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Thesis for the Degree of Master of Engineering

Face Detection and Extraction Based on Ellipse Clustering Method in YCbCr Space

by

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Department of Computer Engineering

The Graduate School

Pukyong National University

February 2010

Face Detection and Extraction Based on Ellipse Clustering Method in YCbCr Space

YCbCr 공간에서 타원 군집 방법에 근거한 얼굴 검출 및 추출

Advisor: Prof. Chong Ho Woo

by

Jia Shi

A thesis submitted in partial fulfillment of the requirements
for the degree of

Master of Engineering

in Department of Computer Engineering, The Graduate School,
Pukyong National University

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Face Detection and Extraction Based on Ellipse Clustering Method in YCbCr Space

A dissertation

by

Jia Shi

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February 25, 2010

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YCbCr 공간에서 타원 군집 방법에 근거한 얼굴 검출 및 추출

시 가

부경대학교 대학원 컴퓨터공학과

요 약

본 논문은 카메라로 촬영한 얼굴이 포함된 이미지에서 얼굴을 검출하고 추출하는 효율적인 방법을 연구했다. 차분 방법과 타원 군집 방법의 결합한 방법을 통해서 얼굴을 검출하고 추출하는 방법을 제안하였다. YCbCr 공간에서 차분방법을 이용해서 얼굴 구역을 검출한 후에 타원 군집방법을 사용하여 얼굴의 피부색정보를 추출한다. 실행결과 실제 복잡한 배경에서 얼굴을 검출할 뿐만 아니라 얼굴의 피부색정보도 추출할 수 있다. 이 방법을 사용하면 광도의 영향을 적게 받고, 차분방법을 적용해서 상대적으로 크게 축소된 얼굴 이미지를 다루므로 계산량과 저장 공간을 크게 줄일 수 있었다. 실험에서는 다양한 환경에서의 촬영한 얼굴이 포함된 이미지를 처리한 결과 제안한 방법의 효율성을 확인하였다. 본 논문에서 제안하는 방법은 회사나 건물의 실제 보안 검사시스템 등과 같은 실시간 얼굴검출 및 얼굴인식시스템에 활용할 수 있다.

1. Introduction

As the development of biometric recognition technologies, as an important branch in this field, face recognition has developed rapidly.

Face detection impacts on the effect and the final result of face recognition as an important preprocess of the face recognition. There are many excellent methods for face recognition such as PCA (Principal Component Analysis), SVM (Support Vector Machine), HMM (Hidden Markov Modal) and so on[1]. However, the experimental environment of many face recognition methods is based on the existing famous face database such as ORL Face Database of University of Cambridge, Yale Face Database of Yale University and Japan Female Face Expression Database (JAFFE). These kinds of face image databases are generally without the complex factors of background and light. Thus, the method of face recognition experiment that based on these databases still has some limitations and restrictiveness when it is used in the real complex environments[2].

In this thesis I propose a face detection method to provide the effective and simple data without background for face recognition. This method not only detects the face location in the original image, but also extracts the better face data from the real environment. The face images extracted from the real environment are similar to the face image of databases mentioned above, which makes the recognition methods based on these databases better applicable in the real environment and provides simpler data for face recognition that needs a great deal of training samples.

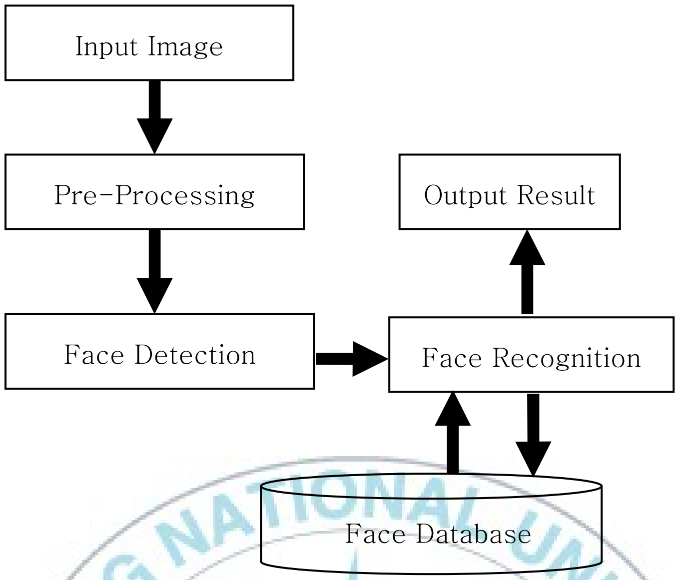

Fig. 1. The processing in general face recognition system

Face detection refers to the process of ascertaining the face location, the size and so on in the input image. Face detection is an important step of face recognition as shown in Fig. 1. The quality of face detection can affect especially the other processes and effects of face recognition. There are mainly 4 methods for face detection as follows: (1) Knowledge-Based Methods, (2) Feature Invariant Approaches, (3) Template Matching Methods, and (4) Appearance based Methods. Because of the deep complexity of image, the exact result of detection always can't be obtained via the single information feature. Thus the detection method with multi-feature information is trending in the face detection research [3]. The method in the thesis belongs to the second method category above, Feature Invariant Approaches.

