

Using The Characteristics of Image Color in Eye Regions For Eye Detection

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Abstract

A Biometric system provides perfect identification of individual based on a unique biological feature or characteristic possessed by a person such as finger print, hand writing, heartbeat, face recognition and eye detection. Among them eye detection is a better approach since Human Eye does not change throughout the life of an individual. It is regarded as the most reliable and accurate biometric identification system available. This paper presents an algorithm to extract eyes from an image containing a human face using a skin color model. The face region is extracted from the image using YCbCr color space. Then construct a ghost image depending on the characteristics of eye region in color space that have high Cb and low Cr to detect eyes area. The algorithm is applied on frontal facial and 30° view images. The results demonstrated successful detection.

Introduction

Automatic extraction of human head, face boundaries, and facial features is critical in the areas of face recognition, criminal identification, security, surveillance systems, human computer interfacing, and model-based video coding [M. H. Yang, 2006, W. Huang , R. Mariani,2009]. In order to detect faces and find the facial features correctly, researchers have proposed a variety of methods which can be divided into two categories. One is based on gray-level template matching, and the other is based on

computation of geometric relationship among facial features [G. C. Feng, 2008]. Eye detection is also the most important and critical task of face detection [C. C. Chiang, 2003].

The problem of human eye detection, localization, and tracking has received significant attention during the past several years because of wide range of human-computer interaction (HCI) and surveillance applications. As eyes are one of the most important salient features of a human face, detecting and localizing them helps

researchers working on face detection, face recognition, iris recognition, facial expression analysis, etc[Kun Peng, Liming Chen, 2005]. In this paper, we propose an algorithm of eye detection using the characteristics of image color in eye regions.

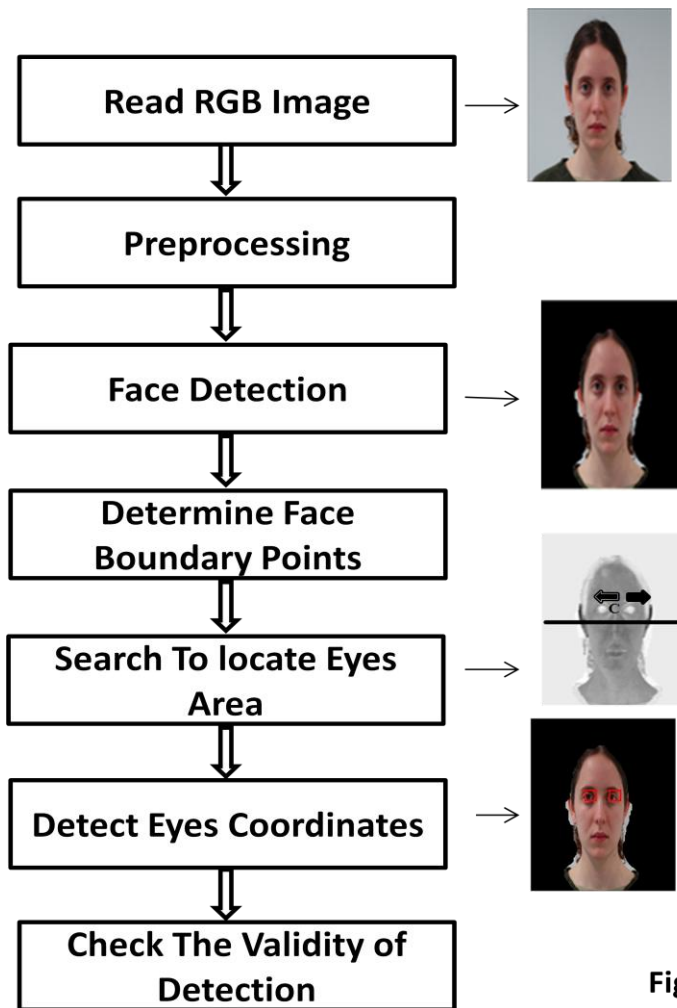
Proposed Algorithm

The eye detection is achieved in three stages. In the first stage, after reading a single face image, the main concern is to identify the image region which contains a face regardless of its orientation and background. The face area is extracted from a color image using

YCbCr color model. It is followed by constructing what I call a ghost image according to the characteristics of eye region. Finally eye areas are localized and check the correctness of the algorithm using the projection functions which employed in each eye. Figure (1) shows the process steps.

1. Face Area Extract

After reading facial image $I(n,m)$, preprocessing is performed to remove noise and convert the image from RGB color space to HVS color space. Then YCbCr color space is obtained by the following equations:



Figure(1) Eye Detection Steps

$$Cb = 0.148 * H - 0.291 * V + 0.439 * S \quad (1)$$

$$Cr = 0.439 * H - 0.368 * V - 0.071 * S \quad (2)$$

After analyzing YCbCr color space found that the best results to localize skin area could be found by using the following thresholds:

$$(139 \leq Cr \leq 165) \ \& \ (140 \leq Cb \leq 192) \ \& \ (0.01 \leq Hue \leq 0.1)$$

Once the skin color area is localized the resultant image is converted to binary image. The process of erosion and dilation is carried out to remove unwanted pixels which were falsely detected as skin color pixels as shown in Figure (2).



Figure (2) Binary Image of Skin Area

2. Construct Ghost Image

This stage is based on the idea that the eye regions have high Cb and low Cr. The ghost image is constructed by:

$$GI = 2 * Cb - Cr \tag{3}$$

This formula is designed to emphasize pixels with high Cb and make the pixels with lower Cr weaker and causes the pixels with high Cb and low Cr brighten, Figure (3) shows the ghost image.

