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Design and Extraction of Facial Components in Automated Face Recognition

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ABSTRACT: Face recognition presents a challenging problem in the field of image analysis and computer vision. Face recognition system should be able to automatically detect a face in an image. This involves extracts its features and then recognize it, regardless of lighting, expression, illumination, ageing, transformations (translate, rotate and scale image) and pose, which is a difficult task. This paper presents a framework for component- based face alignment and representation that demonstrates improvement in matching performance over the more common holistic approach to face alignment and representation. Active shape model (ASM) technique that has been used often for locating facial features in face images. The proposed scheme selects robust landmark points where relevant facial features are found and assigns higher weights to their corresponding features in the face classification stage. For alignment and cropping Procrutes analysis is used. Multi-scale local binary pattern is used for matching automated face image. In MLBP per-component measurement of facial similarity and fusion of per-component similarities is used. The proposed work is more robust to changes in facial pose and improves recognition accuracy on occluded face images in forensic scenarios.

KEYWORDS: Active shape model, Multi-scale local binary pattern, Procrutes analysis, holistic method.

I. INTRODUCTION

Face recognition has been a rapidly growing research area due to an increasing demand for biometric-based security applications. Varying factors such as cosmetics, illumination, and face disguise can hinder face recognition performance. Such varying faces are called as automated faces. Several researchers proposed different automated face recognition algorithms that perform well with unconstrained face images [3]. Recently, the face recognition algorithms based on local descriptors such as Gabor filters, SURF, SIFT, and histograms Local Binary Patterns (LBP) provide more robust performance against occlusions, different facial expressions, and pose variations than the holistic approaches. Appearance based or pixel based representation i.e. representations that extract features per specific facial components is the best technique used for automated face recognition. Using facial components that are precisely extracted through automatically detected facial landmarks, it demonstrates that descriptors computed from the individually aligned components result in higher recognition accuracies than descriptors extracted using the more common approach of dense sampling from globally aligned faces. The strong evidence of component processing in human face perception, and the lack of mature component- based methods in automated face recognition research; a more thorough investigation of the role of component-based processing in automated face recognition is warranted [1].

II. RELATED WORK

1.Three approaches for face recognition

The detail review of different face recognition approaches has been given by V.V. Starovoitov, D.I Samal, D.V. Briliuk. Three approaches for face recognition:

A. Feature base approach

The local features like nose, eyes are segmented and it can be used as input data in face detection in this approach. It is the easier task as only three parameters are used.

B. Holistic approach

The whole face taken as input in the face detection system to perform face recognition. It is more complicated approach as compared to above approach.

C. Hybrid approach

Hybrid approach is combination of feature based and holistic approach. Both local and whole face is used as the input to face detection system.

The computational cost is high, as a large set of randomly generated local deformations must be tested. Elastic bunch graph matching is used to overcome above drawback. Here bunch of jets i.e. instead of actual landmark location, information related to landmark is used. This give more accurate result [1].

2.Face recognition using local binary patterns

The detail review of face recognition by Local Binary Pattern (LBP) has been proposed by Jo Chang-Jo Changyeon. LBP features have worked efficiently in various applications i.e. is for texture classification and segmentation, image retrieval and surface inspection. The original LBP operator labels the pixels of an image by thresholding the 3-by-3 neighborhood of each pixel with the center pixel value and considering the result as a binary number. Figure shows an example of LBP calculation.

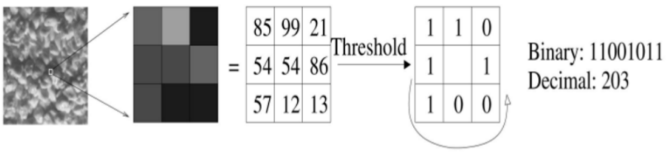

Fig2.1: Computing LBP value at each pixel.

