ABSTRACT

The problem of multiple face detection and missed detection caused by illumination and complex background is avoided. A multi face detection algorithm based on skin color and Adaboost algorithm is proposed. The first chapter of this article is to apply the CbCrCg space based on the least squares of the skin color clustering model as the pretreatment process of face detection. And then you need to go further and take the area as an input image and you go through the Adaboost cascade classifier for face detection. To further remove non-face areas in the skin area, Finally, a more accurate face orientation is achieved.

INTRODUCTION

Face detection technology involves a wide range of things. The process of testing is actually a synthesis of the characteristics of the face pattern. From a different perspective, there are different classification methods for face detection. But in general, there are many ways in which facial examination can be carried out in a comprehensive way. Skin color is an important feature of the face; it doesn't depend on facial features. For the gesture, the change in expression is good stability, and in most cases there is a distinct distinction between the background colors. Face detection based on skin tone has a speed advantage; it is often applied to build a rapid facial detection system.

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Freund and Schapire in 1995 on the basis of Boosting was improved, put forward the Adaboost (the Adaptive Boosting) algorithm [1]. This method is an iterative algorithm, and it's very efficient. In 2001, when people like Paul Viola applied the Adaboost algorithm to face detection for the first time, The concept of integrating image and the method based on Adaboost training for face detection classifier, The first real real-time face detection system was established.

**Skin Color Model Is Established**

The so-called skin color modeling and other mathematical modeling, using an algebraic (analytic) or lookup table form to express which pixel colors are skin color, or the colour of a pixel is similar to the color of the skin. There is a regional model for the skin color model used in the current image processing study. Gauss model, hybrid gauss model and histogram model [2]. It's not hard to see the mapping distribution of the three projection planes in the space CbCrCg. The color of the skin in this space is good, and the skin color mapping region is basically in the same ellipse region, so this article chose the space CbCrCg for the skin color model. In order to avoid the overlap between skin color and non-skin tone, choose to do 3d modeling of skin color in 3d space CbCrCg. Here’s how to do this:

First, you take the cartesian coordinates of the color of the color of your skin and you take the whole transformation to the 256 by 256 image distribution matrix. And then in the skin color plane we use the direct least-squares method to build the skin color model, The mathematical model is as follows:

\[
F_a(x) = x \cdot a = ax^2 + bxy + cy^2 + dx + ey + f = 0
\]  

The direct least-squares method can be converted to the following problem:

\[
\min \sum_{i=1}^{N} ( f(x_i) )^2 - \min \sum_{i=1}^{N} ( f(x_i) )^2 - \min \sum_{i=1}^{N} (x_i - a)^2
\]

(2)

The Lagrange coefficients and the differential coefficients can be obtained for the upper type:

\[
S_n = \lambda C_n
\]

\[
a^T C_n = 1
\]

By calculation:

\[
\lambda \cdot r_1 + \lambda \cdot r_2 = \lambda C_1 r_1
\]

\[
\lambda \cdot r_2 + \lambda \cdot r_1 = 0
\]

(4)

The distribution of skin samples is known, the skin color points are in an ellipse region and are not distributed in a straight line, According to an efficient and robust numerical stability method proposed by R. Halif et al. [3].
The criteria for skin color discrimination are as follows:

\[
\begin{align*}
M a_1 &= \lambda a_1 \\
\alpha_1^T C_1 \alpha_1 &= 1 \\
\alpha_2 &= -S_3^{-1} S_2^T \alpha_1
\end{align*}
\]

\tag{5}

MULTI FACE DETECTION BASED ON SKIN COLOR AND ADABOOST ALGORITHM

The Lack of Face Detection Based on Skin Color and Adaboost Algorithm

Skin color is the main feature information of human face, it has certain stability for rotation and expression change. Therefore, the face detection algorithm based on skin color features has low complexity. The characteristics of fast detection, especially for multi face detection, the change of different gesture expressions is very robust. But the skin color is easily disturbed by light change and skin color information. A part of the skin information is detected in the high light area or the shadow area due to illumination. Some of the skin color information is mistaken for other color because of skin color modeling. Under these circumstances, discontinuous cavities often occur in the skin area, or large amounts of skin tone information. And face verification method based on skin color of skin color detection for each step of high precision, Relying solely on geometric features or simple templates, it often results in high false detection and missing of face. In addition, when there is human face overlap in the image geometric features, such as verification methods, will also be ineffective.

Face Detection Based on Skin Color and Adaboost Algorithm

The advantages and disadvantages of color based and Adaboost based face detection algorithms are discussed. In order to make full use of the advantages of the two, As far as possible to avoid the shortcomings of a single method of interference detection results, In this paper, the skin clustering model based on least square fitting in CbCrCg space is used as the pretreatment process of face detection. The search scope of face detection is reduced, and the skin color loss due to illumination and other factors is effectively avoided. After accurate segmentation of human face color, The image to be detected is divided into skin areas containing human faces and color areas without human faces, Then, the region is used as input image, and then Adaboost cascade classifier is used to face detection, further remove the non-face region in the skin region, More accurate face localization is achieved.
Face Detection Experiment

In order to verify the effectiveness of the method, the article selected 200 images from the inter-network, including multi-face images and single-face images. It covers light, complex background, facial gestures, facial expressions and other factors. In the experiment, the images were grouped according to single-face and multi-face images, the experimental results are shown in figure 1:

![Figure 1. Test results of this method.](image)

The experiment is based on the constructed 226 training images, a total of 502 people face, front face 397, plane deflection face 105. The method of face detection based on direct least squares fitting skin clustering model, face detection method and traditional Adaboost algorithm is used to compare the performance of this method. The performance comparison of three face detection methods is shown in table I:

<table>
<thead>
<tr>
<th>Skin color detection method</th>
<th>Face detection rate</th>
<th>Number of missing faces</th>
<th>Number of missing faces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face detection based on least squares fitting skin clustering model</td>
<td>89.3%</td>
<td>74</td>
<td>42</td>
</tr>
<tr>
<td>Face detection method based on traditional Adaboost</td>
<td>88.4%</td>
<td>58</td>
<td>37</td>
</tr>
<tr>
<td>Inspection method in this paper</td>
<td>93.7%</td>
<td>33</td>
<td>24</td>
</tr>
</tbody>
</table>

This method combines the skin color model with the Adaboost algorithm by least square fitting. It effectively overcomes the influence of illumination, complex background and human face pose. Finally, a good face detection effect is achieved in complex environment.

CONCLUSIONS

This paper proposes a face detection method which combines skin color detection with Adaboost algorithm. This method can effectively solve the problems
of higher detection rate of false skin detection and missed detection of Adaboost method. So as to improve the detection rate and reduce the false detection rate, More accurate face localization is achieved.

REFERENCES