Based on the Multi-scale Integration Face Image Detection Technology Research

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Abstract. In this paper, the color space used in a variety of face detection are analyzed and compared, and through good light compensation realized from the region face, and the input image fusion group points to block colored image segmentation, as well as through the two elliptic order unchanged moments template matching , multi-scale image processing technology to achieve very effective color image of the face of the region .Experiments prove that this method has very high accuracy, good robustness, as well as real-time.

Keywords: face detection; face color extract algorithm; template matching; fusion.

1 Introduction

Since the 1990s, face recognition become a hot research topic, face recognition as an important link - face detection has been many researchers attention. Face detection in the input image is identified in the face of all (if it exists) the location, size and configuration process, and face detection system that may include the importation of face images, the image output is on face the existence of the human face, as well as the number, size, configuration, and other information of the parameters described, the aim is to test the image of his face and split off from the background[1].

2 Face Color Extraction in Color Image

Face color is a primary feature of ones face. Compared to face in terms of the geometric characteristics, face color has characteristics which are little affected by the shape, size and other factors. The face color also can be fit for rotation, and his expression changes, as well as accessories such as shielding can be applied, and with the relative stability of most of the background and the color of objects there are more obvious differences.

According to computer color theory, every color, in the computer, is a different way of expression, thus forming a variety of color systems, the color space. Of course, a variety of colors in the color space is only the expression of different computers within it, and each has its own color space background, application fields. The main color spaces are RGB、YCbCr、HSI、YIQ、YUV、r-g[2-5].

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2.1 Color Model in RGB Color Space

In order to extra the face region from the entire image, a reliable detection of the effect of color model which is suitable for different colors, light conditions and shielding is needed to establish. In this paper, several color space in the establishment of the color model are analyzed and compared.

The face color pixel value in the RGB color space is shown in table.1

Table 1. Data of RGB skin-model

R	G	B	R-G	R/G
231	189	185	42	1.22
225	178	173	47	1.26
211	172	172	39	1.23
221	189	179	32	1.17
176	171	220	49	1.29
219	200	200	19	1.10
191	163	166	28	1.17
179	140	142	39	1.28
230	186	180	44	1.24
216	172	177	44	1.26

According to the upper data and other large mount of data , color pixels R, G, B value satisfy the following three conditions:

In normal light, meet the R> G, R> B, and R> 95, G> 80, B> 80;

Each pixel average R-value is greater than 15; each pixel R / G values fell between interval [1.0, 1.3].

Therefore, in RGB space, color model is:

$$\begin{cases} R > 95 \cap G > 80 \cap B > 80 \\ (R - G) > 15 \\ 1.0 < R/G < 1.3 \end{cases} \tag{1}$$

2.2 Color Model in YUV Color Space

A color image every pixel value R, G, B component through the conversion formula into YUV space in the Y, U, V component, through color for face value function to the region Y, U, V three-component values. Based on a large number of experimental

Table 2. Data of YUV skin-model

Y	100	155	108	104	109	148	170	169	136	171
U	251	243	249	248	250	246	246	246	251	242
V	14	29	15	9	25	27	29	28	22	35

data from a statistics, the color model in YUV can be gotten. Parts of experimental data are shown in table2.

Color model in YUV color space model is:

$$\begin{cases} 80 < Y < 200 \\ 200 < U < 255 \\ 10 < V < 35 \end{cases} \tag{2}$$

2.3 Color Model in HSI Color Space

A color image every pixel value R, G, B component through the conversion formula into HSI space in the H, S, I component, through color for face value function to the region H, S, I three-component values. Based on a large number of experimental data from a statistics, the color model in HSI can be gotten. Parts of experimental data are shown in table3.

Table 3. Data of HSI skin-model

H	0.105	0.175	0.493	0.175	0.226	0.592	0.436	0.329	0.238	0.339
S	0.201	0.225	0.219	0.242	0.223	0.194	0.232	0.315	0.268	0.336
I	150	160	155	149	166	118	155	111	164	110

Color model in HSI color space is:

$$\begin{cases} 0.10 < H < 0.80 \\ 0.10 < S < 0.50 \\ 100 < I < 200 \end{cases} \tag{3}$$

2.4 Analysis and Comparison of Different Face Color Model

The establishment of color model, the original image will be required in accordance with the conversion formula switch to transform the space, and then with other people face color of the different background color, find a suitable threshold, the value of the forthcoming regional extracted from the human face.

Meet the conditions of face color model for the assignment 0, that is, the pixel is black; not satisfied with the conditions for the assignment 255, the pixel is white. The test results are shown in figure 1 to figure 4.

3 Image Light Compensation

Light compensation issue is a in a very important and difficult issue in face detection and tracking. Environmental impact of light is one of the main factors accuracy of

Fig. 1. Original image

Fig. 2. Image of RGB

Fig. 3. Image of YUV

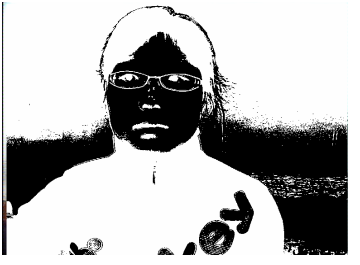

Fig. 4. Image of HIS color extraction mode

face detection. In the different light condition, human face detection rate will be decreased substantially; therefore, it is necessary to light compensation.

