Research and Applications of Optimal Face Recognition System

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ABSTRACT
Face recognition is one of the most significant achievements in human vision. It has emerged that eigenface, neural network, graph matching, hidden markov model, geometrical feature matching ,template matching, 3D morphable model , line edge map (LEM) , support vector machine (SVM) ,multiple classifier systems (MCSs) are fashionable techniques of face recognition. Till date, all existing techniques could not provide satisfactory results. In this view, paper is presented a new system OFRS (Optimal Face Recognition System).This system can be find optimal accuracy of face recognition. The system is based on PCA-SVM (Principle component analysis-Support Vector Machine) combinations. It is used preprocessing, feature extraction, classification, optimization, techniques in the best way. Since, "PCA-SVM combination" suffers from the limitation of scalability. Hence, IPCA (Incremental PCA) is proposed to be used, for the first time with this combination, as feature selection strategy to overcome scalability problem. GA (Genetic Algorithm) is proposed to be used, for the first time, as optimization of SVM kernel for face recognition .At last, paper describes impact of proposed system in academic as well as industry.

Keywords: PCA, SVM, MCS, OFRS, Face recognition

1. INTRODUCTION

Human face recognition has fabulous potential in a wide range of commercial, law enforcement, smart interaction, wearable recognition systems, and robotics applications. Its extensive applications are encouraging and inspiring further research. This research proposal focuses on face recognition. Significant research in the last decade has been dedicated to the problem of face recognition. Even if various techniques work well in constrained environments, it is still an open and very challenging task in terms of finding real applications. To explain this area further, the following subsections provide an overview of the face recognition process and face recognition techniques.

1.1 Face Recognition Process

Human have been using physical features to recognize each other for thousands of years. Physical features include face, voice, and gait. With the advancement in face recognition knowledge, biometric has become an emerging technology for recognizing individuals. Biometric [1] is an automated recognition system of individuals, which is based on physiological or behavioural characteristics. The biometric system includes recognition of fingerprint, face, iris, retina, hand geometry, voice, signature, etc. Biometric has been applied mainly in three areas, that is, commercial, government, and forensics. Some of examples of commercial applications are: credit cards, cellular phones, ATMs, medical records management, e-commerce, electronic data security, and network logins. Some examples of government sectors are: PAN card, driving license, passport control, border control, and social security. Some examples of forensic are: corpse identification, criminal investigation, terrorist identification, parenthood determination, and missing children. Thus, it is clear that face recognition has been used to a greater extent in recent years, and much emphasis is being placed on further research and innovativeness. Face recognition refers to an automated or semi automated process of matching facial images. Commonly, 2D face recognition is used by majority of people because it is easier and less expensive than 3D. There are three steps in the face recognition process [2][3]: detection, feature extraction, and classification. First, the process of converting optical faces into digital faces is called face detection. Second, the process of extracting the attributes from facial images is called feature extraction. Third, the process of arranging data in groups or classes according to similar characteristics is called classification. However, completing these steps is not that easy. There are few challenges for any biometric face recognition systems [4]: (1) During identification, the system has to operate with a large dataset and must identify a match quickly, (2) An identification system needs an efficient searching and matching algorithm, and (3) The number of false-positives in the system should be fewer as the size of the database increases.

1.2. Face Recognition Techniques

Many techniques of face recognition [5] are popular like eigenface, neural network, elastic bunch graph matching (EBGM), geometrical feature matching, template image, 3D morphable models, line edge map, multiple classifier system (MCS) and Support vector machine (SVM)

Nowadays, based on latest research survey [6], face recognition has emerged that combining PCA and SVM may be one of the most potential strategies to yield better results. PCA[7][8] is an orthogonal transform that transform the data to a new coordinate system such that greatest variance by any projection of the data comes to lie on the first coordinate, the second greatest variances on the second coordinate and so on. It is one of the most popular representation methods for face recognition. It does not only reduce the image dimension but also provide a compact feature for representation a face image. Usually PCA is performed in batch mode. It means that all training data have to be ready for calculating the PCA projection matrix training state. This learning stops once the training data have been fully processed. If we want to additional training data into an existing PCA projection matrix, the matrix has to be retrained with all training data. In turn, it is hard to scale up the developed system. SVM [9][10] is based on the idea of optimal hyperplane of linear separateability The basic thought of the SVM could be generalized as fallowing : At first transform the input space to a high dimensional space by non linear transform, then we work out the optimal classify hyperplane in the new space ,While the non linear transformation is achieved by defining a proper kernel function .

