Performance Evaluation of Face Recognition using LBP, PCA and SVM

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Abstract*—Face recognition is the simplest person identification method. Face has been has been chosen as modality for person identification owning to its simplicity in implementation as well as being a non-invasive method in achieving results. Besides its popularity, face recognition still faces issues on its accuracy. It has been observed that while using principal component analysis on varying ambient illumination, recognition accuracy reduces whereas using local binary pattern gives 100% accuracy. For classification, support vector machine is adopted as classifier. The system utilises Yaledatabase and ORL database for experimental results.*

Keyword— *Face Recognition, Local Binary Pattern, Support Vector Machine, Principal Component Analysis*

I. INTRODUCTION

Face recognition is a process in which a person is verified or identified from a digital image or a video frame. It is a popular method for person identification due to its non-invasive characteristic and giving acceptable recognition accuracy. Face recognition is an interesting and challenging problem, and impacts important applications in many areas such as identification for law enforcement, authentication for banking and security system access, and personal identification among others[1].Face recognition, on the other hand, still faces many issue on its recognition accuracy due to environmental condition, especially ambient illumination[2].

Face recognition methods can be classified as structure based and appearance based. In structured based [3] set of geometric facial features such as eyes, nose, mouth corners is extracted; the position of different facial features is the feature vector as the input to a structural classifier to identify the person.In appearance based method, appearance of face is input to decision making and they can be further categorized as holistic and component based. The holistic appearance methods operate on the global properties of face image.

Aface recognition system can be broke down into following stages that is face detection and determining the region of interest, feature extraction where the unique features of the face are extracted which is compared with the images from the database. This is done in the classification phase [9]. The output of the classification part is the identity of a face image from the database with the highest matching score.

The remaining paper is organized as follows. Section II discusses the related work, III describes implementation. Section IV shows the simulation results and section V is the conclusion followed by Acknowledgement and References.

II. RELATED WORK

In [2] author achieved better recognition rate by doing pre-processing before the face detection. The author utilised contrast limiting adaptive histogram equalisation which improves the detection rate on various illumination condition. They achieved higher recognition accuracy by using LBP on different pose and small number of data set.In [3] the authors investigated LBP and its variants and different databases such as JAFFE female database, CMU-PIE and FRGC version2 where centre symmetric local binary pattern gives better accuracy results. In [5] the author investigates recognition of human faces in a meeting room. They conclude that Dynamic Space Warping approach outperforms eigenface approach in terms of low input quality of image, occlusion and illumination. In [6] the author has tackled the face detection tracking using both audio and visual information, they have utilised support vector machine for classification on the challenging AV16.3 dataset. In [7] the authors have performed face recognition using PCA and SVM to achieve better recognition they used wavelet transform for pre-processing which gave better recognition results compared to only using PCA. In [8] the author performed combination between two methods (LBP and FLD) is proposed to deal with and overcome the problem of single sample per person that most of face recognition systems faces.

SVM is utilised giving good separated solutions. Their experimental results on the Yale database shows the effectiveness of proposed method where the recognition rate reaches to 92.6667%. In [13] the authors have reviewed the various nuances of face detection and recognition.

III. IMPLEMENTATION

Face recognition can be implemented using various methods, in this paper, local binary pattern, principal component analysis and support vector machine are used.They are described as follows:

A. Local Binary Pattern

Local Binary Pattern (LBP) is a feature extraction method. This method was introduced in 1996 by Ojala et al. [4]. In this method an image is divided into several small regions from which the features are extracted. These features are comprises of binary patterns of neighbourhood of centred pixel of the region. Binary pattern is concatenated in a histogram forming the image representation. The LBP operator works with the eight neighbours of a pixel, using the value of centre pixel as a threshold. If a neighbour pixel has a higher gray value than the centre pixel (or the same gray value) then 1 is assigned to that pixel, else it gets a zero. The LBP code for the centre pixel is then produced by concatenating the eight ones or zeros to a binary code. Fig.1 illustrates the LBP operator on the region and its corresponding binary pattern.

