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Expansion in Kernel PCA Approach for Face Recognition

Asst. Prof. Ritu Nagila, Asst. Prof. Ashish Nagila
Dept. of SCSA Dept. of CSE
IFTM University, U.P.,India
ritu.upadhayay01@gmail.com, ashishnagila01@gmail.com

***Abstract*- Principle component analysis (PCA) technique is most populating technique of statistics in field of face recognition. Today, numerous extension of PCA is exiting like improved PCA, Fuzzy PCA, Incremental PCA, and Kernel PCA. Kernel PCA (KPCA) is most popular techniques in face recognition in non liner categories. Till date not desirable extensions are accessible. This paper is proposed a novel approach of KPCA. Experiments have been done on ORL database. Proposed method obtained highest recognition rate as 98.6%.**

***Keywords*- PCA, KPCA, Modular PCA, Face recognition.**

I. INTRODUCTION

Traditional PCA allows linear dimensionalit [1] reduction. However, image data has more complicated structures, which cannot be simplified in a linear sub-space. Since, PCA Performs very well in reducing the dimensionality of the data. However, the performance of PCA method (or other linear methods) is not completely satisfactory for problems with high nonlinearity, such as face recognition.

Fortunately,KPCA allows us to generalize traditional PCA to nonlinear dimensionality reduction. The basic idea is[2] to first map the input space into a feature space via nonlinear mapping and then compute the principal components in that feature space. By using a nonlinear kernel function, a dimensional reduction (i.e., nonlinear projection) is performed.

II. LITERATURE SURVEY

In reference [3, 2001], PCA and fisher linear discriminate methods (FLD) was demonstrated in face detection, recognition and tracking. The representation in these subspace methods was based on second statistics of the image set, and does not address higher order statistical dependencies such as the relationships among three or more pixels. Authors was investigated the use of KPCA and kernel FLD for learning low dimensional representations for face recognition. Experimental result was showed that kernel methods achieved lower rates for face recognition.

Paper [4, 2011] was applied KPCA to construct a reduced order stochastic input model for the material property variation in heterogeneous media.KPCA can be considered as a nonlinear version of PCA. Through use of kernel functions, KPCA further enables the preservation of higher-order statistics of the random field, instead of just two-point statistics as in the standard Karhunen–Loève (K–L) expansion. Thus, this method can model non Gaussian, non-stationary random fields. This paper was also proposed a new approach to solve the pre-image problem involved in KPCA. Moreover, polynomial chaos (PC) expansion was used to represent the random coefficients in KPCA which provided a parametric stochastic input model. Thus, realizations, which were statistically consistent with the experimental data, can be generated in an efficient way.

Paper [1 ,2012], firstly talk about the basic ideas of PCA and kernel PCA, and then focus on the reconstruction of pre-images for kernel PCA.This also given an introduction on how PCA is used in active shape models (ASMs), and discussed how KPCA can be applied to improve traditional ASMs. Experiment results were comparing the performance of kernel PCA and traditional PCA for pattern classification. It also finds that KPCA is much better than traditional PCA

A face recognition algorithm based on modular PCA approach was presented in reference [5, 2004]. In this, the face images were divided into smaller sub-images and the PCA approach was applied to each of these sub-images. Since some of the local facial features of an individual do not vary even when the pose, lighting direction and facial expression vary. The accuracy of PCA method and modular PCA method were evaluated under the conditions of varying expression, illumination and pose using standard face databases. Finally, Authors are presented the proposed method to be able to cope with these variations.

In [6 2012] face recognition was done using two feature extraction techniques PCA and MPCA (Modular Principal Component Analysis). PCA is a linear projection method in which dimensionality reduction is applied to the

original image space. MPCA is an improved version of PCA in which each image is divided into number of sub-block image and then PCA is applied for each sub-block image. The experimental result was showed that the accuracy of PCA is les than MPCA for different database images. However, this paper was not attempt KPCA technique. This is author's opinion that it may be used. Paper also motivated that any researcher's may be used any other extension version of PCA or MPCA.

Therefore, the PCA is one of the most successful methods that have been used to recognize faces in images. However, high computational cost and dimensionality is a major problem of this technique. There is evidence that PCA can outperform over many other techniques when the size of the database is small. Existing face recognition system using Kernel PCA has the limitations of low accuracy and more space complexity. Using Improved Kernel PCA this limitation can be removed which will make face recognition system more accurate and less space occupied.

The work is organized as follows. In Section III Exiting Algorithm of PCA and KPCA are presented. In Section IV, define applied approach and algorithm of proposed works in mentioned. Experiments and the obtained results are analyzed and discussed ion section V. Finally, in Section Vi some concluding remarks are presented

III. EXITING ALGORITHM OF PCA AND KPCA

Subsequent to technical study it requires to review of existing algorithm.

1. PCA Algorithm:

- Choose the database.
- Subtract the mean from all the data points.
- Compute the covariance matrix.
- Diagonalize the covariance matrix to get its eigen values and eigen vectors.
- Retain eigen vectors corresponding to the largest eigen values such that equals the desired variance to be captured.
- Project the data points on the eigenvectors.
- Recognize the faces.
- This step calculates weights for both train and test set. The Euclidean distance is used by calculating the difference in weights.

  A threshold value should be set for recognition. If the Euclidean distance is equal to the threshold value, then it is known image having same expression. If it is less than the threshold value, then it is known image having different expression. If it is greater than the threshold value, then it is unknown image which is not recognized.

