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Different Facial Expression Recognition and Face Detection Technique

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Abstract
Face detection is a computer technology that determines the locations and sizes of human faces in arbitrary (digital) images. After detection of face in a picture, it can be compared with the ones present in the database. This paper describes a hybrid approach that uses the fusion of individual techniques used for detection as well as for recognition of human faces.
Index Terms: face detection, skin color extraction, hair extraction, faces, non-faces.

INTRODUCTION

Face detection extracts facial features and ignores anything else, such as buildings, trees and bodies. There are many ways of detecting the human face in a picture; the one used in this paper is the fusion of two individual detections i.e. skin and the hair detection. The place where a combination of skin a hair to certain extent is detected, it automatically considers it as a face.Human face detection has been significantly developed for surveillance system, intelligent robots, digital cameras, 3G cell phones. They play most important role in day to day life. Over past decade, many techniques have been proposed for human face detection: (i) Threshold technique: This technique may not work well under poor or strong lighting condition . (ii)PCA technique: This can only process the faces have the same face expression. (iii)Minimal facial feature algorithm: it is unable to handle weak learners with an error rate greater than 1/2. As a result, this technique may easily fail in the multi-class case. In this paper we proposed a hybrid approach and this method works in two stages.

The first stage involves extraction of pertinent features from the localized facial image using Gabor filters. Second stage requires classification of facial images based on the derived feature vector obtained in the previous stage. And so a Neural Network Based classifier is used which examines an incremental small window of an image to decide if there is a face contained in each window. The neural network is trained to choose between two classes 'faces' and 'non-faces' images. It is easy to get a representative sample of images that contains faces but it is much harder to get a representative sample of those images that do not contain faces.

IMPLEMENTATION DETAILS

1. Detection of faces

In this paper, a convenient method for detecting human faces in real-time is proposed. This method, adopts the geometric characteristics of skin and hair color to detect human faces. In addition, this method can be used to develop to an embedded system, as making a robotic system used for dynamic detection and recognition of human faces.

The detection method includes five main modules--(A)Skin Detection: [1]Using color information to detect possible skin color in an image (B)Hair Detection: Utilizing brightness information to find out where hair probably is (C)Skin Quantization: Quantizing skin color pixels and identifying blocks of the skin (D)Hair Quantization: Quantizing hair color pixels and identifying blocks of the hair (E) Get the Fusion of Features: Determining whether the detected skin area is a part of a human face according to the relative positions between skin and hair regions.

After the detection of the face area, recognition process can begin i.e. the extracted face has to be compared with the ones present in the database so as to complete the system.

A. Skin Detection

Many studies have been involved in defining the range of skin color in an image. Extracting skin color from the Normalized RGB color model was found to be effective since the RGB model without normalization was sensitive to variations of light. The RGB model was therefore transformed to the Normalized RGB model. The formulas for the transformation are listed as equation 1 and 2:

$$r = \frac{R}{R+G+B}$$

$$g = \frac{g}{R+G+B}$$

Equation 1 represents the normalization of a red pixel while equation 2 stands for that of a green pixel.

The two equations stated above accordingly specify the upper limit $F_1(r)$ and lower limit $F_2(r)$of the skin color. We change this color values into hue, saturation, value.

$F_1(r) = 0.148*R - 0.291*G+ 0.439 *B + 128;$

$F_2(r) = 0.439 * R- 0.368 * G-0.071 * B+ 128;$

Skin= { 1 if(140<=cr(i,j) ⋂ cr(i,j)<=165 ⋂ 140<=cb(i,j) ⋂ cb(i,j)<=195 ⋂ 0.01<=hue(i,j) ⋂ hue(i,j)<=0.1)

0 otherwise

B .Hair Detection

The intensity element of HSI color model is employed for detecting the hair color. The relation between the intensity element and RGB elements is as follows:

$$I = \frac{1}{3}(R + G + B)$$

This intensity element is available for evaluating the brightness of an image; moreover, the hair color is specified to be in the range of dark

Hair= { 1 if (I<80 ⋂ (B-G< 15 U B-R <15))

U

(20<H<40)

0 otherwise

2. Recognition from Database

The Principal Component Analysis (PCA) is the technique that is most widely used in image recognition. [3]PCA is a mathematical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of uncorrelated variables called principal components. The number of principal components is less than or equal to the number of original variables. So PCA reduces the large dimensionality of the original data base. The main idea of using PCA for face recognition is to express the large 1-D vector of pixels constructed from 2-D facial image into the compact principal components of the feature space.