Problem: It may be summarized in brief, that several face recognition techniques are being used at present. However, PCA techniques in general (along with its variances like KPCA, 2DPCA, Fuzzy PCA) used for feature extraction, is associated

with the problem of scalability.SVM (along with its variances like Fuzzy, proximal) is used for classification. However, it is more advantageous in the sense that it may work on less number of input features and gives better results, in comparison to ANN, where more data is required [28]. It is also well known that SVM works on the basis of several kernels like linear, polynomial, radial etc. However, to decide which kernel is the best suited for a particular case, is a difficult proposition. In view of the above, there is a need to review old model and propose new model of algorithm, if PCA and SVM may be used in combination for face recognition, due to its potential to yield better results.

2. OLD MODEL AND ALGORITHM OF SVM WITH PCA

The survey [6] and research papers 11][12][13][14][15][16][17][18] have appeared face recognition system using PCA and SVM . The given below Figure [1], shows a model, which is using the combining effect of PCA and SVM to find good performance of face recognition system.

Algorithm:

It may be summarize in the following major steps

1. Use PCA algorithm for feature selection, in both training and test phases
2. After achieving low dimension features from step 2 ,fed it into SVM as kernel classifier in both training and test phases
3. Calculate Accuracy of recognition.
4. Compare and analysis the results.

3. PROPOSED MODEL AND ALGORITHM

Numerous researches are still going on to improvement in accuracy and speed of detection, for face recognition. Yet, there is no ideal methods exists which can give satisfactory results. In respect accuracy of face recognition system, made a need to propose a new model "Optimal Face Recognition System". The performance of face recognition system, combination of PCA and SVM is dependent upon two parameters, firstly, how to choose the optimal feature and, secondly, how to set the best kernel. Therefore, it may be said that the performance of any face recognition system depends upon preprocessing, feature extraction, classification and optimization steps of recognition system. OFRS tries to combine best possible technique of each step.

This proposal is the best represented by Figure [2]. This proposed work can be divided into two phases namely training and testing. According to training phase proposal, first, apply histogram equalization for better feature selection as preprocessor, on training database. Second, extract features from data by using IPCA (Incremental PCA). IPCA will be overcome scalability limitations of a face recognition System. Basically existing IPCA [19][20] algorithm can divide into two categories. The first category computes the principle component without computing the covariance matrix. The second category of IPCA algorithm, reconstruct the significant principle component from the original training images, and a newly added sample. When a new sample is added, the dimension of the subspace is increased by one. The updated eigen space is obtained by using low dimensional coefficient vectors of the original images. The reason is that the coefficient vectors and reconstructed images are only representation in different coordinate frames. Since, the dimension of the eigen space is small; therefore this approach is computationally efficient. So, this proposal will use the second approach for extract features from data.

After achieving, the low dimensional features from feature IPCA, features will be fed into kernel Classifier, named SVM. It was originally designed for binary classification. Since, face recognition is a multi class classification problem. Therefore, SVM has two basic methods for face recognition, known as one against one and one against all respectively. The one against one method is classification between each pair classes. The one against all is classification between each class and all rest class. In this proposal, the one against all methods will be used for recognition.

At this instant, follow also all these steps of training phase like preprocessing, feature selection and classification, to the completion of testing phase.

Now, use genetic algorithm (GA) as optimizer to optimize the SVM parameter for face recognition. Many research have studied optimization using GA[21][22] for text recognition in three ways first; some studied have tried to optimize the kernel function and its parameters, Second; is "feature subset selection", it is methods that uses only a small subset of feature that prove to be relevant to the target concepts. In most classification problem, the selection of an appropriate features subset is important because it enhances classification performance by characterizing each sample more accurately, and it also reduces computation requirements. Thus, many researchers have tried to optimize the input feature of SVM by using GA. The final approach is "Simultaneous optimization of kernel parameters and feature subset selection ".This proposal will use first approach to optimize kernel only. Since, GA uses to optimize SVM parameters; therefore, it may be enhancing the convergence rate and classification accuracy.