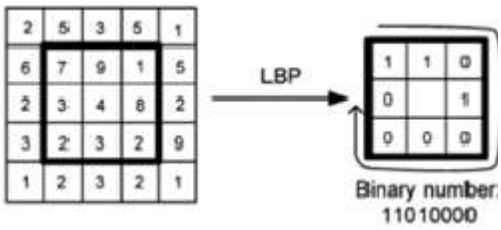

Fig. 1 Illustrationof LPB operator on a region and its Binary number

B. Principal Component Analysis

Principal Component Analysis(PCA), which is also known as Karhunen-Loeve expansion, is a classical feature extraction and data representation technique; it is widely used in the areas of pattern recognition and computer vision[9]. They argued that any face image could be reconstructed approximately as a weighted sum of a small collection of images which define a facial basis (eigenimages), and a mean image of the face. Turk and Pentland proposed the well-known Eigenfaces method for face recognition in 1991 in this context [10]. Since then, PCA has been widely utilised and has become one of the most common and successful approaches in face recognition. Principal component analysis is proposed by Turk and Pentland in 1991, which is often used for extracting features and dimension reduction [10]. In this paper, the PCA face recognition algorithm is used to extract the eigenvectors which is the features of the face images.

C. Support Vector Machine

Support Vector Machine was proposed by Vapnik and his co-workers [11] is a very effective method for general purpose pattern recognition. The method of SVM is based on Structural Risk Minimization which automatically searches the support vector which has the better characteristic capacity to the classification through studying the accurate information of division surface neighbourhood between categories [7]. A set of points belonging to two classes, a SVM finds the hyper plane 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 hyper plane. A classification can be based on binary-class however multi-class classification is also possible. A multi-class recognition system can be obtained by combining two classes SVMs. There are two methods for achieving the purpose. The first method is the one-against-all strategy to classify between each class and all the remaining; the second method is the one-against-one strategy to classify between each pair.

The face recognition system in this paper has been implemented on Matlab 2013b, and utilises Livsvm [12] for multi-class classification. We use the ORL and the Yale database. The ORL face database is composed of 10 different images of 40 distinct people in up-right, frontal position with tolerance for some tilting and rotation of up to 20 degrees. The size of each face image is 92 *pixel*×112*pixel.*Some images of the ORL and Yaledatabase are show in Fig.1.

Fig. 2 ORL database image of one person

The Yale database is consists of 11 different images of 15distinct people.In this paper 15 distinct subject having 10 images each are used for ORL as well as Yale database. The size of each face image is 320 *pixel*×243*pixel.* Each person has following images, one with glasses; three different illuminations: front light, right light and left light;seven invariantexpressions as shown in Fig. 2.

Fig. 3 Yale database image of one person

The following points describe the flow of process employed in our experimental program for the evaluation of face recognition.

1. The first step is data acquisition of training images; for this we select the images from database consisting of training images to be processed.
2. Face detection for each person in the database takes place using Viola-Jones algorithm followed by image resizing and cropping into 70×70 pixel image for the purpose of extracting only the face region.
3. The next step is to apply contrast limiting adaptive histogram equalisation. Once the images are pre-processed LBP and PCA are performed separately to extract features of training images. Feature vectors of each person are assigned a single label number or class. Here, we have 15 classes hence feature vectors of 15 persons are grouped into 15 classes.
4. After training, we select the test image and pre-process in the same manner as the training images. The feature vectors of test image are extracted.
5. For classification, the feature vectors of training images, testing images and class label are input to the SVM classifier which predicts the class of the test image.

IV. SIMULATION RESULTS

The accuracy for LBP+SVM method is shown Table. I. It tabulates the number of subject for each database, number of recognized images, number of unrecognized images and accuracy achieved.

TABLE I
ACCURACY for LBP+SVM METHOD

Database	Number of Subjects	Recognized images	Unrecognized images	Accuracy
Yale	15	15	15	100%
ORL	15	15	15	100%

In LBP+SVM, all images of both the database were recognised correctly. This method gives 100% accuracy for both; Yale as well as ORL database.

TABLE II
ACCURACY FOR PCA+SVM METHOD

Database	Number Of Subjects	Recognized images	Unrecognized images	Accuracy
Yale	15	13	2	86.67%
ORL	15	15	15	100%

While accuracy for PCA+SVM are shown in Table. II. It is to be noted that Yale database has images with high variation in ambient illumination as compared to ORL database which has homogeneous illumination for all persons. In this method, for Yale database, 2 images were recognised falsely. For ORL database all images were recognised.

The confusion matrix for LBP+SVM on Yaleand ORL database are illustrated in Fig. 4 and Fig. 5 respectively.The confusion has predicted class label on y-axis and actual class label on x-axis respectively. It is observed that predicted class label is same as the actual class label for LBP+SVM method for both; Yaleand ORL database.

