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Research Article

An Improvement in Face Recognition for Invariant Faces

Yukti Bakhshi†*, Sukhvir Kaur† and Prince Verma†

†Computer Science and Technology, CTIEMT, Shahpur, Jalandhar, India

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Abstract

Face recognition has recently grown its importance, especially during the past several years as one of the most successful applications of image analysis. It has been a fast growing, interesting and challenging area in real time applications. In last decades a large number of face recognition algorithms have been developed. In this paper an attempt is made to review methods used for face recognition- SIFT, SURF, PCA, PCA-SIFT, etc. for recognition and matching. Scale invariant feature transform (SIFT) used to extract distinct invariant features from images can be used to perform reliable matching. To overcome SIFT drawbacks PCA eigenfaces entered into SIFT. We described the basic process of face recognition system and improvement in matching the invariant faces in this paper. We are using SIFT and SURF to extract the features and then applying PCA to the image for the better performance in terms of rotation, pose and illumination. Performance can be seen on the basis of FAR, FRR, Recognition rate and Computation time. For the implementation of this proposed work we use the Image Processing Toolbox under MATLAB Software.

Keywords: *Image Processing, Face Recognition, Face Recognition Algorithms, SIFT, SURF and PCA.*

1. Introduction

Face recognition is one of most relevant applications of image analysis. Face Recognition is a task of identifying an already detected face and telling exactly who's it is and also deals with unique facial characteristics of human beings It can be applied in various challenging fields like video retrieval, security systems and identity authentication. It involves the pattern recognition and image processing. There are mainly two types of comparisons which are described as follows:

- **Verification** - When the system compares the given individual with the individual whom he says he is and gives a yes or no decision.
- **Identification** – When the system compares the given individual to all the other individuals stored in the database and gives a ranked list of matches.

Facial recognition methods involve a series of steps that are capturing, analyzing and comparing your face to a database of stored images. Below is the basic process that is used by the face recognition system to capture and compare images:

1.1 Detection

The recognition software searches the faces using the video camera when the system is attached to a video surveillance system. And if there is a face in the view, it is detected within a fraction of a second.

1.2 Alignment

Once the system has detected the face, then it determines the head's position, size and pose. For the system to register the face it needs to be turned at least 35 degrees towards the camera.

1.3 Normalization

For the image of the head to be registered and mapped into an appropriate size and pose, it is scaled and rotated. Normalization is performed despite of the head's location and distance from the camera. Light is not an issue in the normalization process.

1.4 Representation

After the normalization has been done, the system converts the facial data into a unique code. This coding process allows for easier representation and comparison of the newly acquired facial data to facial data which is already stored.

1.5 Matching

The newly acquired facial data is compared to the stored data and linked to at least one stored facial representation. The system decides if the features extracted from the newly acquired facial data are a

*Corresponding author **Yukti Bakhshi** is a Research Scholar

match or not. If a score is above a predetermined threshold, a match is declared. (Yukti Bakhshi *et al*, 2015)

2. Face Recognition Algorithms

2.1 PCA

Principal Component Analysis commonly uses the eigenfaces in which the probe and gallery images must be the same size as well as normalized to line up the eyes and mouth of the subjects whining the images. Approach is then used to reduce the dimension of data by the means of image compression basics and provides most effective low dimensional structure of facial pattern. This reduction drops the unuseful information and decomposes the face structure into orthogonal (uncorrelated) components known as eigenfaces. Each face image is represented as weighted sum feature vector of eigenfaces which are stored in 1-D array. A probe image is compared against the gallery image by measuring the distance between their respective feature vectors then matching result has been disclosed. The main advantage of this technique is that it can reduce the data needed to identify the individual to $1/1000^{th}$ of the data presented. (Aruni Singh *et al*, 2012)

PCA solves the recognition problem within a representation space of lower dimension than image space. PCA is an eigenface method which helps in the reduction of the dimensionality of the original data space. But there is a disadvantage of PCA which says that recognition rate decreases under varying pose and illumination.

A face recognition system can be considered as a good system if we extract with the help of Principal Component Analysis and for recognition back propagation Neural Network are used. (Aruni Singh *et al*, 2012)

2.2 SIFT

In 2004 Lowe, invents SIFT descriptor which is invariant to scale, rotation, affine transformation, noise, occlusions and is highly distinctive. SIFT features consist of four major stages in detection and representation; they are (1) finding scale-space extrema; (2) key point localization and filtering; (3) orientation assignment; (4) key point descriptor. The first stage is to construct the key points of images by using Difference-of-Gaussian (DoG) function. The second stage, candidate key points are restricted to sub-pixel accuracy and removed if found to be unreliable. The third stage represents the dominant orientations for each essential point of the images. The final stage constructs a descriptor for each key point location depends upon the image gradients in its local neighborhood. Then the SIFT descriptor is accepting the 128- dimensional vector which used to identify the neighborhood around a pixel. The SIFT extracts the key points (locations and descriptors) for all the database images. Then given an altered image SIFT extracts the key point for that image and compares that point to the dataset. (Priyanka *et al*,2014)