Algorithm:

It may be summarize in the following major steps

5. Apply histogram equalization as preprocessor for better feature selection in both training and test phases
6. Use IPCA algorithm for feature selection which makes system scalable, in both training and test phases
7. After achieving low dimension features from step 2 ,fed it into SVM as kernel classifier in both training and test phases
8. Optimize the kernel parameters of SVM using genetic algorithm as optimizer
9. Calculate Accuracy of recognition.
10. Compare and analysis the results.

The proposed work has following innovative features:

a. Researchers, till date, have not used all steps of face recognition process in best and synchronized manner. However, these, all the 4 steps viz preprocessing, feature extraction, classification and optimization are proposed to be used.

b. "PCA-SVM combination" suffers from the limitation of scalability.

c. Hence, IPCA (Incremental PCA) is proposed to be used, for the first time, as feature selection strategy to overcome the above.

d. GA (Genetic Algorithm) is proposed to be used, for the first time, as optimization of SVM Kernel for face recognition.

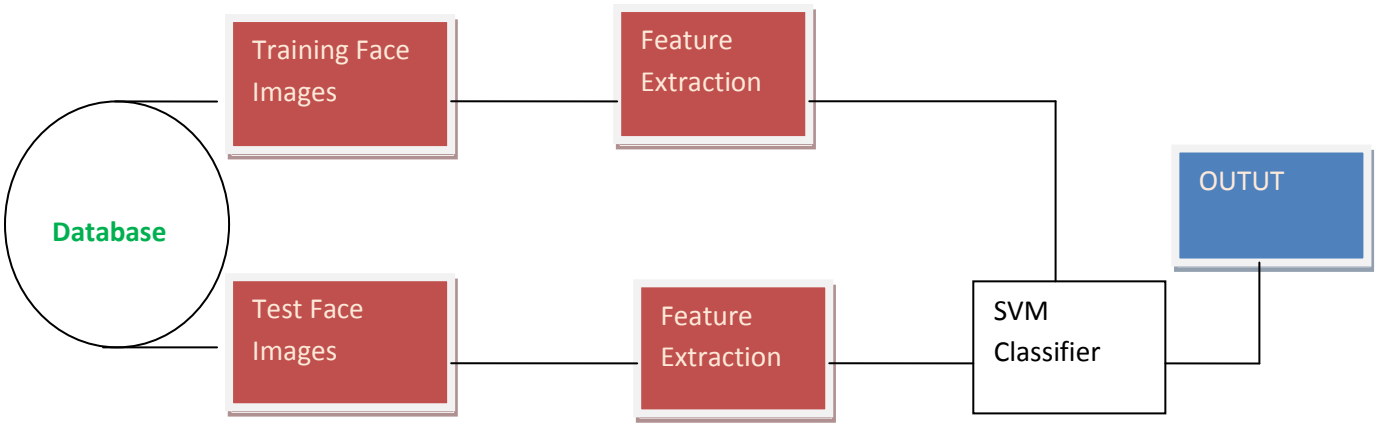

Figure [1]: Old model of combining PCA and SVM

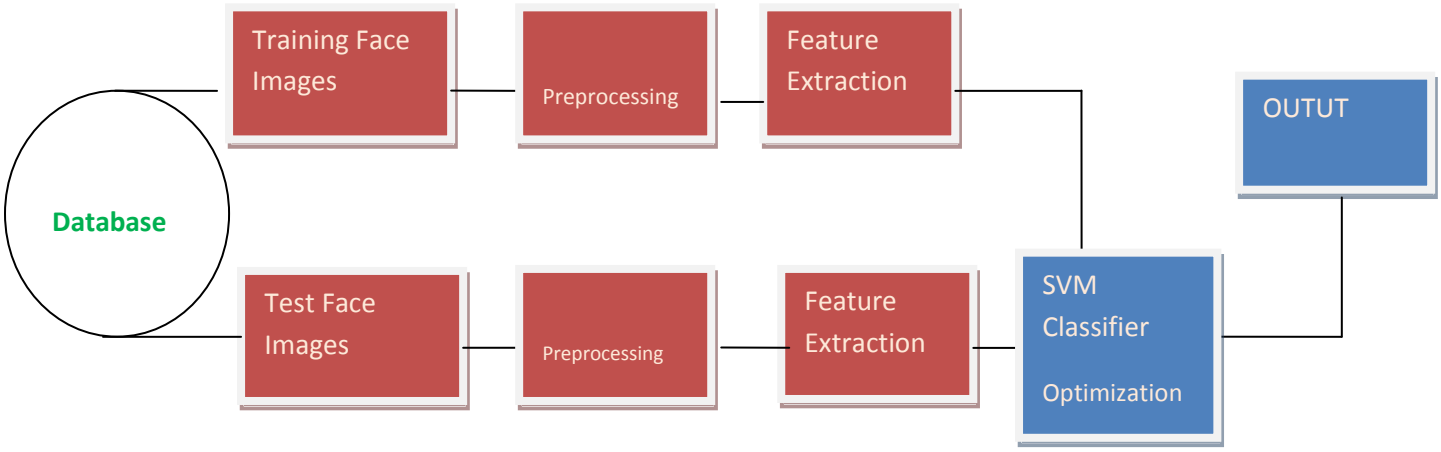

Figure [2]: Proposed model of combining PCA and SVM

4. DISCUSSION

This research design OFRS model.OFRS includes all steps of face recognition system except detection, because of easily availability of standard databases, Authors claimed that all the techniques which are using this model, is synchronized and to obtained the best performance of system. Therefore, it is need to discuss individual performance of each step.

Histogram equalization technique (HE) has been proposed here, as preprocessor. HE technique is one which has equal number of pixel in all its gray levels. It means a perfect image can be obtained after applying this technique. This will be useful to extract good feature from image.Many PCA based face recognition system have also been developed in the last decades. However, existing PCA based face recognition system are hard to scale up because of computational cost and memory requirement system. To overcome this limitation an incremental approach usually adopted. Incremental PCA method has been studied for many years in machine learning community.

SVM will be used as classifier in proposed system. It a learning technique that is considered an effective method for general purpose pattern recognition because of its high generalization performance without the need to add other knowledge [17]. Intuitively, given a set of points belonging to two classes, a SVM finds the hyperplane that separates the largest possible fraction of points of the same class on the same side, while maximizing the distance from either class to the hyperplane. According to [17], this