2. Kernel PCA Algorithm:

- Choose the database.
- Given N data points in d dimensions-
  let X={x1|x2|..|xN} where each column represents one data point.
- Subtract the mean from all the data points.
- Choose an appropriate kernel k.
- Form the NxN Gram matrix-
  K|ij=[k(xi,xj)}
- Form the modified Gram matrix:
  Where 1NxN is an NxN matrix with all entries equal to 1
- Diagonalize K to get its eigenvalues ln and its eigen vectors an
- Normalize an a_n $\leftarrow a_n / \sqrt{\lambda_n}$
- Retain c eigenvectors corresponding to c largest eigenvalues such that

$$\sum_{j=1}^{C} \lambda_j \; / \sum_{j=1}^{N} \lambda_j$$

  Equals desired variance to be captured.
- Project the data points on the eigenvectors.
- Recognize the faces.

IV. APPLIED NEW APPROACH

To address Variations problems like head pose, illumination and facial expression of face invariant recognition the MPCA technique was proposed by Gottumukkal and Asari [5].In MPCA, initially the face images are partitioned into N number of sub-block images and then apply steps of PCA for each and every sub-block image by using local information of the face. Here the first sub-image of test image is taken initially and compared with all the images in the database. The images matched with this first sub-image are selected.

Again, the second sub-image is checked with this set of selected images and then the matched images are found. Further, the third sub-image is compared with the previous set of selected images and the same procedure is applied to find the recognized image. Finally the last sub-image is also compared and the image is recognized. If it got rejected in the first step, then the image is considered as not recognized. MPCA overcomes the problems of PCA under the varying conditions of pose variations, facial expressions, and illumination changes. So it expects that the accuracy rate will be better for Modular PCA. Finally, our proposed approach is the combination of MPCA and KPCA.Therefore, the modified algorithm will be slightly changed.

1. Proposed algorithm

The Algorithmic steps followed in the training procedure are listed below:

1.1 Choose the database.
1.2 Divide into sub blocks.
1.3 Apply KPCA on each sub blocks:
- calculate eigen vector and eigen values.
- Retain eigen vectors corresponding to the largest eigen values.

1.4 Project the data points on the eigen vectors.
1.5 Recognize the faces.

In Figure 1 the block diagram of our proposed method is shown;

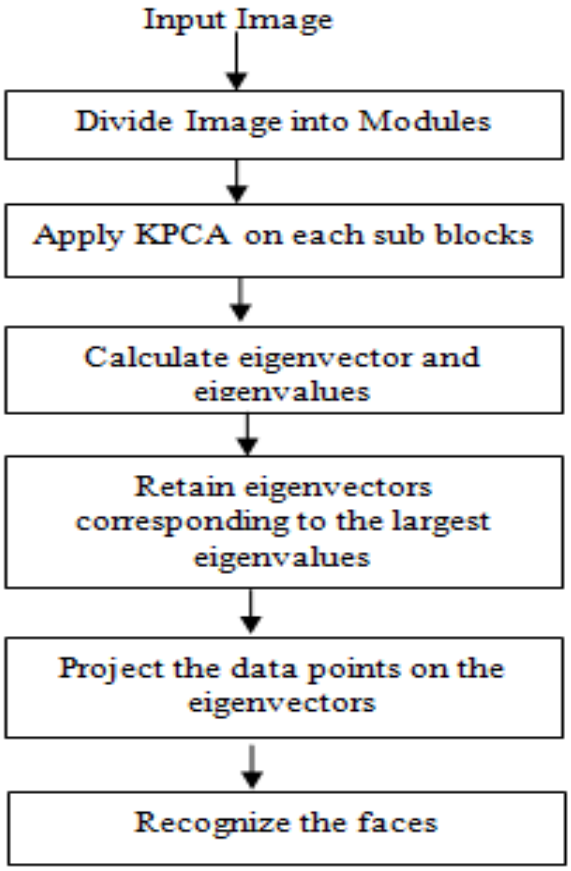

Fig 1. Block diagram for face recognition technique using modular technique.

V. EXPERIMENTS & RESULTS ANALYSIS

ORL database is elected for doing the experiments because it covers a wide range of possible variations in face image. MATLAB is used as platform. To analyze the performance of the proposed KPCA, Two experiments are performed on image databases:

1. The performances of experiments are presented in Table1 in the terms of training time testing time and recognition rate.

Table 1. Prformence of KPCA.

Algorithm Parameters	Proposed KPCA (1)	Proposed KPCA (2)
Training Time (sec.)	15.7845	17.1245
Testing Time (sec.)	8.0861	9.5811
Total Time (sec.)	20.677878	26.7051
Recognition Rate (%)	98.6	94.6

According to reference [8] experiments were performed using the first five images of each individual for training and the rest images for testing. Thus, the total number of the training samples and testing samples were both 200. Reference is presented comparison of CPU time and top recognition rate on ORL database as in Table 2.

Table 2. Comparison of CPU time and top recognition rate of different algorithm on ORL face database.

Algorithm	PCA	KPCA
Training Time (sec.)	4.3238	12.7118
Testing Time (sec.)	0.8031	6.6778
Total Time (sec.)	5.1269	19.3896
Recognition Rate (%)	87.5	89

Comparison of Table 1 and 2 show that recognition rate is high of proposed methodology but total time (training and testing is increased. So, in future we may decrease this time using some other approaches.

VI. CONCLUSION AND FUTURE WORK

We have applied a face recognition method of modified KPCA on the ORL face database. Proposed method obtained highest recognition rate as 98.6%. According to author's view, it may also be improved using some other approach to reduce the time of training and testing phase.

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