The LBP operator has been extended to take different sizes of neighbor. In general, the operator LBP P, R refers to a neighborhood size of P equally spaced pixels on a circle of radius R that form a circularly symmetric neighbor set. LBP P, R produces 2P different output values, corresponding to the 2P different binary patterns that can be formed by the P pixels in the neighbor set. It has been shown that certain bins contain more information than others. Hence, it is possible to use only a subset of the 2P LBPs to describe the textured images. Fundamental patterns with a small number of bitwise transitions from 0 to 1 and vice versa are considered. For example, 00000000 and 11111111 contain 0 transitions while 00000110 and 01111110 contain 2 transitions and so on. Concatenating patterns which have more than 2 transitions into a single bin yields an LBP descriptor [2].

The proposed work is computationally heavy to work on mobile applications. Also LBP requires more time for face recognition as compared to other latest techniques [2].

3. **Automatic local Gabor features extraction for face recognition**

The detail description of automated face recognition has been illustrated by Ben JemaaYousra and Sana Khanfir. It is a very important stage to detect face before face recognition. To identify a person, it is necessary to localize his face in the image. It includes following steps:-

When Gabor filters are applied to each pixel of the image, the dimension of the filtered vector are very large they are proportional to the image dimension. It leads to expensive computation and storage cost. To remove such problem and make the algorithm strong, Gabor features are obtained ten extracted fudicial points [3].

4. **Automatic Face Recognition using Principal Component Analysis with DCT**

The detail description of automatic face recognition with different techniques has been proposed by Miss.RenkePradnya Sunil. It has proved to do instrumental work in this field of face recognition.

The increase in the number of signatures will increase the recognition rate, however, the recognition rate saturates after a certain amount of increases. Hence, it is better to use robust image pre-processing systems, such as geometric alignment of important facial feature points (eyes, mouth, and nose) and intensity normalization which increases the recognition rate and at the same time decreases the number of signatures representing images in the PCA space[4].

5. **Enhancing the Performance of Active Shape Models in Face Recognition Applications**

The detail review of active shape model has been given by Carlos A. R. Behaine and Jacob Scharcanski. It has proved to be instrumental in the field of face recognition through active shape model.Active shape model (ASM) is an adaptive shape matching technique that has been used to locate the facial feature of an image.

As structural constraints given by the face, ASM model-based detection can handle small variations in pose and expression. ASMs are sensitive only to the initial placement of landmarks prior to the iterative updating of

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model parameters. And insensitive if this initial placement is not closely aligned to the true landmark locations and then the ASM may converge on an inaccurate set of landmarks [5].

III. PROPOSED ALGORITHM

The detail review of component based representation has been proposed by Kathryn Bonnen, Brendan F. Klare. This work has been instrumental in identifying the key domains of research in image processing particular to recognition of automated faces.

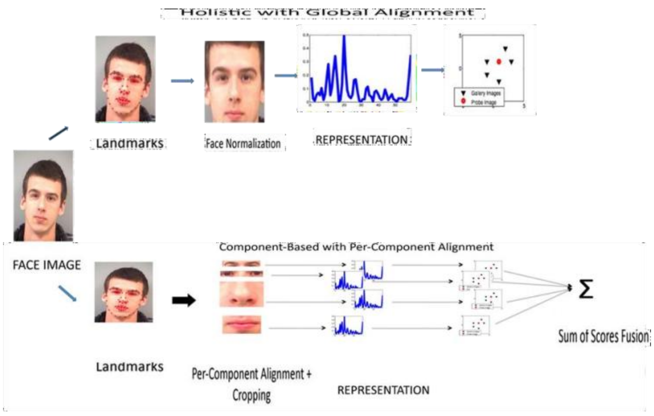

Fig.3.1 overview of comparison between holistic and component based approach

The above diagram describes outline of the per- component alignment performed to yield the proposed component based representations. This work demonstrates the value of rep- resenting faces in a per-component manner. When compared to a globally aligned holistic representation, and other representations found in the literature, the component- based representation offers strong accuracy improvements in a number of face recognition scenarios [11].

