HUMAN FACE DETECTION IN COLOR IMAGES BASED ON SELF-ORGANIZE MAPPING

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Abstract

Face detection is one of the important issues which nowadays many communities deal with it and beside, faces recognition is one of the most important areas of research in most of the industrial and research centers. Three main pillars has been considered in face detection which are: classified as the skin and non-skin color, design templates for face, and feature extraction from face images enable us to identify faces correctly.[1,2]

One of the effective methods that have been proposed in recent years is face detection by using skin-color feature. In this proposed method, at first skin and non-skin areas are specified by using YCbCr model, then by matching the face template on skin areas that are likely to identify a face, the faces zone can be determined in images. The main advantage of the proposed method is using simple rules to detect the skin regions. In this method, the positive error rate is almost low, because the skin color modeling and identification of the skin regions, especially in images with low quality, noisy images and images from a far distance to the character is more efficient and it has ease of access and more fast speed. For comparison, a set of 105 images consists of 82 images include only one face and 23 images containing multiple faces, as a total of 134 figures has been used.[3,4,5]

Key words: face detection – skin model – color space Ycbr – pattern matching

1- Introduction

The figure of face is a unique feature of the human kind. Even in spite of the great similarity of the two twins about the face, there are still slight differences. This makes it possible to use the figure of face as one of the criteria to identify people. In all of the applications that use face features; at first the face location must be determined.

To specify the skin parts, a model for human skin color must be calculated at first. For this purpose we use the color space Ycbr where Y is the brightness component and cbr is the color component in desired space. After that, skin color model can be achieved based on a histogram which calculated with two components Y and cbr. To calculate the skin color histogram, a set of images containing different species of human skin areas belong to the different bloods where used, and the regions where were relative to skin had been extracted from the images, after denoising them, each skin image will be convert from the RGB color space to Ycbr color space, and then for each pixel in this image, a corresponding value in the histogram increases by one unit, and the finally histogram is normalized.[2,3,4,6]

The main points to be discussed in this article include:

1) Propose an algorithm to detect the human face at different positions in the image with regard to the skin and non-skin regions in the image.

2) Design a format for face, so different figures been detected by this mechanism.

3) Applying face detection accurately by using the desired format.

2- Algorithm Explanation
In some cases where there is a color similar to the skin color between two skin areas in an image, two skin areas can be detected as one region incorrectly. To solve this problem, the edge information is used which the Sobel edge operator, is used to find the points on the edge. By getting this histogram and the edge image, the input image will be convert from RGB space to become Ycbcr and then for each pixel of the image, if its corresponding cell in the histogram be above the threshold value 0.1 and the edge gradient be smaller than the threshold value, pixels will be classified in skin region. Otherwise, this pixel will consider as non-skin regions. Finally, a binary image is created which contain only the pixels that showing the one dot belong to skin regions. [7,8,9]

To test the criterion of skin color than other colors, based on the distance ratio of each of the colors in the image sample to be tested, the standard deviation of each of the elements in skin color was defined as follows, that as you can see the pixel values of cr, cb of the input image which already converted to the Ycbcr space, now is the covariance between cb, cr that we used in the image.

\[
\begin{align*}
    cb_{(\cos r)} &= \frac{(c_{bi} - c_b)^2}{(\partial_{cb})^2} \\
    cr_{(\cos r)} &= \frac{(c_{ri} - c_r)^2}{(\partial_{cr})^2}
\end{align*}
\]

(1) (2)

Then, after obtaining images of skin points, only the information about that a pixel is belongs to the skin or not is available. We must now determine which one of the points belonging to the face. For this purpose, we use the labeling algorithm with 8 connections to fraction the binary image to skin regions, and then for each area of the skin, its surface area is calculated, and so by determining the area of skin, it’s possible that the skin area can be consider as the face candidates. It should be noted that the area can be adjusted.

If a grayscale part come into existence in the image, by using this feature we calculate the difference between the input image and its closing, opening, and then we use the obtained differences for the uniformity of background and enhance the image, that the closing, opening steps is applied on the image by using the following formula. So we create a grayscale image by using f and then by using of b, we will get the interested image scale. And then the size and width of image were extracted by Tw and Tb from the image. The formula used for processing the morphology is expressed as follows.[10,11,12]

\[
\begin{align*}
    T_w(f) &= f - f \circ b \\
    T_b(f) &= f \bullet b - f
\end{align*}
\]

Figure 1: a) Original image b) Output image after binary processing c) Output image after closing operator actions
3- Algorithm performance evaluation

Matching the schema is using for determine the existence of face in image. The implementation of this schema will perform with averaging of different images. This schema can be seen in Figure 2.

