Face Recognition:A Template Based Approach

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Abstract—**In this paper, we proposed a template based face recognition approach. Here we compared our approach with the holistic feature based approach Principal Component Analysis (PCA). PCA is a statistical feature based approach works on Eigen space. PCA is a simple approach for face recognition of only frontal faces and proposed system is based on grey level template matching. To know the greatness of proposed system we have done experiment and compared with existing systems in a systematic way to check the performance of the systems. We observed that the correctness or efficiency of recognition rate using PCA is only about 70-75%, PCA was not able to recognize the faces if there is change in illumination, pose, in-plane rotation, noise etc.,. in the query input image. Where as for template matching we observed that got better results (more than or equal to 20%) than PCA, template matching recognition process can recognize the faces efficiently and invariant to all above factors.**

Keywords—face recognition; Prinicipal Component Analysis; Template based face recognition.

I. INTRODUCTION

Face recognition[7][10][12] has been widely used in biometric systems for personal identification in case of driver licenses, passports, human computer interaction, database retrieval, virtual reality, banking, law enforcement like investigation , personal security, home video surveillance system etc. Face identification or face recognition is an "automated matching method for knowing the identity of a person by comparing an input face with stored face database". Image acquisition, face detection and face recognition are the steps involved in face recognition process. Image acquisition is a process of capturing or acquiring the image from physical source like imaging hardware scanners, digital cameras, digital videos, faxed pictures etc and converting them into manageable image data. Face detection is a task of identifying and locating human faces in an image regardless of their location, scale, in plane rotation, orientation pose and illumination.

Face recognition techniques [7] [10] [12] can be divided into four categories. They are holistic approaches, feature based approaches, template based approaches, and Part based approaches. In holistic approach the complete face area is taken into consideration as an input data for face detection system. It performs some transformation on the input data to get a compact representation for face recognition. Principal Component Analysis (PCA) [8], Independent Component Analysis (ICA), Linear Discriminate Analysis (LDA) are some of the holistic approaches. Feature based methods exploit more information from image processing, computer vision and domain knowledge form human. They derive the features from facial features points or the whole face and compare these features for recognition. Gabor wavelet feature, local binary pattern are some of the feature based methods. Template based methods compare the input image against a set of stored templates of the faces. Templates can be constructed by using tools like PCA, LDA, and Support Vector Machine (SVM) etc. Elastic Bunch Graph Matching algorithm, Active Shape Model are some of the template based approaches. Part based methods detect the significant part from the face image and combine the part appearance with machine learning tools for recognition. Component based method such as Support Vector Machine is a part based method.

Challenges in face recognition process are illumination, head pose, occlusion, aging, plane rotation, expression changes, gender identification etc. In this paper efficiency of face recognition is measured and compared with holistic approach PCA [11].

This paper is organized as follows: Section-II discusses about one of the holistic feature based approach Principal Component Analysis, Section-III discussed about template based matching strategy, Section-IV discusses about advantages of template matching over PCA, and Section-V deals with the performances of the discussed approaches, and Section-VI deals with conclusion of the paper.

II. PRINCIPAL COMPONENT ANALYSIS(PCA)

Principal Component Analysis [8] [9] [11] or Karhunen-Loeve transformation is a holistic face recognition technique. It is a statistical feature based approach and can be used for both dimensionality reduction and face recognition using Eigen faces. Procedure for PCA algorithm is: Acquire the training set of the face images and then the Eigen faces of the training images are calculated. This forms the face space. Consider the input query image that is to be recognized. Calculate the Eigen face of the input image. Then calculate the weights of the M Eigen faces by projecting it onto each of the stored Eigen face [11]. Advantage of PCA is it is easy to implement. No knowledge of geometry or specific feature of the face is

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required. Little preprocessing work. Efficiency of the algorithm is about 70 to 75 percentage. Disadvantages of the approach are it is applicable only to frontal view. Performance of the algorithm is good only under controlled background. Global projection suppresses local information and it is not resilient to face illumination condition, facial expression variation, head pose, in-plane rotation. Memory requirement is more. Dimensionality reduction is achieved only if original variables are correlated. Complexity order is about O (d2), where d is number of pixels in training image. The results of face recognition are shown in the following fig.1 and fig.2 images stored in database are recognized. Result is shown below in Fig.3. Images which are not stored in the database are not recognized.

