Face Detection in Color Image

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Abstract

Human face detection plays an important role in variable applications. A face detection method based on skin-color information and facial feature in color images is proposed in this paper. First, the RGB color space is transformed to YCbCr space and only the skin region is extracted with the skin color information. And then, the candidate where face is likely to exist is selected after labeling processing. Finally, we detect facial features in face candidate. The experimental results show that the method proposed here is effective.

1. Introduction

With the wider recognition of the importance of the protection and management of information, various authentication systems using biometric recognition are being developed. Of the biometric recognition, face recognition has the advantage over the other recognition as they do not require direct contacts and do not require high cost equipment. Detecting faces is a crucial step in face recognition.

A lot of face detection methods have been suggested, including those based on wavelet, neural network and so on. But these methods have complexity in calculation and are not efficient[1].

To resolve these disadvantages, we propose an efficient face detection method based on skin color information and facial features.

We detect the face candidate region using skin color information at first and then verify the candidate region by facial features.

Section 2 describes the face detection method proposed in this paper and section 3 presents the experimental results of our method and gives the conclusions and future work.

2. Face Detection Algorithm

The entire flow of the algorithm is as follows:

1) Extract the skin color image from the original image.

(1) Remove the noise using low-pass filter

(2) Change RGB color space into YCbCr

space.

(3) Extract the skin color region with pre-defined threshold of Cb,Cr value.

2) Select face candidate through labeling processing.

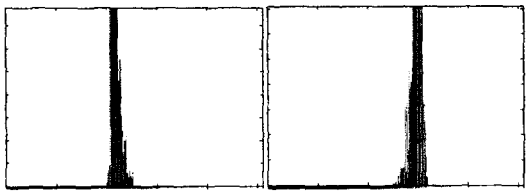
3) Detect facial features in face candidate and verify it as a face.

2.1 Extraction of Skin Color Region

To make the face detection more efficient, we remove the noise of input image using low-pass filter. Then, we transform RGB color space into YCbCr space for the reason that it is not sensitive to the light condition. The transformation is performed according to the following formula (1).

$$\begin{bmatrix} Y \\ Cb \\ Cr \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ -0.169 & -0.331 & 0.500 \\ 0.500 & -0.419 & -0.081 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \quad (1)$$

Figure 1 is the distribution of skin color in YCbCr color space. We recognize from the figure that the skin color distribution is Gaussian Distribution.



(a) Cb histogram (b) Cr histogram

Figure 1 Skin color distribution

Through the experiments that were performed previously, we know that Cb and Cr values of skin color belong to the range [94,119] and [145,162] respectively[5]. The pixels whose values satisfy the above conditions are selected as skin color pixels.

2.2 Selection of Face Candidate

The skin color pixels are divided into several regions after labeling processing. On every region we put a minimum rectangle that includes all of the pixels of that region.

If the region satisfies the following two conditions, the region is selected as a face candidate.

$$1 < \frac{Y}{X} < 2; \quad (2\text{-}1)$$

$$Y * X < \frac{5}{2} * the\ number\ of\ pixels; \quad (2\text{-}2)$$

where X and Y represent the vertical size and horizontal size respectively.

(a)

(b)

Figure 2(a) Original image (b) Face candidate

2.3 Verification of Face

The facial features such as eyes, mouth and so on, have the lower luminance (the value of Y in YCbCr color space) than the other region of the face. Since facial features such as eyes, mouth and so on, have the lower luminance (the value of Y in YCbCr color space) than the other region of the face, we consider the luminance to extract the facial features. We only consider the upper half of the face candidate because the eyes are located in this region[4].

The vertical line edges are detected by the Sobel edge operation (3). This step is done from the bottom to the top. And the first two features detected by this step, which are located at both sides, are considered as eyes.

$$\begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} \qquad (3)$$

3. Experimental Results and Conclusions

The face detection method suggested in this paper showed successful results in the case of detecting frontal faces.

However, the method failed to detect faces when the faces are slant (the tilt angle is bigger than 10°) or only one eye is showed in the image.

Furthermore, the Cb,Cr thresholds are obtained only by the yellow race. So it is suitable only for the yellow race.

To solve the above problems, a more robust and efficient method that can detect in all cases of images and all the races should be developed.

(a)

(b)

(a) Successful results (b) Failure

Figure 3 Experimental results

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