MATHEMATICAL ANALYSIS OF PCA

Let's consider we have a total of M 2-D images Now in PCA each of this image is converted into 1-D column vector of size N(=number of rows × number of columns) by concatenating its rows and column. so there are total of M such 1-D vectors.

$x_i = [p_1 : : : p_N]^T ; \quad i = 1; : : : ; M,$

where pi represents the pixel values

Now place all the column vectors into a single matrix X of dimensions $N \times M$.

The next step is to find the mean centered image that is found by subtracting the mean image from each image vector. Let m represent the mean image, then

$$m = \frac{1}{M}\sum_{i=1}^{M} x_i$$

Let a_i is the mean centered image, then

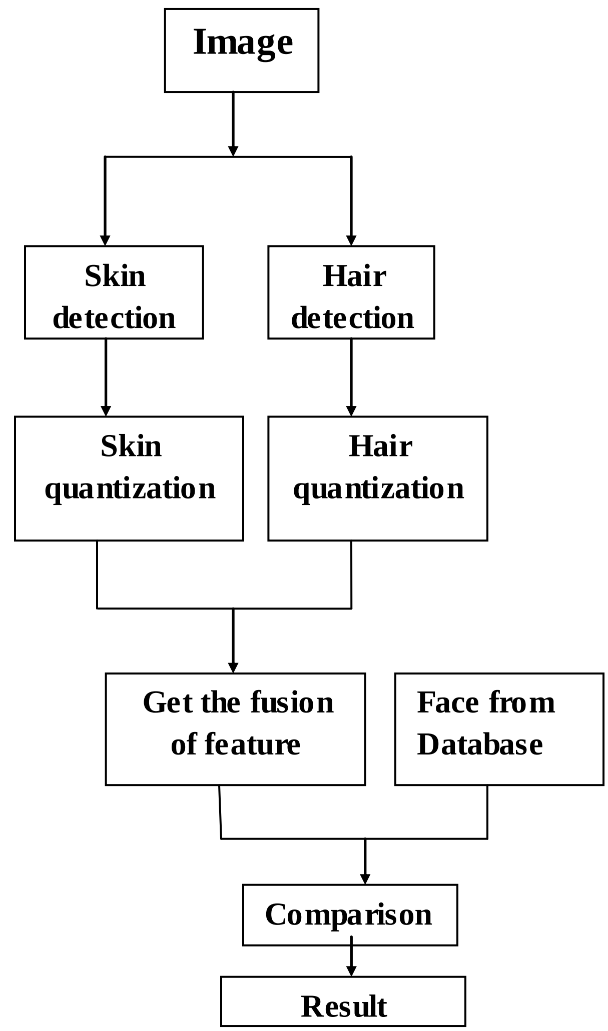
$a_i = x_i - m$.

Now find the eigen values and eigen vectors u_k of the covariance matrix C,

$$C = \frac{1}{M}\sum_{i=1}^{M}(\phi_i \phi_t^{\,T})$$

The calculated eigen vectors uk, k=1,…..M-1 also called eigen features are termed as principal components which can even be used for the reconstruction of the original images. The eigen vector having highest associated eigen value carries the largest information of the image. Any image outside this eigen space can be transformed into the eigen space using the same procedure.

The following figure shows the flow chart of the hybrid approach:



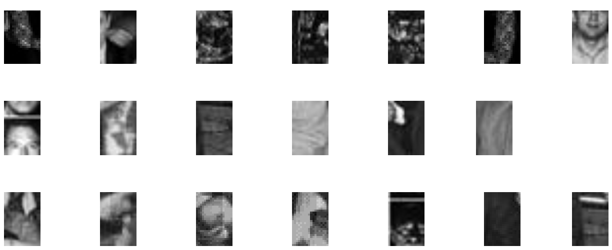
RESULTS AND DISCUSSIONS

Detection of Faces in a Picture

An insight into the true performance of the system can only be achieved through the use of an independent test set of "unseen" images. The test set should contain images of various resolutions, with both face and scenery examples present. The appropriate choice of an image database for training is extremely important in order to fulfill the goals set for training. The strengths include the large number of different subjects; the dataset has good diversity across age, race, and gender.

