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An Efficient Face Recognition System Using SIFT Feature Transform

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Abstract— *The In recent years face recognition has attracted the attention of many researchers in the field of computer vision and pattern recognition. Face recognition is an important biometric security system in access control, airports, banks, railway stations and other public places. Many algorithms have been proposed for face recognition but success is limited by the conditions imposed by real time applications. This paper presents a novel approach to face recognition using the scale invariant feature transform (SIFT) descriptor in which the SIFT features are extracted from all face images in database. When a test image comes for recognition process, then the extracted features of that test image are compared against the features from each face image in database. For classification Euclidean distance measure is used. Experimentation was carried out on YALE database and results obtained are encouraging proving the efficacy of the approach.*

Keywords— Face recognition, Biometric, SIFT feature, YALE database

I. INTRODUCTION

Face recognition is a biometric method used to identify or verify a person from a still image or video image using stored database of images. Face recognition technology is classified into two domains namely, identification and verification. In an identification or recognition system, input face is matched against all faces in an available database, which in turn provides the determined identity. A verification or authentication system compares an input face with a similar-claimed face from a database. It either validates or rejects the claim based on the matching score [1]. These phases of the face recognition system are shown in Figure 1 and 2. Many approaches have been proposed for face recognition problem. The face recognition approaches are divided into two categories namely feature-based and holistic or appearance based approaches [2]. The feature based approaches are based on particular feature of face such as eyes, nose, mouth and their relations to make final decision. Whereas, appearance based approach recognizes face by using overall information of face as whole. All of these approaches work well when the gallery and probe images have taken under controlled imaging conditions and performance degrades if images have taken in un-controlled conditions. The system is not robust if there is a change in size, pose and expression. In this paper, we propose a face recognition system using SIFT features where SIFT extracts local features from image which are invariant to scale, rotation and illumination. And the features extracted from SIFT help in reliable match between different views of the same image. The rest of the paper is organized as follows. In section 2, an overview of the existing methods is given. Section 3 we discuss the proposed method in detail. Section 4 presents the experimental results and section 5 gives the conclusion.

Fig. 1 Face verification or authentication (1:1 matching)

Fig. 2 Face identification or recognition (1: N matching).

II. LITERATURE REVIEW

Several approaches have been proposed in the literature for handling one or more challenges like pose, expression and illumination which affect face recognition

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performance. The eigen faces are based on dimensionality reduction approach of principal component analysis (PCA) is one of the most popular approaches for face recognition [3]. PCA gives good recognition accuracy, but it is less computationally intensive.

A variant of PCA, termed as 2DPCA [4] gives more efficient approach to dimensionality reduction as compared to ordinary PCA. 2DPCA is more efficient compared to PCA. Kernel PCA (KPCA) a nonlinear approach which is an extension of PCA for face recognition is also developed. Even though PCA gives good results, it is computationally expensive and complex with the increase in the database size.

Fisher's linear discriminate analysis (LDA) [5] used for classifying samples of unknown classes based on training samples with known classes. LDA is a supervised dimensionality reduction method that aims at finding linear combinations of the data that maximize the between class variability while minimizing the within class variability i.e. it tries to find a new reduced subspace that provides the best separation between the different classes in the input data. In LDA each face image is considered a point in a higher dimensional space. Then, LDA is applied to the data to get the new basis vectors, called the Fisher faces. Face images are then projected onto this basis, where the matching is performed. For matching process we can use Nearest Neighbor classifier.

Though LDA outperforms Eigen face method, it also suffers from the small sample size problems that arise when there are a small number of available training samples compared to the dimensionality of the sample space. However, the performance of holistic matching methods will drop when there are variations due to expressions or poses. Reference [6] gives more details on face recognition methods.

III. PROPOSED METHOD

Scale invariant feature transform (SIFT) descriptor has been proposed by Lowe [7] to extract local features from an image which are invariant to scaling, rotation and illumination. The paper presents a novel approach to recognize the faces using SIFT transformation. The basic idea of this approach is to extract local features from test image which are compared against the features from all images in database. The best match between extracted features is based on Euclidian distance. The features are extracted in four steps. Four steps include Scale-Space Extrema Detection, Key Point Localization, Orientation Assignment and Key Point Descriptor [8]. The scale-space extrema detection locates the interesting points in an image by detecting maxima and minima of a set of Difference of Gaussian (DoG) applied at different scales all over the image. Figure 3 shows sample Difference of Gaussian image at different scales for Yale database [9].