hyperplane is called optimal separating hyperplane (OSH) which minimizes the risk of misclassifying not only the examples in the training set but also the unseen example of the test set. SVM can also be viewed as a way to train polynomial neural networks or Radial Basis function classifiers. The training techniques used here are based on the principle of structure risk minimization (SRM), which states that better generalization capabilities are achieved through a minimization of the bound on the

generalization error. Indeed, this learning technique is just equivalent to solving a linearly constrained quadratic programming (QP) problem. In summary, the main characteristics of SVMs are: (1) that they minimize a formally proven upper bound on the generalization error; (2) that they work on high-dimensional feature spaces by means of a dual formulation in terms of kernels; (3) that the prediction is based on hyperplanes in these feature spaces, which may correspond to quite involved classification criteria on the input data; and (4) that outliers in the training data set can be handled by means of soft margins.

Many optimization techniques have been developed but genetic algorithm differ from other optimization and search procedure in following way [23]

- Sometimes near optimal solutions that can be generated quickly, using GA are more desirable than optimal solutions which require a large amount of time.\
- GA work with a coding of the parameter set not the parameters themselves. Therefore they, can easily handled or discrete variables.
- GA can provide globally optimal solution.
- GA use only objective function information, not derivations or other auxiliary knowledge, Therefore, the can deal with the non smooth, non-continuous and non differential function.
- GA use probabilistic transition rules, not deterministic rules.

Consequently, HE gives a perfect picture. PCA is applicable as feature extractor on different lighting, pose and illumination conditions. This technique reduces a large number of features into small number of features. Therefore, it may be more able to reduce the complexity of system comparatively other techniques. As for as classification is concerned, SVM is a strong classifier because it works less number of parameters compare than neural network and others.SVM is an effective method to solve structural risk minimization and get best compromise between learning accuracy and learning ability, under the finite sample circumstances, with a view to achieve the generalization performance. Consequently, SVM with PCA combination for face recognition may have greater strength compare than others. GA use probabilistic transition rules, not deterministic rules. Hence, the discussion finds that all best steps are combining here which may increase the performance of face recognition system. This system can be say optimal face recognition system.

