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Face Recognition and Gender Classification Using Features of Lips

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ABSTRACT: This paper presents a novel approach for Face Recognition and Gender classification strategy using the features of lips. Here feature extraction is carried out by using Principal component analysis (PCA) and Gabor wavelet. The proposed algorithm converts the RGB image into the YCbCr color space to detect the skin regions in the facial image. But in order to detect facial features the color image is converted in to gray scale image. This method locates the lip region and the mouth region. The gender classification method classifies almost all the images with different image sizes. The best classification rate is achieved by using the methods given in this work. The whole idea is offering a simple, reliable and robust method for extracting features of lips for face recognition and gender identification. For recognition experiments we used face images of persons from different sets of the FERET and AR databases. Recognition experiments with the FERET database (containing photographs of persons) showed that our method can achieve maximal 97-98% first one recognition rate and 0.3-0.4% Equal Error Rate.

KEYWORDS: Face recognition, Gender classification, Principal Component Analysis, Gabor wavelet, YCbCr.

1 INTRODUCTION

Biometrics is the study of methods for measuring unique biological and psychological characters of human being that can be used for uniquely recognizing or verifying the individual's identity. Biometric identification methods have been proved to be very efficient, more natural and easy for users than traditional methods of human identification. There are several biometric methods such as face recognition, fingerprint recognition, iris localization, palm-vein recognition, signature analysis etc. But we need to investigate novel methods of authentication that find mass appeal. This brings us to identification and authentication using FACE RECOGNITION SYSTEMS.

This paper proposes a new technique for Face Detection and Gender Identification by using the features extraction of lips. Lip detection is one of the biometric systems based on which a genuine system can be developed which holds an advantage of making the system secure. The Gender classification tells us that whether the given facial image belongs to the gender male or female. Here face detection and gender classification methods are combined. The face detection acts as a pre-processing step for the gender classifier that determines the gender of the individual. The most important factors are usually the detection and classification accuracies. The other important factors are detection and classification speeds. The main issues of the face detection and gender classification are the selection of the color space to detect skin region, face detection and gender classification methods. The connection between face detection and gender classification are examined experimentally. Face Detection in feature-based approach, the apparent properties of the face such as skin color and face geometry are exploited. In this system face detection method depends on feature derivation and analysis to gain the required knowledge about face. Facial features may be skin color, face shape, or facial features like mouth, eyes, and nose. In all the face and skin detection algorithms, the 2-D image are used. The threshold values (of intensity) are applied on the image to determine the skin region on the face. The face feature area is calculated. The facial features such as mouth, eyes and nose are estimated through the lip point detection and applying the standard threshold values of measurements (in number of pixels) to get the entire portion of the features. Lips have certain advantages over the more established biometric traits such as ear, palm-vein, fingerprint etc, they have a rich and stable structure that is preserved well even at the old age. The size of the lip is large compared with the iris, retina, and fingerprint and therefore is more easily captured.

Here database is generated and images of the faces are stored for future verification. In our system Feature extraction is carried out by using two methods first one is PCA transform and second one is Gabor wavelet. After transformation feature extracted image is given for testing and identification of the gender is done by using Minimum distance classifier method which tells us that either the input image is male or female.

The paper is organized as follows: first literature review of different methods is given then next point is about system development followed by conclusion and references.

2 Literature Survey

This section gives an overview on major human face detection and gender classification methods that apply mostly on frontal faces**.** The main issues of the face detection and gender classification are the selection of the color space to detect skin region, face detection and gender classification methods. The connection between face detection and gender classification are examined experimentally. Face Detection in feature-based approach, the apparent properties of the face such as skin color and face geometry are exploited. Feature–based face detection method depends on feature derivation and analysis to gain the required knowledge about face. Facial features may be skin color, face shape, or facial features like mouth, eyes, and nose. Among the face and skin detection algorithms, the 2-D image are used. The threshold values (of intensity) are applied on the image to determine the skin region on the face. The face feature area is calculated. The facial features such as mouth, eyes and nose are estimated through the lip point detection and applying the standard threshold values of measurements (in number of pixels) to get the entire portion of the features.