The training dataset was restricted only to frontal view images and it contains 136 training examples, 86 face and 50 non-face images. The images in the dataset are of 27x18 pixels; each image is a Grayscale image in JPEG format. Some samples of images of faces and non-faces from database are shown in figures below:

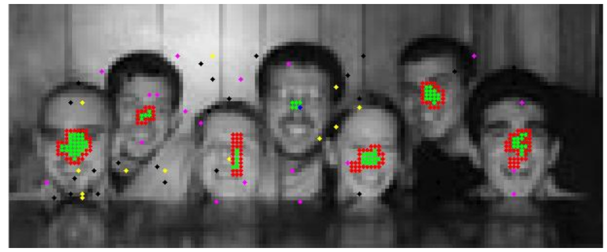
Samples of Faces from Database used in the Face Detection System.

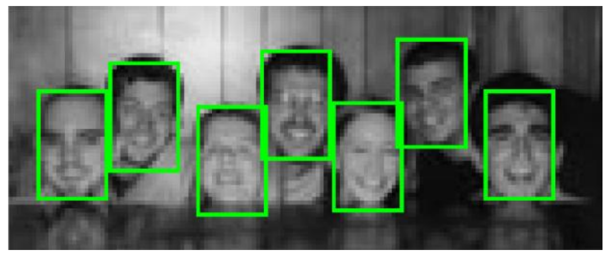


Samples of Non-Faces from Database used in the Face Detection System.

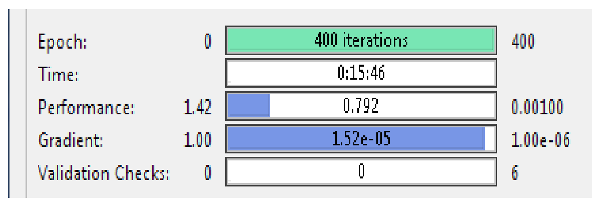
Gabor Mask Used in the Face Detection System

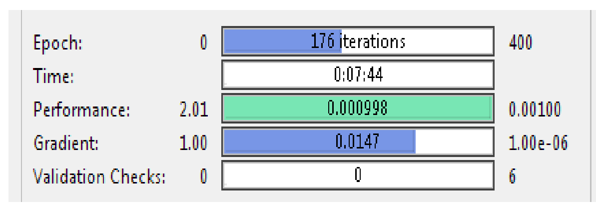
Interesting feature points in the face image are located by Gabor filters. The feature points are typically located at positions with high information content (such as facial features), and at each of these positions we extract a feature vector consisting of Gabor coefficients.

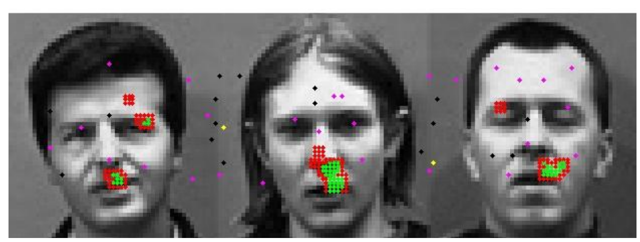




Training of Neural Network:







Comparison of Detected Faces With The ones in the Database

A new database is created containing a set of pictures only of the faces, now this set is compared with the faces detected in the technique used earlier. This comparison is done using a technique known as Principle Component Analysis (PCA). Each one of the extracted faces can be compared with the pictures of faces of same persons but with different expressions.

CONCLUSION AND FUTURE WORK

The main limitation of the implemented system is that it only detects upright frontal faces and the variation like rotated faces and side views are restricted .The aim of future proceeding in this system should be to improve the detection rate, to minimize the number of false positives, to improve the speed of the detection process and to look for the detection of face taking the 3-dimensional view considering the various different angles. This will further make the system more secure and accurate.

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