2.3 SURF

The SURF also extracts the key points from both the database images and the altered images. This method matches the key points between altered image and each database image. In 2008, H. Bay invents SURF descriptor which is invariant to a scale and in-plane rotation features. It consists of two stages such as interest point detector and interest point descriptor. In the first stage, locate the interest point in the image. Use the Hessian matrix to find the approximate detection. (Priyanka *et al*, 2014)

SURF is a scale and in-plane rotation invariant detector and descriptor. (Geng Du *et al*, 2009) SURF detectors are find the interest points in an image, and descriptors are used to extract the feature vectors at each interest point just as in SIFT. SURF uses Hessian-matrix approximation to locate the interest points instead of difference of Gaussians (DoG) filter used in SIFT. SURF as a descriptor uses the first-order Haar wavelet responses in x and y, whereas the gradient is used by SIFT. SURF usually uses 64 dimensions in SURF to reduce the time cost for both feature matching and computation. SURF has three times better performance as compared to SIFT. (Yukti Bakhshi *et al*, 2015)

3. Related Work

In (Dong Li *et al*, 2015), a pose-invariant face-verification method is proposed, which is robust to alignment errors, using the HR information based on pore-scale facial features. A new keypoint descriptor, pore-Principal Component Analysis (PCA) - Scale Invariant Feature Transform (PPCASIFT) - adapted from PCA-SIFT is devised for the extraction of a compact set of distinctive pore-scale facial features.

This article (Vrushali Purandare *et al*, 2014) provides the overview of Scale invariant feature transform (SIFT) to extract distinctive invariant features from images can be used to perform reliable matching. Results shows that SIFT is flexible recognition algorithm as compared to Contour matching algorithm for heterogeneous images.

(Isra'a Abdul-Ameer Abdul-Jabbar *et al*, 2014) Presents a novel human face identification approach. This approach consists of three parts: de-noised face database, Adaptive Principle Component Analysis based on Wavelet Transform (APCAWT), and the Scale Invariant Feature Transform approach, (SIFT). For feature extraction the eigenface of PCAWT entered to SIFT algorithm, and thus only the SIFT features that belong to clusters, where correct matches may be expected are compared according to a specific threshold.

Article (B.K. Bairagi *et al*, 2012) presents expressions invariant face recognition by detecting the fiducial points and employing speeded up robust feature (SURF) along with Gabor filter. The presented method is tested with test images with different expressions and found to be a better performer over the conventional SURF algorithm.

(Shungang Hua *et al*, 2012) Focuses on the matching of the SIFT features between two images, and calculating the distance for SIFT feature vectors to evaluate the degree of similarity between the original and the resized image.

In (Shinfeng D. Lin *et al*, 2012) article, a robust face recognition scheme is proposed. Speeded-Up Robust Features algorithm is used for extracting the feature vectors with scale invariance and pose invariance from face images. Then PCA is introduced for projecting the SURF feature vectors to the new feature space as PCA-SURF local descriptors. Finally, the K-means algorithm is applied to clustering feature points, and the local similarity and global similarity are then combined to classify the face images.

In (Ergun Gumus *et al*, 2010), an evaluation of using various methods for face recognition is presented. As feature extracting techniques we benefit from wavelet decomposition and Eigenfaces method which is based on Principal Component Analysis (PCA). After generating feature vectors, distance classifier and Support Vector Machines (SVMs) are used for classification step.

The objective of (T.F. Karim *et al*, 2010) is to develop the image processing and recognize the faces using PCA-based face recognition technique. MATLAB based programs are implemented to identify the faces using Indian databases and the Face recognition data, University of Essex, UK. For matching unknown images with known images, different techniques like sum of absolute difference (SAD), sum of squared difference (SSD), normalized cross correlation (NCC) etc. can be used which has been shown.

(Yan Ke *et al*, 2004) examines (and improves upon) the local image descriptor used by SIFT. Like SIFT, the descriptors used encode the salient aspects of the image gradient in the feature point's neighborhood; however, instead of using SIFT's smoothed weighted histograms, principal components analysis (PCA) are applied to the normalized gradient patch. Our experiments demonstrate that the PCA-based local descriptors are more distinctive, more robust to image deformations, and more compact than the standard SIFT representation.

4. Proposed Approach

A new approach is proposed for invariant faces with better results in case of rotation, change in expressions and poses. The block diagram of the proposed system is shown in the figure 1.

The input image will be loaded into the system. The image then will be pre-processed into gray-scale image. The features will be extracted from that image using both SIFT and SURF algorithms respectively. And then there will be an image produced which consists of combined features using SIFT and SURF.