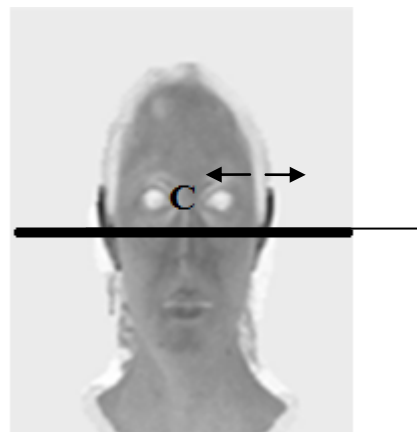


Figure(3) Ghost Image

3. Eye Region Localization

The step of the eye detection is determining the top, left and right sides of the face region. This step is important since finding the boundaries of the face region narrow down the area in which the eyes are.

Once the face region boundaries have detected, the upper part of the face is taken because it contains the eyes. Then find the center (xc, yc) of the upper part of the face and move to the left and to the right looking for the pixels of high values which represent the eyes area. The pixel values of this region can be found using the following threshold $100 \leq P \leq 131$.



Figure(4) Determine the center of Upper Part

The following steps used to find the eyes area:

- a. Find the center (xc, yc) of the upper part.
- b. At point (xc, yc), move left until 15 consecutive pixels with the threshold $100 \leq P_{ij} \leq 131$ are found. Check the boundaries of each pixel in this region. If the number of the pixel boundary in the range $100 \leq P_{ij} \leq 131$ is greater than 5 then this pixel is belong to the eye area.
- c. At point (xc, yc), move right until 15 consecutive pixels with the threshold $100 \leq P_{ij} \leq 131$ are found. Check the boundaries of each pixel in this region. If the number pixels of the pixel boundary in the range $100 \leq P_{ij} \leq 131$ is greater than 5 then this pixel is belong to the eye area.

To check the correctness of the previous step the intensity changes on the face have been found. This is done by calculating the average for each horizontal value and vertical value (equation (4)). After that, find the most significant valleys, which will indicate the eye region. The second largest valley with the next lowest y-coordinate is the eye. This step is done for the left and right side of the face.

$$\left. \begin{aligned} HP_i &= \frac{1}{m} \sum_{j=1}^m I_{ij} \\ VP_j &= \frac{1}{n} \sum_{i=1}^n I_{ij} \end{aligned} \right\} \quad (4)$$

If the horizontal and vertical values belong to the area that allocated in the previous steps then the algorithm works in a good manner.

$P_{i-1,j-1}$	$P_{i-1,j}$	$P_{i-1,j+1}$
$P_{i,j-1}$	$P_{i,j}$	$P_{i,j+1}$
$P_{i+1,j-1}$	$P_{i+1,j}$	$P_{i+1,j+1}$

Experimental Results

The proposed algorithm was implemented in MATLAB and 100 facial images from GTAV Face Database were used to test the algorithm. The input images vary greatly in background, expression and illumination, some images also including glasses wearing. The eyes are marked with red rectangles. Figure (4) shows some true detection. The accuracy of eye detection was 89.6%.

Conclusion

This paper has been introduced an eye localization and detection algorithm for facial color image. The algorithm detects eyes in face image. A flexible threshold applied on eye candidates. The proposed method can deal with glasses wearing. The eye detection will fail if eyes are closed or the reflection of glasses is strong. Closed eyes will not influence the results of eye location; however, the precise eye detection will fail because the intensity variance on the eye region is changed.

GTVA Face Database

This database includes a total of 44 persons with 27 pictures per person which correspond to different pose views ($0^\circ, \pm 30^\circ, \pm 45^\circ, \pm 60^\circ$ and $\nu 90^\circ$) under three different illuminations (environment or natural light, strong light

source from an angle of 45°, and finally an almost frontal mid-strong light source. Furthermore, at least 10 more additional frontal view pictures are included with different occlusions and facial expression variations. The resolution of the images are 240x320 and they are in BMP format [F.Tarrés, A. Rama].

References

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Figure (5) Sample of true detection

تحديد العين باستخدام خصائص اللونية للصور في منطقة العين

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يوفر النظام المعتمد على الصفات الحيوية تعريفا متكاملًا عن الفرد لغرض تحديده و تمييزه من خلال اعتماده على معالم حيوية (خلاقية) فريدة وهي صفات عائدة لشخص ما مثل بصمة الاصابع و خط اليد و ضربات القلب و تمييز الوجه او اكتشاف العين . يعتبر اكتشاف العين الموضوع الأبرز والأفضل على اعتبار إن عين الإنسان لا تتغير خلال سنوات حياته ، كذلك يمكن اعتباره الأكثر موثوقية ودقة متوفر حاليا .

يقدم هذا البحث خوارزمية لاستخلاص العين من صور تحتوي على وجوه بشرية مستخدما تقنية لون البشرة ، حيث يتم في البداية استخلاص الوجه من الصورة مستخدما فضاء الألوان YCBCr ، ومن ثم يتم بناء صوره معكوسة الألوان (شبحية) معتمدا على مواصفات منطقة العين ضمن فضاء الوان يأخذ أعلى Cb وأقل Cr من أجل اكتشاف منطقة العين . الخوارزمية تم تطبيقها على صور تحتوي على وجوه امامية ومائلة بدرجة (30°) وقد أعطت نتائج اكتشاف ناجحة وكبيرة .