It mainly describes component-based representations i.e. representations that extract features per specific facial components. It involves following steps:-

1. **Landmark Detection**

For aligning the facial components is to extract a predefined set of 76 anthropometric landmarks. A subset of these anthropometric landmarks provides a general outline of the component for each component of given image. Active shape model is mainly used for landmark extraction. But ASM is sensitive if there is the small variation in pose and orientation and insensitive large variation. To overcome this problem PittPatt's Face Recognition SDK. In this first automatically detected the centre of the two eyes, and the centre of the nose. Because these three landmarks are also present in the ASM, initialized the ASM landmarks by (i) solving the affine transformation from these three ASM points to the corresponding PittPatt detected points, and (ii) applying this transformation to the set of 76 ASM landmarks (representing the mean face in the model). The result of this step is an initial placement of facial landmarks that is well suited to correctly converge on the proper locations [6].

2. **Alignment and Cropping**

It gives the rigid transformation which minimizes the mean squared error between two ordered sets of coordinates. It reduces the variation in translation, scale, and rotation, which allows for a more accurate similarity measure between facial components after performing Procrustes analysis on each component in each face image, the rotation, translation and scaling parameters, is obtained. They are used to rigidly align the parameters. Cropping is done by creating a bounding box around the aligned landmarks. The bounding box is obtained by first performing the horizontal cropping boundaries from the minimum and maximum values. The vertical cropping boundaries are determined based on a ratio of the crop width. To improve the subsequent descriptor extraction A small pixel border

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around each set of landmarks is used. The same method is then later applied for per aligned and cropped component to get more accurate results [6].

3. **Representation**

Multi-scale local Binary Patters (MLBP) is used for representation of facial components. It is the combination of local binary pattern. Each facial component is divided into regions of d*d pixels m overlapping by pixels where m<d. For each region, a histogram of LBP values is obtained from comparisons at each pixel. The LBP value is calculated at each pixel is computed by comparisons selected pixel with the surrounding pixel at a radius of length which gives the gray value at each of the surrounding pixels. This creates a histogram of dimensionality, which further reduced by mapping LBP values without "uniform patterns" to the same value where a uniform pattern is an LBP binary string which produces 2 or fewer bitwise transitions. The MLBP representation concatenates two or more LBP descriptors [6].

4. Component-Based Discriminant Analysis

The RS-LDA approach includes the following steps for training.

1) The feature space is randomly sampled into subspaces, with each subspace sampling a fraction s (0<s<1).
2) For each of the random k sample spaces, principal components analysis is performed in order to retain percent of the variance.
3) LDA subspaces are learned from each of the PCA representations.
4) From these trained subspaces, images then sampled into each of the k random feature subspaces, projected into the corresponding PCA and LDA subspaces
5) For each of the subspace vectors are combined into a final feature vector[10].

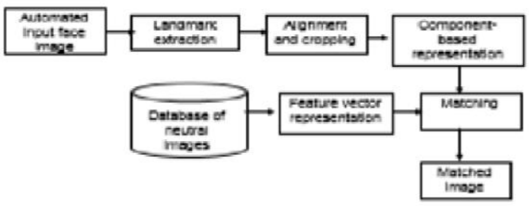

Fig 3.2 block diagram of proposed meth of propose method

This is the block diagram of proposed method. It consist of automated face image which is given as input as probe image. Landmarks are extracted from that which helps to extract components. Later on extracted components per-component alignment and cropping is performed. Each extracted component is represented in form of histogram which is obtained through multi-scale local binary pattern. With the help of histogram vector is obtained for probe image. Later on remaining images feature vector extraction is performed using random sampling linear discriminant analysis (RSLDA). The feature vector is obtained for gallery images. Matching done by cosine similarity measure. The image with minimum distance is obtained as the output or matched image which is matched with most of the components in the probe image. So, it give more accurate results as compared to holistic approach [9].

IV IMPLEMENTATION AND EXPERIMENTAL RESULTS

It consists of 4 modules:

1. Landmark extraction:-It is the process of extracting the predefined set of landmarks such as eyes, nose, eyebrows and mouth which provide the general outline for component. Active shape method is used which handles variation in occluded faces.

