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Feature Extraction Techniques for Face Recognition

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Abstract: *Face Recognition is non-intrusive method of identifying individual faces by the feature extraction and classification of faces. Facial feature extraction is one of the most important and attempted problems in computer vision. This paper compares the different facial feature extraction techniques like geometry-based feature extraction (Gabor wavelet transform), appearance based techniques, color segmentation based techniques and template based feature extraction. These techniques provide diverse performance with various factors such as illumination variation, face expression variation noise and orientation.*

Keywords: *Face recognition, Feature extraction.*

I. Introduction

Face recognition is the automatic assignment through which a digital image of a particular person can analyze using the features of the face in that image. Face recognition method consists of three components: face detection, image processing with feature extraction and face identification. Computer learning is used in face detection to detect the location of any faces within an image. Image processing consists of segmentation, image rendering and scaling to prepare the face for identification. Face identification uses mathematical techniques on the features in the facial area of an image or on the pixel values to build the association of novel face images with known models. Face recognition application has been categorize in two main parts: law enforcement and commercial application [1]. Face recognition technology is primarily used in law enforcement, especially in advance video surveillance, CCTV control, base portal control. Under the commercial applications matching of photograph on credit cards, ATM cards, passports, driver's licenses, National ID has come. After extensively studied of more than 40 years it is one of the most imperative subtopics in the domain of face research [2], [3]. Recent research in image analysis and pattern recognition opens up the possibility of automatic detection and classification of emotional and conversational facial signals. Various researches have shown that feature extraction importance cannot be overstated in face recognition. Neurophysiologic research and studies have determined that eyes, mouth, and nose are amongst the most important features for recognition [4]. Almost every face recognition systems need facial features in addition to the holistic matching methods, for example, eigenfaces proposed by Turk and Pentland [5] need accurate locations of key facial features such as eyes, nose, and mouth to normalize the detected face. Most facial feature extraction methods are sensitive to various non-idealities such as variations illumination, noise, orientation, time-consuming and color space used [6]. A good feature extraction will improve the performance of face recognition system. Various techniques have been developed for feature extraction in last decade and these techniques can be divided into three categories. Geometry based, template based and color segmentation based [7] Researcher conducted numerous studies comparing various feature extraction techniques and their robustness to facial appearance changes. Facial feature extraction has some problem like small variation processing of face size and orientation can affect the result. Sometime image has different brightness, shadows and clearness which can be failed the process and feature may be covered by other things, such as a hat, a glasses, hand or hairs.

II. Feature Extraction Technique

Some image processing techniques extract feature points such as eyes, nose, and mouth and then used as input data to application. Various approaches have been proposed to extract these facial points from the images. The basic approaches are as follows.

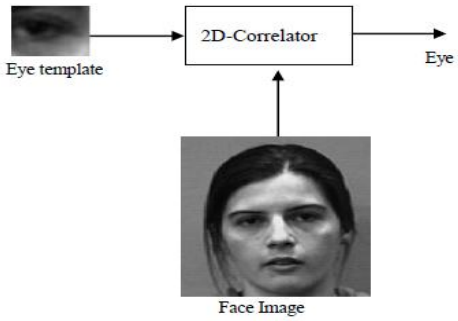
A. Geometry –based Technique

In this technique feature are extracted using the size and the relative position of important components of images. In this technique under the first method firstly the direction and edges of important component is detected and then building feature vectors from these edges and direction. Canny filter and gradient analysis usually applied in this direction. Second, methods are based on the grayscales difference of unimportant

components and important components, by using feature blocks, set of Haar-like feature block in Adaboost method [8] to change the grayscales distribution into the feature. In LBP [9] method, every face image divides into blocks and each block has its corresponding central pixel. Then this method examine its neighbor pixels, based on the grayscales value of central pixel it changes neighbor to 0 or 1. Therefore, every pixel will be represented in a binary string. After that a histograms is build for every region and then these histograms are combined to a feature vector for the face image. Technique proposed by Kanade [10], also comes under this. Mark Nixon presented a geometric measurement for eye spacing with the Hough transform technique to detect the instance of a circular shape and of an ellipsoidal shape. The result of this paper illustrate that it is possible to derive a measurement of the spacing by detection of the position of both the iris, which is a most accurate technique [11]. Nevertheless these techniques require threshold, which given the prevailing sensitivity, may adversely affect the achieved performance.

B. Template Based Techniques

This technique will extract facial feature based on the previously designed templates using appropriate energy function and the best match of template in facial image yield the minimum energy. Methods have been proposed by Yuille *et al.* [12], detecting and describing features of faces using deformable templates. In deformable templates the feature of interest, an eye for example, is described by a Parameterized template. These parameterized templates enable a priori knowledge about the expected shape of the features to guide the detection process [12]. An energy function is defined to links peaks, edges, and valleys in the image intensity with corresponding properties of the template. After that the template matching is done with the image, by altering its parameter values to minimize the energy function, thereby deforming itself to find the best fit. For the descriptor purpose final parameter value is used. In the Template based eye and mouth detection first an eye template is used to detect the eye from image. Then a correlation is found out between the eye templates with various overlapping regions of the face image. Eye region have a maximum correlation with the template. The block diagram of this method is shown in figure 1.