Fig.1. Sample training images

Fig.2. Stored Eigen faces of input images

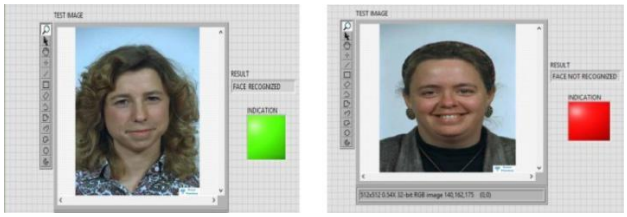

Fig.3. PCA Results

PCA cannot recognize the faces even if there is small noise change in illumination, in-plane rotation, shown in Fig.4.

Fig.4. Faces not recognized by PCA

III. TEMPLATE BASED FACE RECOGNITION

In template based face recognition [1] [2] [3] [4] [5] [6], a standard face pattern is predefined by using a function. The pattern matching is defined and the unwanted regions in the templates are ignored to reduce the memory required for storing the templates. Then the curve parameters like extraction mode, edge thresholding, edge filter size, minimum length are specified to make the facial features prominent. The additional curves were also drawn to enhance the operation of face template matching. Sample input image and its template is shown below in Fig.5.

Fig.5. Sample Input Images

The normal curves and the additional curves are customized and the unwanted regions which still remain are ignored. The offsets like angle, x and y position are set. Result is shown below in Fig.6.

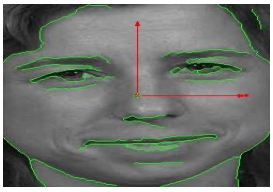

Fig.6. Result image after offsets at x and y positions are set

Using vision module, we can easily scan the whole image to locate the availability of the template in the image. The module itself returns the co-ordinates which indicate the location of the face in the image with the background. Once the face is recognized, the numbers are overlaid on the faces. Output sample recognized images using template based matching are shown below in Fig.7.

Fig.7.Recognized images using proposed method

IV. ADVANTAGES OF TEMPLATE BASED FACE RECOGNITION OVER PCA

PCA is a statistical based approach and can used to recognize the input faces whose Eigen is already stored in the data base. Even there is a small change in the input face like illumination change, presence of noise, change in the pose, in-plane rotation etc; PCA cannot recognize the input face as shown in Fig.4. This is because the Eigen face calculated for the query face will be different from the stored Eigen face.

These problem can be rectified by using template based face recognition. Template based face recognition is immune to noise. Even if there is change in the illumination condition the algorithm works. And it is verified under various illumination conditions and for high noise. Even if there is change in the pose the algorithm is able to work. Algorithm performance is also evaluated for in plane face rotation up to ±55 degrees. Performance of the algorithm is shown below in the Fig.8.

Fig.8. Recognized images using proposed method

V. PERFORMANCE COMPARISON OF PCA AND TEMPLATE BASED APPROACH

Following table shows the comparison of performance of PCA and template based face recognition approaches. Efficiency of PCA is about 70 to 75% . Whereas the efficiency of template based face recognition is 100%.

	PCA	TEMPLATE BASED
Face with noise	Not recognized	Recognized
Change in illumination	Not recognized	Recognized
Change in pose	Not recognized	Recognized
In-plane rotation	Not recognized	Recognized
Recognition rate	70-75%	100%

Table-1

VI. CONCLUSION

We have studied the performance comparison of two race recognition techniques over the images of FERET database. The two approaches are compared in terms of their efficiency of face recognition. The two approaches are

Holistic feature based approach, Principal Component Analysis.

Another is a template based matching strategy.

The template matching strategy has shown superior performance in the process of face recognition. It is a very simple approach. PCA occupies lesser memory space but was able to work for only frontal faces. It could work for recognizing the faces with change in illumination, pose, in-plane rotation, noise. Efficiency of the algorithm was only about 70-75%.

The template based matching approach that has been implemented from grey level has higher efficiency than PCA, and is about 100%. Our algorithm is simple based on defining the templates by removing the unwanted regions using pattern matching function for saving the memory. Additional curves are also drawn for enhancing the performance of the face recognition process. Using vision module input image is scanned for the availability of template in the database for recognition. It has been observed that template matching approach was able to recognize the images even there is change in the illumination, pose, in-plane rotation, noise as shown in Fig.7. That is, the efficiency of face recognition using template matching approach is 100%.

We can extend the algorithm for recognizing the faces with change in expression, aging factor. It can be extended to work for face recognition in multiple images not only for single images.

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