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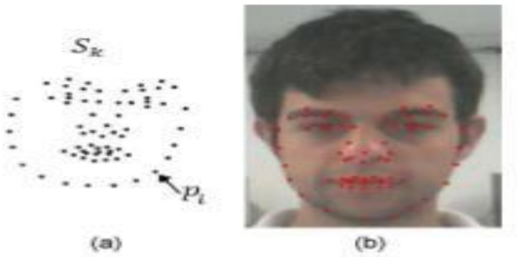

Fig 4.1 point distribution model with landmarks extracted

2. Per-component alignment and cropping:-From the outline obtained due to landmark extraction each component is cropped and aligned properly.

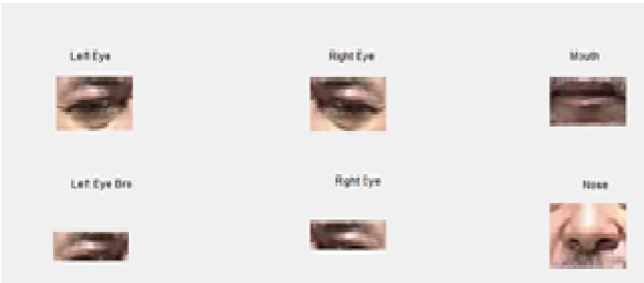

Fig 4.2 extracted components after performing per-component alignment and cropping

3. Representation of each extracted component: Extracted component is represented through multiscale local binary pattern which will give the histogram. MLBP is obtained from LBP values and histogram is obtained.

LBP	10011110	LBP	11001100110	LBP	11101100011101
Decimal of LBP	158	Decimal of LBP	1638	Decimal of LBP	15133
Type of LBP	Non Uniform	Type of LBP	Non Uniform	Type of LBP	Non Uniform
No of 0's	3	No of 0's	5	No of 0's	5
No of 1's	5	No of 1's	6	No of 1's	9
All ones	NO	All ones	NO	All ones	NO
All Zeros	NO	All Zeros	NO	All Zeros	NO

Fig 4.3 LBP pattern obtained with different radii

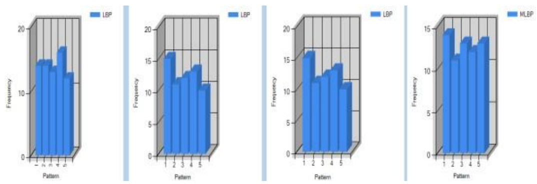

Fig 4.4 LBP histogram with r=1,2,3 and their combined histogram

4. RSLDA on remaining images: - Random sampling linear discriminant analysis is applied on remaining images. The result of which is used for matching with the result of MLBP.

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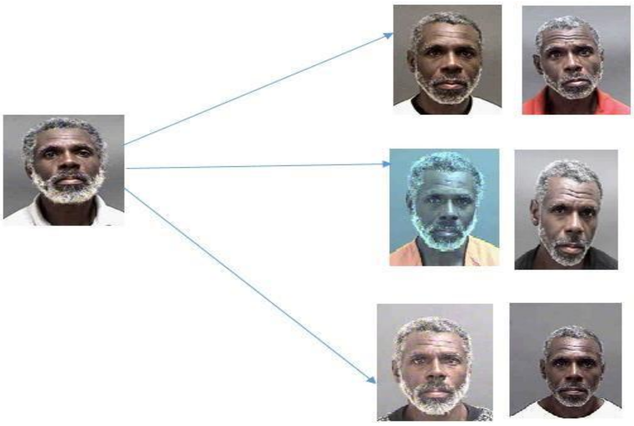

Fig 4.5 output obtained after face recognition under different illumination, pose, facial expression and age

IV. CONCLUSION AND FUTURE WORK

The main objective is to demonstrate the potential of different face recognition such as face recognition by geometric approach, elastic bunch graph matching, neural network, local binary pattern, automatic local gabor features extraction, principal component analysis with discrete cosine transform, active shape model and multi-scale local binary pattern. The difficulties in extracting individual facial components prevented the effective use of component-based approaches in automatic face recognition. A viable future research topic is a dedicated study on how to best tailor learning-based methods to component-based representations which improves face recognition accuracy [7]. From the different face recognition component based approach has proven to be more efficient. Providing the extension to component based approach such for proposed work to be used for make-up faces, water images or instead of neutral image if automated image is present in training image the system should work efficiently [8].

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