A Survey on various Feature Extraction Techniques for Face Recognition

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Abstract- In this paper we are discussing the various feature extraction techniques which are being used in Face recognition and their importance and available feature extraction techniques with pros and cons of methods. Automatic facial feature extraction is one of the most important and attempted problems in face recognition.It is a necessary step in face, expression recognition, face detection, facial image compression and automatic image morphing.

Keywords – face feature extraction, Gabor wavelet transform, template based feature extraction.

I. INTRODUCTION

Human facial features play a significant role for face recognition and Neurophysiologic research..According to studies it is determined that eyes, mouth, and nose are amongst the most important features for recognition. Recognizing someone from facial features makes human recognition a more automated process. Basically the extraction of facial feature points, (eyes, nose, mouth) plays an important role in many applications, such as face recognition, face detection, model based image coding ,expression recognition, facial animation and head pose determination. It is important to note that because the systems use spatial geometry of distinguishing facial features, they do not use hairstyle, facial hair, or other similar factors. Facial recognition can be used generally for police work purposes. For example, public safety, suspected terrorists, and missing children.

Facial feature extraction has some problems which must be thought and be solved. Some problems of facial feature extraction are given as follow: Small variations of face size and orientation can be effected the result. As the input image comes from the webcam in the rooms condition the captured image has different brightness, shadows and clearness which can be failed the process. Sometimes facial features may be covered by other

things, such as a hat, a glasses, hand or hairs. Human faces have a variety of emotions by many different expressions,but this system can detect the corner of the features in the case of neutral, sad, happy and surprise. Most facial feature extraction methods are sensitive to various non-idealities such as variations illumination, noise, orientation, time-consuming and color space used[1]. Also a good feature extraction will increase performance of face recognition system.

The remaining part of our paper is organized as follows: In section II discuss existing feature extraction techniques with A. Geometry based methods, B. color segmentation based methods, C. Appearance based methods and D. Template based methods With pros and cons

of techniques.finally in section III we will conclude the paper and give the future aspects of this paper.

II. FEATURE EXTRACTION TECHNIQUES

Some image processing techniques extract feature
points such as nose, eyes , mouth are extracted and
then used as input data to application. For some application it has been the central step. Several Various approaches have been proposed to extract
these facial points from images or video sequences of faces. The four basic approaches are as follow:

A. Geometry-based Techniques

The features are extracted by using relative positions and sizes of the important components of
face. this group methods concentrates in two directions. First, detecting edges, directions of important components or region images contain important components, then building feature vectors from these edges and directions. Using filters such as Canny filter to detect eyes or mouth region of face image, or the gradient analysis method which is usually applied in this direction. Second, methods are based on the grayscales difference of important components and unimportant components, by using feature blocks, set of Haar-like feature block in Adaboost method[6] to change the grayscales distribution into the feature. In LBP[7] method, it divides up the face image to regions (blocks) and each region corresponds with each central pixel. Then it examine its pixel neighbors, based on the grayscales value of central pixel to change its neighbor to 0 or 1. Therefore, every pixel will be represented in a binary string. Since then, we build histograms for every region. Then these histograms are combined to a feature vector for the face image. One of the method is Gabor wavelets transform[5][12] feature extraction, is described here.

I Gabor Wavelets Transform Face Feature Extraction

The Gabor wavelet transform uses a set of Gaussian enveloped basis functions that are orthogonal-like basis functions. Gabor wavelets provide analysis of the input image in both spatial and frequency domains simultaneously. Gabor wavelets are widely used in image analysis and computer vision [5].