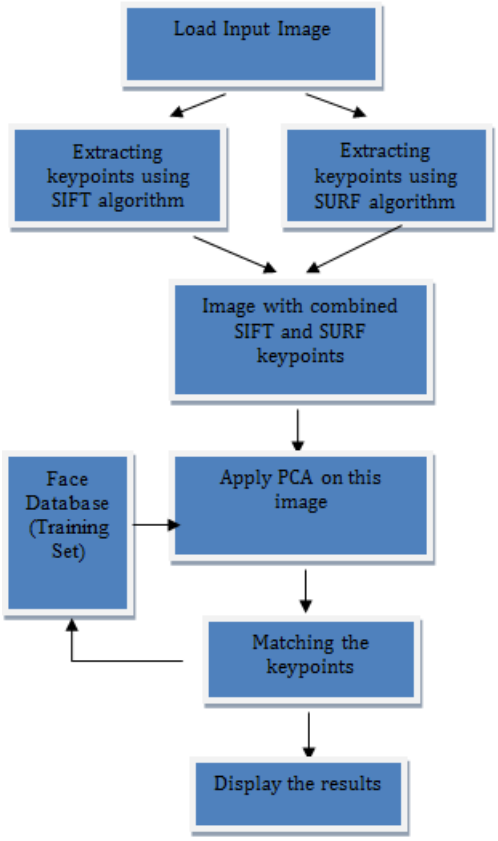

Fig.1 Flowchart of Proposed Work

PCA will be then applied directly to that image and eigenvectors will be extracted from each face. The goal is to extract the important information from the face data to represent it as a set of new orthogonal variables called principal components. On the above basis, matching will take place between the input image and the image on which PCA is applied for invariant faces having different expressions, poses and rotation.

4. Results

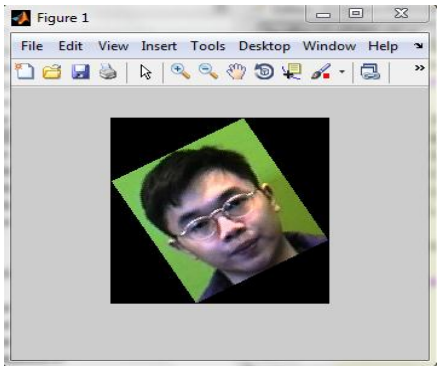

Fig.2 Loading the input (rotated) image

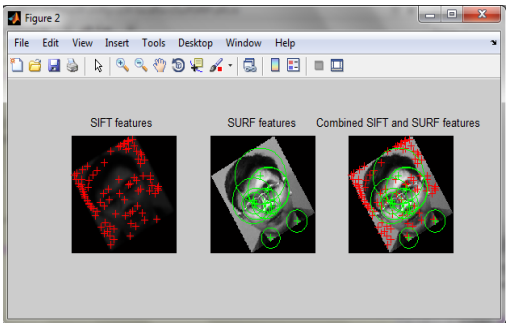

Fig.3 Interest points in the image using SIFT, SURF and combined SIFT-SURF

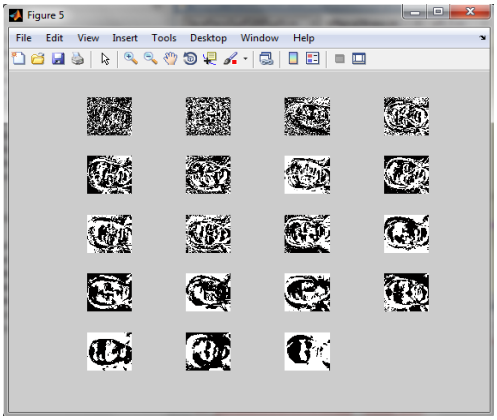

Fig.4 Eigenvalues of the image are generated using PCA

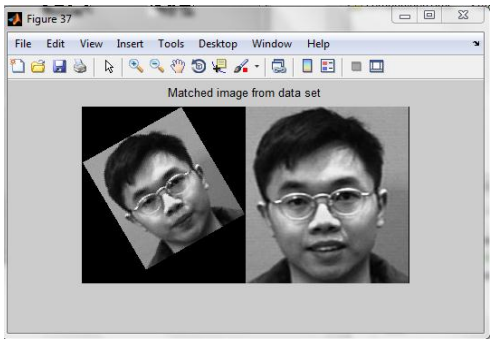

Fig.5 Matched image with rotation and change in expressions

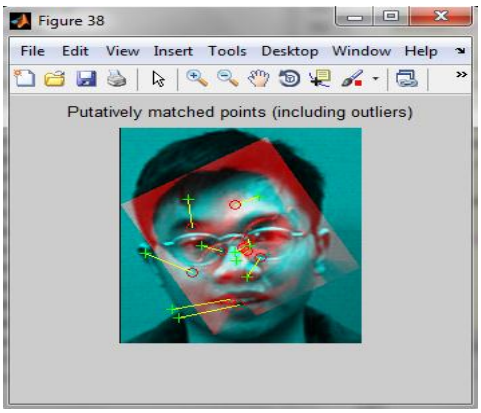

Fig.6 Input (rotated) image has been matched to the image in database

Conclusions

This article presents an effective face recognition method which uses SIFT and SURF features to classify face images and finally PCA technique is applied to the image for better matching results in case of rotation as well as change in expressions. Results show that the performance of the proposed scheme is better than other methods. More precisely, PCA-based SIFT and SURF local descriptors are more robust than original SIFT local descriptors and PCA-SIFT to the accessory, expression, and pose variations. The introduction of PCA reduces the dimension of feature space. The goal is to extract the important information from the face data to represent it as a set of new orthogonal variables called principal components.

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