Evaluation of Gender Classification Methods with Automatically Detected and Aligned Faces [1]. This paper included study and comparison of four fundamentally different gender classification methods and four automatic alignment methods together with non-aligned faces and manually aligned faces. They also analyzed how the classification accuracy was affected when face image resizing occurred before or after alignment. Finally, they conducted a sensitivity analysis for the classifiers by varying rotation, scale, and translation of the face images.

Gender Classification with Support Vector Machines [2], the first automatic system for combined face detection and gender classification. They used maximum-likelihood estimation for face detection and for facial feature detection. For gender classification, they used several different classifiers. The experiments were carried out with a set of FERET images [3]. The most interesting findings in the context of this paper were that the Support Vector Machine (SVM) performed better than the other classifiers and resolution of the face did not affect the classification rate with the SVM.

A Unified Learning Framework for Real Time Face Detection and Classification [4]. This paper combined the cascaded face detector by Viola and Jones with discrete Adaboost-based gender and ethnicity classification. The advantage of the system. is that many preprocessing and book keeping calculations can be shared by the face detector and the gender classifier. Boosting Sex Identification Performance [5] presented an Adaboost system for gender classification with manually aligned faces. They carried out a thorough experimental comparison between the Adaboost and an SVM classifier by varying face image scaling, translation, and rotation. Similar comparative analysis was conducted An Experimental Study on Automatic Face Gender Classification [6] reported a detailed analysis of how different normalizations affect gender classification accuracy. They had three different methods for alignment and three gender classifiers: an SVM, an FLD, and a two-layer Real Adaboost classifier. They used Chinese face images in the experiments. The most interesting fact from the viewpoint of this paper was their claim that shape-free alignment may produce better classification results with methods that use local features such as haar-like features, while shape preserving alignment methods may produce better results with global features.

3 System Development

The face detection and the gender classification methods are described in the flow chart given in figure given below.