Gabor wavelet define by[12]

$$\varphi(x, y, \omega^{\circ}, \theta) = \frac{1}{2\pi\sigma^2}(\mu\vartheta) \qquad (1)$$

Where

$$-((xcos\theta + ysin\theta)^2 + (-xsin\theta + ycos\theta)^2)/_{2\sigma^2} \qquad (2)$$

$$\mu = e$$

and

$$v = [e^{i(\omega_0 x\cos\theta + \omega_0 y\sin\theta)} - e^{-\omega_0^2\sigma^2/2}] \qquad (3)$$

where x, y define the pixel position in the spatial domain, ω_0 the radial center frequency, the θ orientation of the Gabor wavelet, and the **σ** standard deviation of Gaussian function along the x and y -axes. In addition, the second term of the Gabor wavelet $-e^{-\omega_0^2\sigma^2/2}$ compensates for the DC value because the cosine component has nonzero mean (DC response) while the sine component has zero mean. As the half – amplitude bandwidth of the frequency response is about 1-1.5 octaves along the axes. The relationship between **σ** and ω_0 can be derived as

$\sigma = {}^{k}/_{\omega_0}$ where

$$k = \sqrt{2ln2}\left(2^{\emptyset} + {}^{1}/_{2^{\emptyset}+1}\right) \qquad (4)$$

where Φ is the bandwidth in octaves. The Gabor representation of image can be derived from the convolution of the image and Gabor wavelets. Let G(x,y) denote the image , then the convolution of G(x,y) and $\varphi(x, y, \omega°, \theta)$ is defined as follows:

$$C_{\varphi G}(x, y, \omega_0, \theta) = G(x, y) * \varphi(x, y, \omega_0, \theta)$$

Where * denote the convolution operator and $C_{\varphi G}(x, y, \omega_0, \theta)$ is the convolution result corresponding to the Gabor wavelet at radial centre frequency ω_0 and, θ so it can be obtained multihierarchal Gabor representation of the image G(x,y). according to Methods[3][5] suggest that good result can be obtained by using Gabor wavelets of five different scales ω_0 {0, . . . , 4} and θ eight orientations, θ {0, . . . , 7} ,σ = 2π. it is called ,σ = 2π. it is called Gabor wavelet faces. The down sampled Gabor wavelet transform results by the factor of 64 formed a feature vector[10][11]. So 40 Gabor wavelets can be used to extract key points feature. Following figure explain flowchart of method. Fig. I

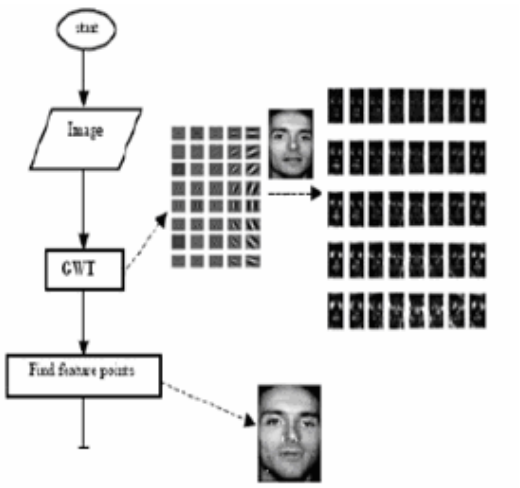

Fig. I Gabor wavelets transform Feature extraction[11]

Nevertheless these techniques require threshold, which, gives the privileged sensitivity. But it may affect the achieved performance. The advantages of these methods are concentration on

important components of face such as eyes, nose, mouth, etc. but the disadvantage is not to represent face global structure and face texture.

B. Color Segmentation Based Techniques

This approach makes use of skin color to isolate the face. Any non-skin color region within the face is viewed as a candidate for eyes or mouth[13].

I. Color based feature extraction

By use Color models such as RGB , YCbCr or HSV with certain range of color pixels, skin region is detected[2][16][17]. After getting the skin region, facial features viz. Eyes and Mouth are extracted. The image obtained after applying skin color statistics is subjected to binarization. it is transformed to gray-scale image and then to a binary image by applying suitable threshold. This is done to eliminate the hue and saturation values and consider only the luminance part. This luminance part is then transformed to binary image with some threshold because the features for face are darker than the background colors. After thresholding, opening and closing operations are performed to remove noise.These are the morphological operations, which are used to remove holes. Then eyes, ears, nose can be extracted from the binary image by considering the threshold for areas which are darker in the mouth than a given threshold[18]. So triangle can be drawn with the two eyes and a mouth as the three points in case of a frontal face. And it is easy to get an isosceles triangle (i j k) in which the Euclidean distance between two eyes is about 90-110% of the Euclidean distance between the centre of the right/left eye and the mouth. 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 [15][19][20]. The performance of such techniques on facial image databases is rather limited, due to the diversity of ethnical backgrounds.