General to resolve the question of compensation by light illumination changes are not sensitive to the image that method, the image brightness compensation, or the amount of compensation color to achieve. Such as the edge of the image map, gray-scale image of the first order, second-order derivative, nonlinear transformation, "reference white" approach and color balance method, etc[6].

Under normal light conditions, the RGB color experiment has proved to be accurate and more complete regional extract color, as far as possible a very good model for robust, taking into account the algorithm simpler, real-time higher, and not to further light compensation. RGB color model because there are certain limitations, that is more sensitive to light, when the light is weak, it is impossible to accurately extract color, so mainly to solve the evening or on overcast days, and other low light conditions under the light compensation.

In the procession of face detection, using rough first "reference white" light method of compensation, and then RGB color model color extraction.

The relaxation coefficient of luminance signal can be accessed through the image brightness for RGB image through relaxation coefficient of image brightness amendments to the light compensation.

The extraction of image before and after light compensation is shown in figure 5 to figure 8.

Fig. 5. Original image

Fig. 6. Image of RGB color extraction model

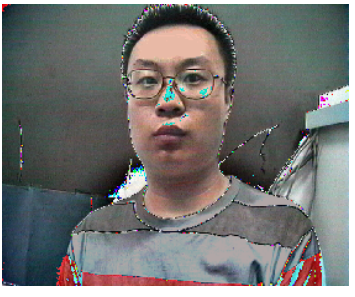

Fig. 7. Image of Light compensation

Fig. 8. Image of RGB

4 Face Image Segmentation and Matching

Through light compensation, RGB color model used in the context of complex human faces from the region, relying solely on color information, extracted from the region and is likely to face the same color but not the face region. Therefore, in accordance with their needs in space on the relevance of a possible split face region, the use of the geometric characteristics of the region it is a human face test, to rule out other similar skin color objects region.

4.1 Face Image Segmentation

After extraction RGB color model, the color image is changed into a rough area contains face candidate, but because of the limitations of algorithms, image noise will inevitably point, and a large area of connectivity in the region there are still some small hollow, these are the noise in the image. So, mathematical morphology operation is indispensable to the regional image. The experimental results show that, after one time of erosion and dilation, the majority can remove noise, the effect can be achieved request.

In this paper, the blocking mission point coloring algorithm is used to segment the image, as mission point coloring algorithm computes so much to effect the real-time processing. Experiments using the block method, the image 768×576 will be divided into 64×64 blocks, one for every 12× 9 (pixels for the unit of measure). Coloring such a mission point, to block scanning units and judgments, and the calculation of far smaller than a single pixel scanned. Using probabilistic methods, statistics for each

Fig. 9. Original image

Fig. 10. Image of multi-face effect

piece of black pixels in the number of points, with the total number of pixels compared. If the proportion of more than a threshold value, the block that people face this region, otherwise, this block is that the background of the block to 0. The results are shown in figure 9 to figure 10.

4.2 Template Matching

The researchers found that the contours of face similar elliptical shape, so the template matching can be used as parameters, through the establishment of ellipse parameters of the geometric mode[7, 8]. Because the images of human faces are different or in different posture, its shape is not exactly the same, and it may consider using the same moment, on the face of regional identification. Once images of the human face boundary curve shape of the plane or the number of suitable properties or characteristics of the pool, the shape of face can be recognized. Three second-order center moments are used to establish elliptical model. θ is Elliptic dip; a is long elliptical axis and b is short elliptical axis.

$$\theta = \frac{1}{2}\arctan\left(\frac{2\mu_{11}}{\mu_{20} - \mu_{02}}\right) \tag{4}$$

$$I_{\min} = \sum_{(x,y)\in C}[(x-\bar{x})\cos\theta - (y-\bar{y})\sin\theta]^2 \tag{5}$$

$$I_{\max} = \sum_{(x,y)\in C}[(x-\bar{x})\sin\theta - (y-\bar{y})\cos\theta]^2 \tag{6}$$

$$a = \left(\frac{4}{\pi}\right)^{1/4}\left[\frac{(I_{\max})^3}{I_{\min}}\right]^{1/8} \tag{7}$$

$$b = \left(\frac{4}{\pi}\right)^{1/4}\left[\frac{(I_{\min})^3}{I_{\max}}\right]^{1/8} \tag{8}$$

μ_{11}, μ_{20}, μ_{02} are second-order center moments of image.

The test results are shown in figure 11, 12.

Fig. 11. Result of single

Fig. 12. Result of multi-face detection

5 Conclusion

Through the input image of the multi-scale testing, after the input image of the RGB color model extraction, light compensation, image compression segmentation, template matching, an oval fitting and so on, can be achieved under the complex environment of multi- faces detection. Experiment proved that this method has high detection accuracy and better real-time, and has a high anti-jamming capability on-site environment of the time, the light and the complexity. This method has laid a good foundation for robot vision to track man face.

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