4.1. Performance assessment:

Recognition performance has many measurements standards. The most important and popular formula are given below.

Recognition rate= (the number of recognized images ÷ the number of testing image)

Run time= (run for all testing images ÷ the number of testing image)

Error rate= total images÷ total not recognized images.

Accuracy rate= ((total recognized images- total not recognized image) ÷total number of images))*100

5. IMPACT OF PROPOSED RESEARCH IN INDUSTRY AND ACADEMIC

Impact of proposed research work in industry and academic can be observed easily by discussing its wide are of applications and its future work.

5.1 Applications

Proposed work may be use in face recognition system of different categorized area. It includes entertainment, Information security, Law enforcement and surveillance, Smart environment, Commercial, Government application and wearable recognition system

- Entertainment

It contains video game, virtual reality, Training Program, human robot interaction and human computer interaction etc.

- Information security

It includes application security, database security, file encryption, intranet security, internet access, medical records, secure trading terminal and etc

- Law enforcement and surveillance

It covers advance video surveillance, CCTV camera, Portal control, burglary, Suspect tracking and investigation etc

- Smart environment

Today's, researchers are building smart environments (i.e. visual, audio, and hap tic interfaces to environments such as rooms, cars, and office desks). In these applications a key goal is usually to give machines perceptual abilities that allow them to function naturally with people to recognize the people and remember their preferences and peculiarities, to know what they are looking at, and to interpret their words, gestures, and unconscious cues such as vocal prosody and body language. Researchers are using these perceptually aware devices to explore applications in health care, entertainment, and collaborative work. Recognition of facial expression is an important example of how face recognition interacts with other smart environment capabilities..

- Commercial

It includes, day care, missing children/runaways, gamming Industry, residential security, Internet, E- Commerce, health care, benefits Payments and banking.

- Government application

It consists of UID cards, smarts cards, Voter ID cards, driving license. Passport, personal device log on, office automation, employee attendance, migration, legislature correctional institution /Prisons etc.

- Wearable recognition system

When build computers, cameras, microphones and other sensors into a person's clothes, the computer's view moves from a passive third-person to an active first-person vantage point These wearable devices are able to adapt to a specific user and to be more intimately and actively involved in the user's activities Face recognition is an integral part of wearable systems like memory aides, remembrance agents, and context-aware systems. Thus there is a need for many future recognition systems to be integrated with the user's clothing and accessories. For instance, if you build a camera into your eyeglasses, then face recognition software can help you remember the name of the person you are looking at by whispering their name in your ear.

- Robotics and controls

Robotic teams also called multi robot system. Face recognition system may be most popular application in robotics and controls. It may be increased recognition power of robots, which may help to increase the functionality, power and knowing behaviors of others.

So, it may be concluded that proposed system have significant impact, which will extendable and practicable.

5.2 Future work

In near future, may be improve recognition system by using proposed algorithm. The proposed system framework is scalable, that is, other face recognition module can be easily added into this framework. When number of training sample is not enough, judgment accuracy will not affect as in the case of neural network approaches. Since, SVM will be use, therefore, it adopts structure risk minimization principle which avoid local minimum and effective solves the over learning and assures good generalization ability and better classification accuracy. Future work may consider other incremental PCA algorithms and different database. Beside future work may include study of the effect of number of training images on recognition rate. The processing time for various strategies may also be compared. Other popular approaches may also be considered for incremental study and combining with SVM with optimizer GA.

6. REFERENCES

[1] Anil K. Jain, Sarat C. Dass and Karthik Nandakumar, "Can soft biometric traits assist user recognition? " , Proceedings of SPIE, 2004, Volume 5404, pp: 561-572

[2] W. Zhao Sarnoff Corporation, Princeton, NJ R. Chellappa, " Face recognition: A literature survey", ACM computing surveys (CSUR) , 2003,Volume 35 , pp: 399-458

[3] Elham Bagherian, Rahmita Wirza O.K. Rahmit," Facial feature extraction for face recognition: a review ", IEEE, 2008, pp: 1-9

[4] Surya Prakash, Devdatt and Phalguni Gupta U. Jayaraman, "An Indexing Technique for Biometric Database," IEEE, 2008, pp: 758-761