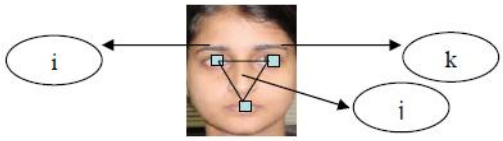

Fig. III color based feature extraction [15]

C. Appearance Based Techniques

This type of methods is using linear transformation and statistical methods to find the basic vectors to represent the face. Methods have been proposed in the literature for this aim such as PCA and ICA [9].In detail, goal of PCA method is to reduce the number of dimensions of feature space,but still to keep principle features to minimize loss of information. PCA method uses second-order statistic in the data. However, PCA method has still disadvantages. High order dependencies still exist in PCA analysis, for example, in tasks as face recognition, much of the important information may be contained in the high-order relationships among the image pixels, not only second-order. While other method ICA uses technique independent component analysis. it is an analysis technique not only use second-order statistic but also use high order statistic.PCA can be derived as a special case of ICA which uses Gaussian source

models. PCA is not the good method in cases non Gaussian source models. 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[13]. but it require that the image matrices must be first transformed into vectors, which are usually of very high dimensionality. This causes expensive computational cost and sometimes the singularity problem The appearance based method group has been found the best performer in facial feature extraction because it keeps the important information of face image, rejects redundant information and reflect face global structure.

D. Template Based Techniques

This method group will extract feature of face such as eyes, mouth, etc. based on template function and appropriate energy function[4]. An image region is the best appropriateness with template for eye, mouth or nose, which will minimize the energy. The methods have been proposed such as deformable template and genetic algorithms. In the deformable template method[8], the feature of interest, an eye, for example, is described by a parameterized template. An energy function is defined to links edges, peaks, and valleys in the image intensity with corresponding properties of the template. Then 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. The final parameter values can be used as descriptors for the features.

I. Template based eye and mouth detection

In this method, first an eye template is used to detect the eye from face image. The correlation of eye template with various overlapping regions of the face image is found out. The region with maximum correlation with the template refers to eye region. The block diagram of the method is shown in Figure.

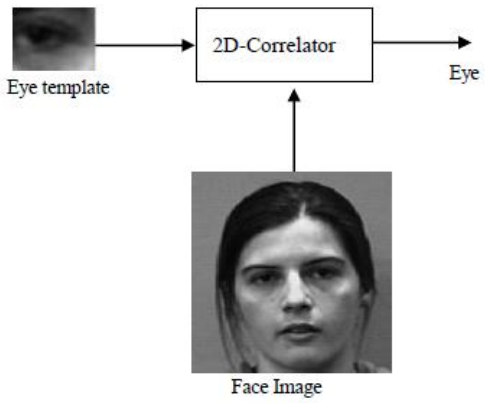

Fig. II Template based Feature detection[14]

The method of template matching is given as an which is simple and easy to implement. Some steps are as follows[14].

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 complex mathematical calculation and prior knowledge about the features geometry. This techniques are easily implemented with key face features but it does not represent global face structure.

V. CONCLUSION

This paper has discussed face feature extraction, which is important application for various other applications with different techniques considering different parameters. Every method has pros and cons such as Template based methods are easy to implement but not represent global face structure.
While color segmentation based methods used color model for skin detection with morphology operation to detect features. So different color model and illumination variation these factors can affect performance. Appearance based methods represent optimal feature points which can represent global face structure but disadvantage is high computational cost. Geometry based methods such as Gabor wavelet transform face feature extraction provide stable and scale invariant features. wavelets enable localization in both spatial and frequency domains with high frequency salient feature detection. And such set of continuous 2D Gabor wavelets will provide a complete representation of any image. So In future work of research we are trying to implement Gabor wavelet transform face feature extraction method which can be used as input for automatic image morphing algorithm.

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