Figure 2: pattern-face

Template matching criterion is usually done by standard correlation function. To extract facial area in the image, select a template for defined face and consider the values of this template as -2 for completely dark areas and -1 for partly dark areas and +1 for clear areas and +2 for fully clear areas; dimensions of this template are chosen as 10 × 9 pixel is chosen. To match the images, firstly images get smaller 25 times (5 times in each dimension) by using of the sample (consider mean value instead of each neighbor pixel), then the center of template will move on the small image and grade of matching between template and the image will be calculate here. Due to the size of the face, the number of dark points of the face can be determined. These areas make up about 25 percent of the face. Thus, 25 percents of the images area which template are above them have the less bright level. So these parts will be considered as dark points and the other parts considered as the bright points. However, in practice, by taking 35 percent instead of 25 percent of points, better solutions are achieved. The dark point’s value selected as -1 and this value for bright points is +1.[13,14,15,16]

In adapting the above model with different images, we use the following formula to match the interested image on the created template.

(3)

\[ r(p) = T^{-1}(gim) - (\bar{g} + Qg c) \]

We defined the template image texture by using the above formula and the parameters c and t are the positions of the points of model on which matched on the other images, and so we determined the pixels in the image with face model by using these parameters, and then to minimize the difference between input images and adapt it on the desired pattern, the following formula is used.

(4)

\[ P^T = (c^T \mid t^T \mid u^T) \]

Figure 3 the template used for extracting the position of face based on dark and clear areas which on the face are shown.
Figure 3: The template used to extract the position of face

The matching criterion is the sum of the product of the image points corresponding to template in all the points. If the bright or dark points of the image match on the points of the same type in template, the result of sum will be positive and the criteria increases, otherwise the product will be negative and the criteria will be reduced. Finally the region of the image which has the most coincidence with the template will be considered as the position of the face. Implementation of this method on all skin areas of the image will result a clear face similar to Figure 4 (c).[17,18,19]

Figure 4: (a) separation of skin color. (b) Corresponding pattern(c) final image

By changing the method of skin color modeling and matching the pattern, we did improve the above methods. The improved method shows best results in test images; in this method matching patterns used to find the areas which specify the face.[20,21,22]

Comparison of the proposed method

In this section, we compare the proposed method with other methods. For this purpose, we compared the database images used in several reference articles and the results of evaluation of the proposed method were
tested. This comparison yielded acceptable results. The following table shows the evaluation results of the proposed method.

<table>
<thead>
<tr>
<th>Comparison methods</th>
<th>detecting accuracy percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper [4]</td>
<td>90%</td>
</tr>
<tr>
<td>Paper [5]</td>
<td>92%</td>
</tr>
<tr>
<td>Paper [6]</td>
<td>87%</td>
</tr>
</tbody>
</table>

Table 1: Comparison of proposed method.

3- Experiment results

In some papers and literatures related to face detecting methods based on skin color, standard database were not used, and so evaluate the methods was conducted on various images and most of the designers have to collect different pictures by themselves. To evaluate the mentioned method we used the available images in other papers as well as some of images which are various in terms of quality, variety, lighting conditions and complex backgrounds, an example of implementing the algorithm on a database of images are shown in Figures 5 and 6. Also to model human skin colors, lots of different images from various races of humankind were collected and the skin areas were separated in them.

Figure5: face detection in single-face images
To evaluate the above method two criteria positive error and negative error were used. Positive error occurs when non-face areas will be announced as the face and the negative error occur when there is a face in the image, but it will not be detected by the program. Here, we just compare the above method only with the mode which uses the skin color feature. For comparison there is 105 images which 82 images which 82 of them consist single-face and 23 images containing multiple faces as a total of 134 figures are included has been used. Evaluation results can be seen in Table 2. As it can be seen in the proposed method there is less positive error number.

<table>
<thead>
<tr>
<th>Method’s name</th>
<th>No. of positive error</th>
<th>No. of negative error</th>
<th>Positive error</th>
<th>Negative error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face detection by using skin color</td>
<td>15</td>
<td>5</td>
<td>75%</td>
<td>25%</td>
</tr>
<tr>
<td>Face detection by using skin color and pattern matching</td>
<td>3</td>
<td>6</td>
<td>33/33%</td>
<td>67/66%</td>
</tr>
</tbody>
</table>

Table 2 - Results of evaluation face detection by using presented method on 134 figures
4- Conclusion

In this paper, we introduced a face detection method using face pattern. In this method, we reduce the images which contain non-skin areas that are isochromatic the skin by this way and the positive error rate was decreased. By applying this algorithm on various images, we obtained significant results, and problems with face detection were solved to some extent by implementing presents methods in this system. In total, results of face detection methods based on skin color, looks very promising and further work in this area can be achieved acceptable performance.

References