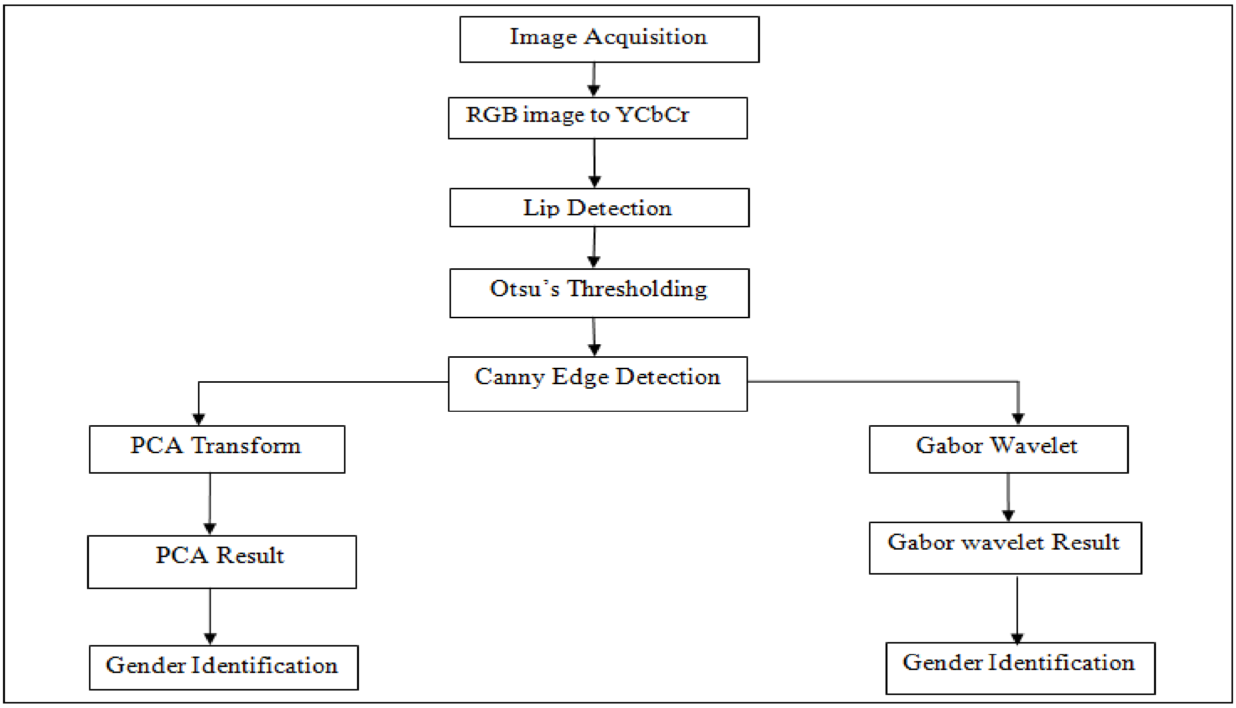

Fig 1: Flow Chart

3.1 Face Detection

The proposed algorithm first locates the face region using skin-color. The YCbCr color space is used to detect the skin region on the given input face image. The given input RGB image is converted into the YCbCr color space. Color is a powerful cue of human faces. The distribution of skin clusters is in a small region of the chromatic color space. Processing color is faster than processing other facial features. Therefore, skin color detection is firstly performed on the input color image to reduce the computational complexity as described in Face Detection System Based on Feature – Based Chrominance Color Information [7]. In order to improve the performance of skin color clustering, YCbCr space is used to build a skin color model. The chrominance components are almost independent of luminance component in the space. There are non-linear relations between chrominance (Cb, Cr) and luminance (Y) of skin color in the high and low luminance region. As stated in 'Face Detection in color Images Using AdaBoost algorithm' based on skin color information[8] the apparent difference in skin color perceived is mainly due to the darkness or fairness of the skin, characterized by the difference in the brightness of the color, which is governed by Y but not Cb and Cr in YCbCr color space. Y, luminance component is brightness component, whereas Cb and Cr are chrominance components, which correspond to color components. In the color detection process, each pixel is classified as either skin or non-skin based on its color components. The gamma corrected RGB value is determined through the formula as in "Digital Image Processing" [9] that uses the constant values. Then lip detection is carried out by cropping lip part from the whole face region. After lip detection Otsu's thresholding is done for the segmented image acquisition . Lastly Canny edge detection is performed for perfect shape analysis to be done in our system. Once the perfect shape analysis is done then we may proceed for the feature extraction of lips and then to identify the gender of the particular individual. The whole work is done by programming in MATLAB. In programming we initialize the wait bar for showing our progress of detection and identification. One training set is generated in which images of faces are stored for the verification and one testing set for the verification. Feature extraction of ROI i.e. lip here is done by the following two methods:

- **PCA Method:**

The purpose of PCA is to reduce the large dimensionality of the data space (observed variables) to the smaller intrinsic dimensionality of feature space (independent variables), which are needed to describe the data economically. This is the case when there is a strong correlation between observed variables. The jobs which PCA can do are prediction, redundancy removal, feature extraction, data compression, etc. Because PCA is a classical technique which can do something in the linear domain, applications having linear models are suitable, such as signal processing, image processing, communications, etc. Face recognition has many applicable areas, moreover, it can be categorized into face identification, face classification, or gender determination. Starting from the successful low dimensional reconstruction of faces using KL or PCA projections eigen pictures have been one of the major driving forces behind face representation, detection, and recognition. It is well known that there exist significant statistical redundancies in natural images. For a limited class of objects such as face images that are normalized with respect to scale, translation, and rotation, the redundancy is even greater. One of the best global compact representations is KL/PCA, which decorrelates the outputs. Some of this noise may be due to small occlusions, as long as the topological structure does not change. For example, good performance under blurring, partial occlusion and changes in background has been demonstrated in many eigen picture based systems, as illustrated in This should not come as a surprise, since the PCA reconstructed images are much better than the original distorted images in terms of their global appearance. Computing the eigenvectors: Performing PCA directly on the covariance matrix of the images is often computationally infeasible. If small, say 100 × 100, greyscale images are used, each image is a point in a 10,000-dimensional space and the covariance matrix S is a matrix of 10,000 × 10,000 = 10^8 elements. However the rank of the covariance matrix is limited by the number of training examples: if there are *N* training examples, there will be at most *N* − 1 eigenvectors with non-zero eigenvalues. If the number of training examples is smaller than the dimensionality of the images, the principal components can be computed more easily as follows. Let T be the matrix of preprocessed training examples, where each column contains one mean-subtracted image. The covariance matrix can then be computed as $S=TT^T$ and the eigenvector decomposition of S is given by

