of Emerging Technology and Advanced Engineering Website (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 4, Special Issue 2, April 2014).

[8] Tudor Barbu, "Gabor Filter-based Face Recognition Technique", Proceedings of the Romanian Academy, Series A, Volume 11, Number 3/2010, pp. 277–283.

[9] Amina Khatun and Md. Al-Amin Bhuiyan, "Neural Network based Face Recognition with Gabor Filters", IJCSNS International Journal of Computer Science and Network Security, VOL.11 No.1, January 2011.

[10] Mounika B.R, Reddy N.J and Reddy V.B.D , "A Neural Network based Face Detection using Gabor Filter Response", IJNN (International Journal of Neural Networks **)** ISSN: 2249-2763 & ESSN: 2249-2771, Volume 2, Issue 1, 2012, pp.-06-09.

[11] Hung-Fu Huang and Shen-Chuan Tai, "Facial Expression Recognition Using New Feature Extraction Algorithm", Electronic Letters on Computer Vision and Image Analysis 11(1):41-54; 2012.

[12] Thai Hoang Le, Len Bui, " Face Recognition Based on SVM and 2DPCA", International Journal of Signal Processing, Image Processing and Pattern Recognition Vol. 4, No. 3, September, 2011.

[13] D Murugan, Dr. S Arumugam, K Rajalakshmi and Manish T I, " Performance Evaluation of Face Recognition using Gabor Filter , Log Gabor Filter and Discrete Wavelet Transform", IJCSIT(International Journal of Computer Science and Information Technology) Vol .2, No. 1,Feb 2010.

[14] Avinash Kaushal , J P S Raina, "Face Detection using Neural Network & Gabor Wavelet Transform", IJCST Vol. 1, Issue 1, September 2010.

[15] Saqib Hayat, Abdul Basit Siddiqui and Sajid Ali Khan , " A Study of Feature Subset Selection Methods for Dimension Reduction", International Journal of Signal Processing, Image Processing and Pattern Recognition Vol.7, No.1 (2014), pp.251-266.

[16] Mr. Hamid M. Hasan, Prof. Dr. Waleed A. AL.Jouhar & Dr. Majed A. Alwan, "Face Recognition Using Improved FFT Based Radon by PSO and PCA Techniques", International Journal of Image Processing (IJIP), Volume (6) : Issue (1) : 2012 .

[17] Rabab M. Ramadan and Rehab F. Abdel – Kader, "Face Recognition Using Particle Swarm Optimization-Based Selected Features", International Journal of Signal Processing, Image Processing and Pattern Recognition Vol. 2, No. 2, June 2009.

[18] Nitish Sinha, Priyanka.G, "Implementation of Binary PSO Based Face Recognition System using Image Preprocessing", International Conference on Signal, Image Processing and Applications IPCSIT vol.21 (2011).

[19] Aneesh M U, Abhishek A K Masand, K Manikantan , "Optimal Feature Selection based on Image Pre-processing using Accelerated Binary Particle Swarm Optimization for Enhanced Face Recognition", International Conference on Communication Technology and System Design 2011.

[20] P.V Shinde, B.L. Gunjal, " Particle Swarm Optimization-Best Feature Selection method for Face Images", International Journal of Scientific & Engineering Research Volume 3, Issue 8, August-2012 ISSN 2229-5518.

[21] Dr.S.B.Thorat, S.K.Nayak and Miss.Jyoti P Dandale, "Facial Recognition Technology: An analysis with scope in India", (IJCSIS) International Journal of Computer Science and Information Security, Vol. 8, No. 1, 2010.

[22] Dattatr V.Jadhao, Raghunath S.Holambe; "Feature Extraction and Dimensionality Reduction Using Radon and Fourier Transform with Application to Face Recognition", International Conference on Computational Intelligence and Multimedia Application 2007.

[23] Zhao, W., Chellappa, R., Phillips, P. J., and Rosenfeld, A., \Face recognition: A literature survey," ACM Comput. Survey. 35(4), 399{458 (2003).

[24] Veeramachaneni, K., Peram, T., Mohan, C., and Osadciw, L. A., \Optimization using particle swarm with near neighbourinteractions," in [GECCO 2003, Lecture Notes Computer Science, Springer Verlag], 2723/2003 (2003).

[25] Perez, C., \New algorithms generate improved templates for biometric recognition," (Apr 2007).

[26] Veeramachaneni, K., Osadciw, L., and Kamath, G., \Probabilistically driven particle swarms for discrete multi valued problems: Design and analysis," in [Proceedings of IEEE Swarm Intelligence Symposium], (April 1-5, 2007).

[27] Phillips, P. J., Moon, H., Rizvi, S. A., and Rauss, P. J., \The feret evaluation methodology for face-recognition algorithms," IEEE Trans. Pattern sAnal. Mach. Intel. 22(10), 1090{1104 (2000).

[28] Turk, M. and Pentland, A., Eigenfaces for recognition," Journal of Cognitive Neuroscience Vol.3(1),No. 71{86} ,1991.

[29] Martinez, A. M. and Kak, A. C., \PCA versus LDA," IEEE Transactions on Pattern Analysis and Machine Intelligence 23(2), 228{233 (2001).

[30] Lu, J., Plataniotis, K. N., and Venetsanopoulos, A. N., \Face recognition using LDA-based algorithms," IEEE Trans. on Neural Networks Vol.14, No.195 ,January 2003.

[31] Alec Banks, et al. "A review of particle swarm optimization. Part II: hybridization, combinatorial, multi criteria and constrained optimization, and indicative applications", Nat Compute (2008) 7:109-124, DOI 10.1007/s11047-007-9050-z.