This method can be given as algorithm which is so simple and easy to understand and steps as follows [13].
Step 1: An eye template of size m × n is taken.
Step 2: The normalized 2-D auto-correlation of eye template is found out.
Step 3: the normalized 2-D cross-correlation of eye template with various overlapping regions of the face image is calculated.
Step 4: The mean squared error (MSE) of auto correlation and cross-correlation of different regions are found out. The minimum MSE is found out and stored.
Step 5: The region of the face corresponding to minimum MSE represents eye region.
Step 6: From eye region eyes points extracted.
Step7: From eye points mouth point can be detected.
The method does not require any mathematical calculation and any prior knowledge of features geometry. But before the Yuille, Fischler and Elschlager [14], measured features automatically and described a linear embedding algorithm that used local feature template matching and a global measure of fit to find and measure facial features. These algorithms require a priori template modelling, in addition to their computational costs, which clearly affect their performance. Genetic algorithms have been proposed for more efficient searching times in template matching.

C. Appearance –based approach

This approach process the image as two dimensional patterns. The concept of "feature" in this approach is different from simple facial features such as eyes and mouth. Any extracted characteristic from the image is referred to a feature. This method group found best performer in facial feature extraction because it keep the important information of image and reject the redundant information. Method such as principal component analysis (PCA) and independent component analysis are used to extract the feature vector. The main purpose of PCA is to reduce the large dimensionality of observed variable to the smaller intrinsic dimensionality of

independent variable without losing much information. This technique would be later the foundation of the proposal of many new face recognition algorithms [15]. In PCA analysis high order dependencies exist and this is the disadvantage of this method because much information may contain in the high order relationship. While other method ICA uses technique independent component analysis which not only use second-order statistic but also use high order statistic. It has been observed that many natural signals, including speech, natural images, are better described as linear combinations of sources with super-Gaussian distributions. In that case, ICA method better than PCA method because: I) ICA provides a better probabilistic model of the data. II) It uniquely identifies the mixing matrix. III) It finds an unnecessary orthogonal basic which may reconstruct the data better than PCA in the presence of noise such as variations lighting and expressions of face. IV) It is sensitive to high-order statistics in the data, not just the covariance matrix [16]. Some problems with this method like that it requires that image matrices must be transformed into vectors, which are usually of very high dimensionality and this causes high computational cost and complexity.

D. Color –based approach

This approach uses skin color to isolate the face area from the non face area in an image. Any non-skin color region within the face is viewed as a candidate for eyes or mouth [17]. The performance of such techniques on facial image databases is rather limited, due to the diversity of ethnical backgrounds [18].

III. Color Based Feature Extraction

With the help of different color models like RGB skin region is detected [19], [20]. The image obtained after applying skin color statistics is subjected to binarization. Firstly it is transformed to gray-scale image and then to a binary image by applying suitable threshold. All this is done to eliminate the color and saturation values and consider only the luminance part. After this luminance part is transformed to binary image with some threshold because the features for face are darker than the background colors. After thresholding noise is removed by applying some opening and closing operation. Then eyes, ears, nose facial features can be extracted from the binary image by considering the threshold for areas which are darker in the mouth than a given threshold[u]. A triangle shape can be drawn considering the two eyes and nose as three points of triangle. After getting the triangle, it is easy to get the coordinates of the four corner points that form the potential facial region. Since the real facial region should cover the eyebrows, two eyes, mouth and some area below the mouth, this coordinates can be calculated [21][22]. The performance of such techniques on facial image databases is rather limited, due to the diversity of ethnical backgrounds.

Author	Technique	Methods	No. of feature	Advantages	Disadvantages
T. Kanade, 1997	Geometry -based	Gabor wavelet method	eyes, mouth and nose	Small data base Simple manner Recognition rate 95%	Large no. of features are used
A. Yuille, D. Cohen, and P. Hallinan, 1989	Template-based	Deformable template	eyes, mouth, nose and eyebrow	Recognition rate 100% Simple manner	-computational complexity -description between template and images has long time
C. Chang, T.S. Huang and C. Novak,1994	color-based	Color based feature extraction	Eyes and/or mouth	Small database Simple manner	-discontinuity between colors -in profile and closed eyes has a problem. Performance is limited due to diversity of backgrounds.
Y. Tian, T. Kanade, And J.F. Cohn,2002	Appearance -based Approaches	PCA, ICA, LDA	Eyes and mouth	Small no of feature -recognition rate 98%	-need good quality image. -large database require -illumination

Table-1 comparison between various feature extraction techniques.

IV. Conclusions

Feature extraction is most important part of face recognition because classification is totally depend on this part. A best feature extraction is not determined without evaluation of face recognition algorithm. That's why best feature set for face recognition are still a problem. This paper discusses various feature extraction technique. Every technique has its pros and cons such as appearance based technique represent optimal feature points which can represent global face structure but disadvantage is high computational cost. Template based methods are easy to implement but not represent global face structure. Color segmentation based methods used color

model for skin detection with morphology operation to detect features of face but different color model and illumination variation factors can affect performance.

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