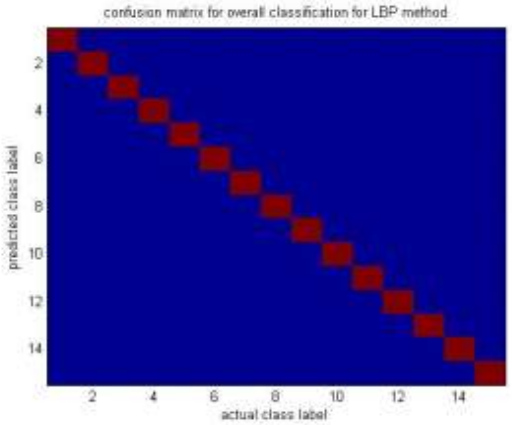

Fig. 4Confusion Matrix for LBP+SVM(Yale)

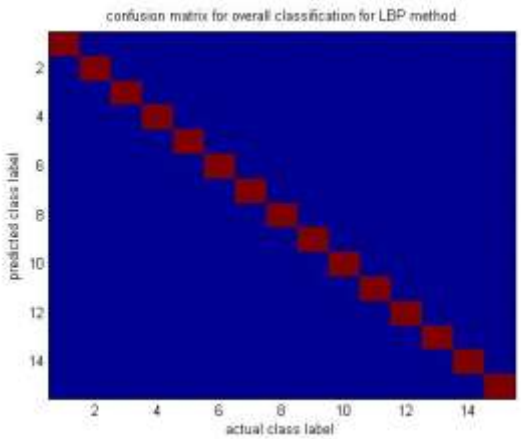

Fig. 5Confusion Matrix for LBP+SVM(ORL)

Fig. 6 and Fig. 7 illustrate the confusion matrix for PCA+SVM on Yaleand ORL database respectively. In PCA+SVM we observed that 13 predicted class label are predicted same as the actual class label while 2 predicted class label differ from actual class label indicating that the person is falsely recognized.

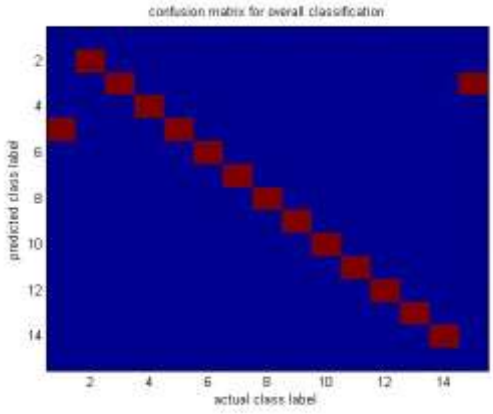

Fig. 6Confusion Matrix for PCA+SVM (Yale)

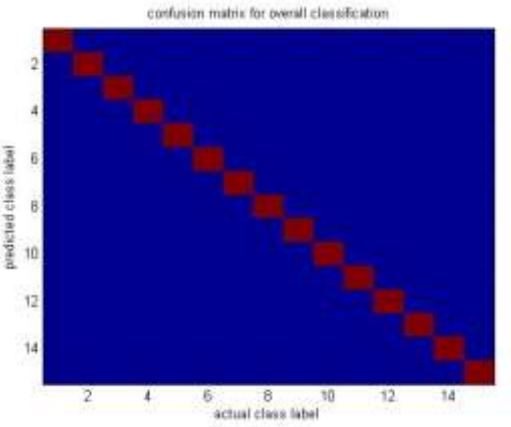

Fig. 7 Confusion Matrix for PCA+SVM (ORL)

V. CONCLUSION

In this paper, face recognition has been performed by extracting features by two different methods namely; Principal Component Analysis and Local Binary Pattern. Once the features are extracted they are applied to the SVM classifier. For face recognition the SVM classifier predicts the class label of the face image. PCA is the simplest method for face recognition but it gives low accuracy for Yaledatabase as it comprises of images having changing ambient illumination conditions and face occlusion, out of 15 persons 2 were recognised falsely. However, for ORL database, PCA+SVM give 100% accuracy. The face recognition using the LBP and SVM is proved to be reliable in the case of changing illumination and face occlusion giving accuracy of 100% with Yaledatabase as well as ORL database. For further work it is proposed that a real time face recognition system can be materialised which would overcome the issues of changing illumination, pose and expression variation, and facial occlusion. Also another modality such as voice can be combined with face to perform speaker recognition.

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