

Face Recognition using SIFT, SURF and PCA for Invariant Faces

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Abstract — This paper consists of review methods used for face recognition- SIFT, SURF, PCA, PCA-SIFT, etc. for recognition and matching. SIFT and SURF is used to extract features to perform reliable matching from the images. PCA eigenfaces are used, they are entered into SIFT. The basic process of face recognition system is described here and improvement is shown in matching the invariant faces in this paper. SIFT and SURF are used to extract the features and then applying PCA to the image for the better performance in terms of rotation, expression and contrast. Performance can be seen on the basis of Recognition rate. Image Processing Toolbox under MATLAB Software is used for the implementation of this proposed work.

Keywords — Face Recognition, Face Recognition Algorithms, SIFT, SURF and PCA, Recognition Rate.

I. INTRODUCTION

Face Recognition is one of the most relevant applications of image analysis. Face Recognition is a task of identifying an already detected face and telling exactly whose 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 verification and identification [19].

II. FACE RECOGNITION ALGORITHMS

A. 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 1/1000th of the data presented [11].

This is a linear method and widely used in appearance-based approaches for FR (Face Recognition). This approach aims at solving the recognition problem within a representation space of lower dimension than image space [2].

B. 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 [2].

C. 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 [2]. SURF is a scale and in-plane rotation invariant detector and descriptor [14]. SURF detectors are used to 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 [19].

III. RELATED WORK

In [1], 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.

[5] Presents a novel human face identification approach. This approach consists of three parts: denoised 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 [7] 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.

[8] 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 [10] 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.

The objective of [13] 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.

[18] 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.

IV. PREVIOUS WORK

In the previous work, SIFT (Scale Invariant Feature Transform) is used for the extraction of features of the image. After the feature extraction and eigenvectors to be extracted from each face image, PCA (Principal Component Analysis) is applied directly to that image. The goal of PCA is to extract the important information (features) from the face data to depict it as a set of new orthogonal variables which are called principal components. But in case of PCA-SIFT, the problem arises when there is a change in expression or contrast. Rotation also does not give better results. Recognition rate decreases under varying expressions, contrast as well as rotation.

V. PROPOSED APPROACH

A new approach is proposed for invariant faces and described as follows:-

The input image is loaded into the system. The image is then converted 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. 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, contrast and rotation.

VI. RESULTS AND DISCUSSIONS

1) Results when the image is normal

Input image is matched to the image already stored in the database.

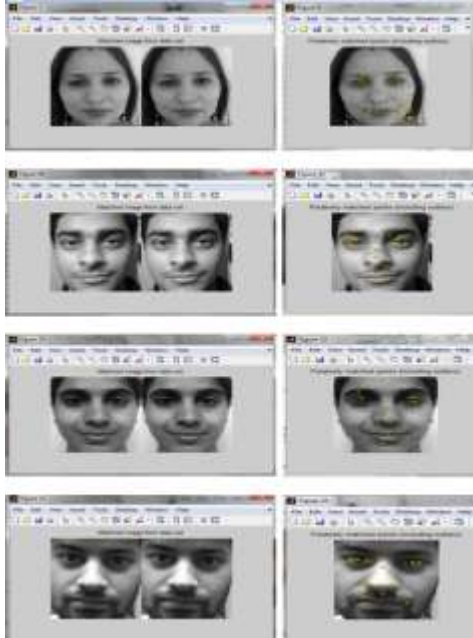


Fig. 1 Input normal images matched to the images stored in the database.

2) Results when the image is rotated

Input (rotated) image is matched to the image already stored in the database.



Fig. 2 Input (rotated) images matched to the images stored in the database.

3) Results when there is change in contrast

Input (rotated) image as well as with different contrast is matched to the image already stored in the database.

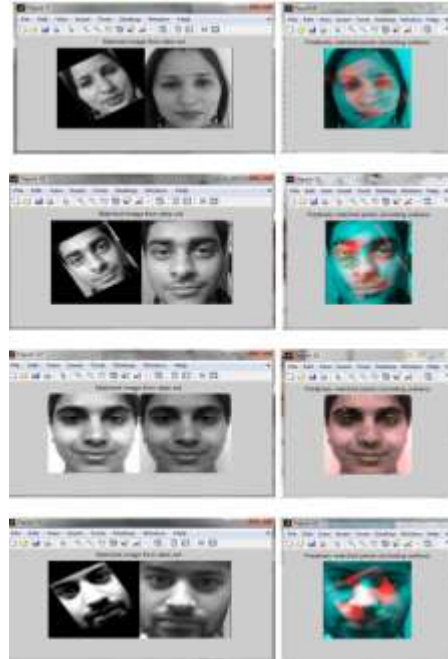


Fig. 3 Input (rotated) images as well as with different contrast matched to the images stored in the database.

4) Results when there is change in expression

Input (rotated) image as well the image with different expression is matched to the image already stored in the database.



Fig. 4 Input (rotated) images as well as with different expression matched to the images stored in the database.

Performance of the proposed work has been examined by recognition rate:

RECOGNITION RATE = Number of faces recognized/Number of faces presented

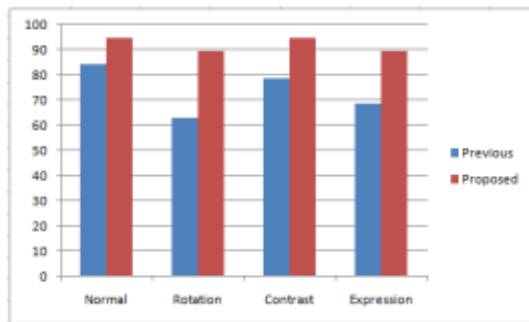


Fig. 5 Recognition Rate between previous and proposed approach

TABLE I

Table illustrating the recognition rate between previous and proposed approach

Case	Previous %	Proposed %
Normal	84.19	94.70
Rotation	63.20	89.52
Contrast	78.90	94.70
Expression	68.48	89.52

VII. CONCLUSIONS

The work represents method to solve the problem of matching of images in case of invariant faces. SIFT and SURF features are used to extract the features from face images for the effective face recognition method. For better matching results in case of change in expressions and contrast as well as rotation, PCA technique is applied to the image. This method is fast and provides better recognition rate.

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