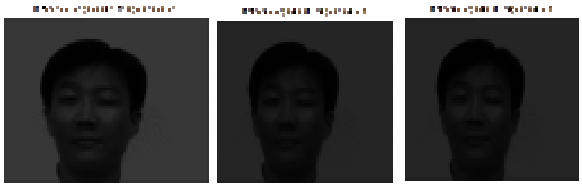

Fig.3: Sample DoG YALE database

Once these DoG are found images are searched for local extrema over scale and space. It means, one pixel in an image is compared with its 8 neighbors also 9 pixels in next scale and 9 pixels in previous scale. If it is a local extrema then it is a key point. In key point localization, the key points located in extrema detection are refined to get accurate key points. So, key point locations are discarded with low contrast to get stable key points. This can be done by setting a threshold for key point to get only stable points.

Next in orientation assignment step, an orientation assigned for each key point based on its local features. It determines key point's direction which ensures feature's rotation invariance.A neighbourhood is taken around the key point location with different scales then gradient magnitude and direction is calculated in that region. Peaks in this histogram correspond to the dominant directions of each feature point [10]. Finally, the local feature descriptor is computed at each key point. The descriptor is based on local image gradient, transformed according to the orientation of key point. These steps are depicted in Figure 4.

Thus, we apply SIFT feature transform to extract features from face images which are invariant to scale, pose and illumination for both training and test images. For matching trainingand test image feature vectors we are using Euclidian distance. A feature is considered to be matched with another feature when the distance to that feature is less than a certain threshold T of the distance to the next nearest feature then test image is recognized and label of that image is displayed. If the distance with all images exceeds a threshold T, then test image is considered as an unknown face.

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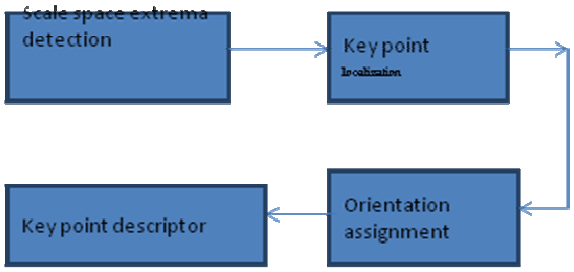

Fig.4 Steps in SIFT trarnsformation

IV. EXPERIMENTAL RESULTS

We have performed experiments using Matlab on YALE database [9].It contains 165 images for 15 subjects, with 11images per person. The images contain different facial expressions and illumination conditions for each subject. The image size is 243 × 320 pixels, and an average of 250 SIFT features are extracted for each image. Figure 5 shows a sample of images from YALE database and key features of face images extracted using SIFT transform.

Training database is formed from 165 images of YALE database. We have tested our approach with different test data. We have taken a total of 120 test images from YALE database and achieved 100% recognition rate. Test dataset2 contains 130 images with slight variation in lighting condition. Test dataset3 contains 130 images with slight variation in pose. The experiment results are shown in TABLE 1

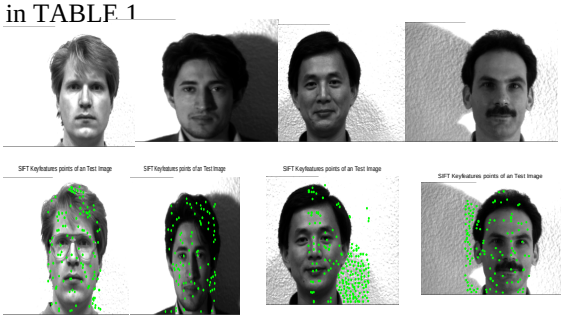

Fig. 5. Sample image from YALE database

The experiments done with different dataset and achieved good results compared to existing methods. Figure 6 shows accuracy of face recognition system.The proposed system gives promising results in un-controlled conditions like when test and training images are caputred in different lighting conditions, different pose and expressions.

***Table** 1. Results of face recognition system*

No. of training images	No. of test images	No. of recognized images	Accuracy	Remarks
165	Dataset1 (120)	120	100%	Test data same as training data
165	Dataset2 (130)	124	93%	Test data have different illumination condition
165	Dataset3 (130)	122	90%	Test data have different pose

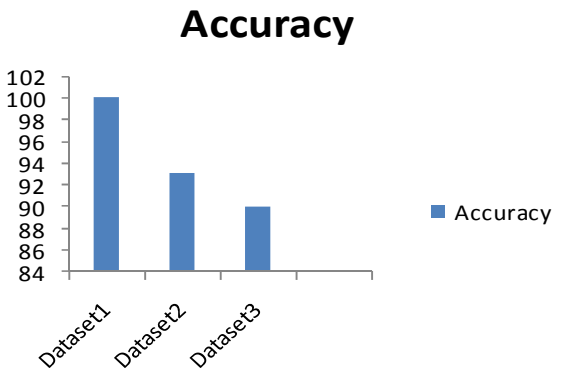

Fig.6. Recognition accuracy of face recognition system

V. CONCLUSION

Face recognition is an important biometric technology used in many security and access control systems. The SIFT feature transform is applied to face recognition and achieved promising results in an uncontrolled conditions. The experiments are performed on YALE database and 93% recognition rate is achieved.

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