[5] A. S. Tolba, A.H. El-Baz, and A.A. El- Harby,"Face Recognition: A Literature Review" International Journal of Information and Communication Engineering, 2006, Volume 2, pp: 88-103

[6] Rakesh Kumar Yadav, A.K Sachan, D.Rai,"Sate of art in kernel classifier SVM with PCA for face recognition", Journal of computer Egineering ", 2012, Volume 3, Isuue1, pp: 6-16

[7] M. Turk, and A. Pentland, "Ejgenfaces for Recognition," Journal of Cognitive Neuroscience, 1991, Volume. 3, Number 1, 1991, pp: 71-86,

[8] Rakesh Kumar Yadav,Abhishek k Mishra,Naveen Prakash, Himnashu Sharma,"Princilple component analysis from multiple data representation", International journal of computer and network security, 2010, Volume 2, Number 5, pp: 8-10

[9] N.Gistiane and J Taylar, "An introduction to support Vector machine and other Kernel based Learning Methods", Cambridge university, Press, 2000

[10] C.Cortes and V.Vapnik. "Support vector networks", Machine Learning, 1995, pp: 273–297

[11] Kebin Cui; Feng Han; Ping Wang ,"Research on Face Recognition Based on Boolean Kernel SVM ", Fourth International Conference on Natural Computation, IEEE,2008 Volume: 2, pp: 148 - 152

[12] Jianke Li; Baojun Zhao; Hui Zhang; Jichao Jiao ,"Face Recognition System Using SVM Classifier and Feature Extraction by PCA and LDA Combination", in proceeding of IEEE conferences on International Conference on ,2009 , pp: 1 – 4

[13] Faruqe, M.O.; Al Mehedi Hasan, M .,"Face recognition using PCA and SVM "in proceeding of IEEE conferences on 3rd International Conference on Anti-counterfeiting, Security, and Identification in Communication, 2009, pp: 97 - 101

[14] Zhao Lihong; Song Ying; Zhu Yushi; Zhang Cheng; Zheng Yi,"Face recognition based on multi-class SVM ",in proceeding of IEEE conferences on International Conference on Control and Decision Conference, 2009, pp: 5871 - 5873

[15] Sani, M.M.; Ishak, K.A.; Samad, S.A ,"Evaluation of face recognition system using Support Vector Machine ",IEEE Student Conference on Research and Development (SCOReD), 2009 ,pp: 139 - 141

[16] Ivanna K. Timotius, Iwan Setyawan, and Andreas A. Febrianto," Face Recognition between Two Person using Kernel Principal Component Analysis and Support Vector Machines",International Journal on Electrical Engineering and Informatics - Volume 2, Number 1, 2010 ,pp: 53-61

[17] Len Bui; Dat Tran; Xu Huang; Chetty, G ,"Face Gender Recognition Based on 2D Principal Component Analysis and Support Vector Machine", 4th International Conference on Network and System Security (NSS),IEEE, 2010, pp:579 - 582

[18] Chengliang Wang; Libin Lan; Yuwei Zhang; Minjie Gu; "Face Recognition Based on Principle Component Analysis and Support Vector Machine", 3rd International Workshop on Intelligent Systems and Applications (ISA), IEEE, 2011, pp:1-4

[19] Hatim A.Aboalsamh,Hassan I. Mathkour,Ghazy M..R.Assassa and Mona,M.Mursi, "Face recognition using Incremental Principle Components Analysis", 2009, IEEE, pp:39-43

[20] HaitaoZhao,Pong Chi Yuen,James T Kwork and Jingyu Yang , "incremental PCA Based Face recognition", IEEE ,2004, Volume 1, pp: 687- 691.

[21] Meijuan Gao, Jingwen Tian, Shiru Zhou;, "Research of web Classification Mining Based on Classify Support vector Machine", CCCCM 2009,IEEE, pp: 21-24

[22] Cheng-leing huang, Chieh-jen wang, "A GA based feature selection and parameters optimization for support vector machine", Expert system and applications, Elsevier, 2006, pp: 231-240

[23] Goldberg, David E. (1989)," Genetic Algorithms in Search Optimization and Machine Learning", Addison Wesley, Pp 41, ISBN 0201157675