$Sv_i = TT^T V_i=\lambda_i V_i$

However TT^T is a large matrix, and if instead we take the eigenvalue decomposition of

$T^T T u_i= \lambda_i u_i$

then we notice that by pre-multiplying both sides of the equation with T, we obtain

$TT^T T u_i= \lambda_i T u_i$

Meaning that, if u_i an eigenvector of $T^T T$, then $v_i = Tu_i$ is an eigenvector of S. If we have a training set of 300 images of 100 × 100 pixels, the matrix $T^T T$ is a 300 × 300 matrix, which is much more manageable than the 10,000 × 10,000 covariance matrix. Notice however that the resulting vectors v_i are not normalised; if normalisation is required it should be applied as an extra step.

- **Gabor Wavelet Method:**

If Gaussian window is used in STFT, it is also named Gabor Transform, which is widely used due to its less leakage in time-frequency domain The major advantage of SHFT is that it could provide us the time-frequency location of the signal, which we are interested in, and some of their applications in Pattern recognition. Gabor filters are examples of Wavelets having two bases for images , Pixels are localized in space & Fourier are localized in frequency ,so such filters can be used for measuring frequency locally The Gabor transform can be explained as: Its impulse response is defined by a sinusoidal wave (a plane wave for 2D Gabor filters) multiplied by a Gaussian function. Because of the multiplication-convolution property (Convolution theorem), the Fourier transform of a Gabor filter's impulse response is the convolution of the Fourier transform of the harmonic function and the Fourier transform of the Gaussian function. The filter has a real and an imaginary component representing orthogonal directions.[4] The two components may be formed into a complex number or used individually. The Gabor transform is like the short time Fourier transforms. We can see that the Gabor transform kernel is the Fourier transforms kernel plus a Gaussian function. Therefore we can make a lot of transforms like the Gabor transform. Since the Gaussian signal is more concentrated than the rectangular function in the frequency domain, the frequency resolution of the Gabor transform is much better than short time Fourier trans form, Gabor transform, or named by short time Fourier transform (STFT)

Complex

$$g(x,y;\lambda,\theta,\psi,\sigma,\gamma) = \exp\left(-\frac{x'^2+\gamma^2 y'^2}{2\sigma^2}\right)\exp\left(i\left(2\pi\frac{x'}{\lambda}+\psi\right)\right)$$

Real

$$g(x,y;\lambda,\theta,\psi,\sigma,\gamma) = \exp\left(-\frac{x'^2+\gamma^2 y'^2}{2\sigma^2}\right)\cos\left(2\pi\frac{x'}{\lambda}+\psi\right)$$

Imaginary

$$g(x,y;\lambda,\theta,\psi,\sigma,\gamma) = \exp\left(-\frac{x'^2+\gamma^2 y'^2}{2\sigma^2}\right)\sin\left(2\pi\frac{x'}{\lambda}+\psi\right)$$

where

$$x' = x\cos\theta + y\sin\theta$$

and

$$y' = -x\sin\theta + y\cos\theta$$

In this equation, λ represents the wavelength of the sinusoidal factor, θ represents the orientation of the normal to the parallel stripes of a Gabor function, ψ is the phase offset, σ is the sigma/standard deviation of the Gaussian envelope and γ is the spatial aspect ratio, and specifies the elasticity of the support of the Gabor function.

3.2 GENDER IDENTIFICATION

After the feature extraction process two databases are created, one for testing and another for training. It is mandatory for the image to be tested is stored in the database of training images. First perform the feature extraction of lips of test image by using PCA and Gabor then apply Minimum distance classifier method for the gender identification. Minimum distance classifier method means test image is compared with image of training set individually. If the extracted features of test image matches with female features then it will gives the result of that particular individual as female or else it can be considered as male that means extracted features of the test image matches with male features.

4 CONCLUSIONS

In this paper, face recognition and gender identification is carried out by feature extraction of lips and for extraction purpose PCA and Gabor filter are used. The extracted features of lips are then stored in the database known as training set and are then compared with the test image from test set. For the gender identification of particular individual the Minimum distance classifier method gives the best result with no extra efforts. Out of two techniques i.e. PCA and Gabor used for feature extraction the results of Gabor filter are more accurate and fast because it is having less leakage in time frequency domain.

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