The shape, size, veins and color of face could greatly change according to the people, time and light, which make the face detection be a complex subject. As an important information of face, the skin color is relatively stable for face rotation, facial expression, and the parts occluded by glasses, a cap, and a scarf, which is independent on the specific feature of face detected. Thus the skin color is an effective factor for face detection. There are many methods for face detection such as the neural networks, wavelet transformation, mosaic diagram method and color texture, and so on. These methods are based on the statistics or the structure analysis of facial feature. These methods need many analytical procedures with so many training samples and are noise-sensitive so that it's hard to do a real-time detection[4-6].

This thesis proposes a face detection method based on the skin color, which ascertains the facial region in YCbCr space using difference method, and then extracts the skin color information from the image by the method of ellipse clustering in the acquired facial region. As it is not necessary to train by a large quantity of samples and don't require the intensive computations, its implementation are easy and speedy, it has a promising application prospect on the face detection in the practical systems such as the security inspection, security management, video conferences and so on. Compared to the existed methods, it can not only detect the facial region but also can completely extract the facial region with the face skin color to make the face data directly be adopted to the face recognition system based on the skin color and provide an excellent information.

The structure of this thesis is follow; firstly the 2 and chapter describe the existing difference method, YCbCr space and the clustering characters of skin color in this space. Then the improved method, the process and the advantage of two combined methods have been mentioned in the 3, 4 and 5 chapter. The experimental results are described in the 6 chapter. The 7 and 8 chapter is respectively the conclusion and references.

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2. Related Works

2.1 Difference Method

The basic principle of difference method in the image processing is transformed by grayscale in the detected region minus the background image in the image space region, and can be denoted as following equation(1)[7].

$$Df_i, f_j(x,y) = f(x,y,t_i) - f(x,y,t_j) \tag{1}$$

Where $f(x,y,t_i)$ and $f(x,y,t_j)$ are respectively the luminance of t_i time and t_j time at (x,y) pixel dot between 0 and 255. The obvious difference of the luminance of $f(x,y,t_i)$ and $f(x,y,t_j)$ at (x,y) pixel dot is as follow formula (2).

$$\frac{\left(\frac{s_i + s_j}{2} + \left(\frac{m_i - m_j}{2}\right)^2\right)^2}{s_i s_j} > t \tag{2}$$

where m_k and $s_k (k=i,j)$ are the average and the variance of $f(x,y,t_k)$ in some small region Q(x,y) of (x,y), and t is the threshold value. If the formula (2) is hold, it means that the luminance of $f(x,y,t_i)$ and $f(x,y,t_j)$ at (x,y) are obviously different and $Df_i,f_j(x,y)=1$, if the formula (2) is wrong, $Df_i,f_j(x,y)=0$.

Based on the difference method, the face location can be obtained easily by a simple subtraction when the background is static. As is shown in Fig.2, the result via difference method in the RGB color space can detect the general location of face in the image.

(a) (b) (c)

Fig. 2. Difference method in image processing

However, because of the influence of light, color and other factors, usually the face information can't be detected exactly. Much human body information (non-skin color information) is contained in the detection result. There is still noise in the region of background and face.

2.2 Ellipse Clustering Method in YCbCr Space

Anil K. Jain et al. had selected the 853571 pixels of skin color among 137 images from the image library of Heinrich Hertz Institute and projected them in the YCbCr space and the 2D projection in the Cb-Cr subspace[8, 9]. And they got the results shown in the Fig. 3.

Fig .3.(a) is the projection of the general image in YCbCr space. Fig.3 (b) is its skin color dot projection in Cb-Cr space. However, the red region is the region of the gathered skin color. The mode is mainly about making the skin color information be nice clustering characters in color space of some color via the transformation of color encoding.

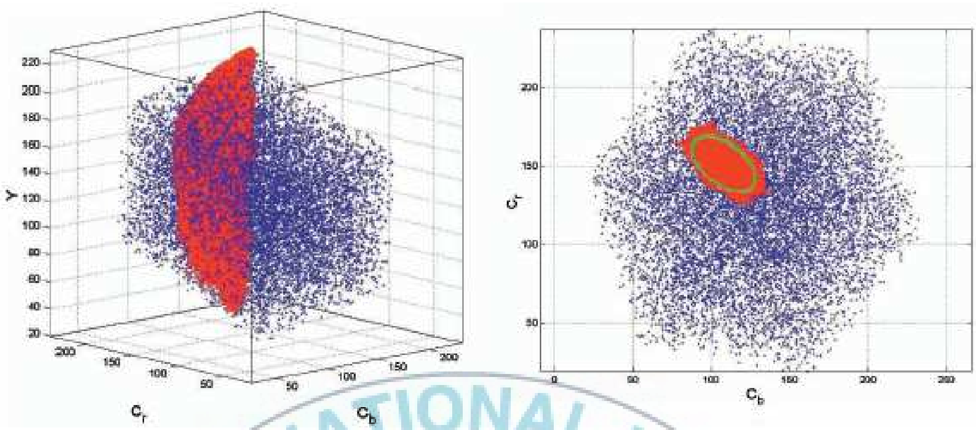

Fig. 3 Projection of skin color in color space (a) Skin color in YCbCr space. (b) Skin color in Cb-Cr space[9]

Thus the face location and detection can be simplified and the YCbCr space that can separate the luminance of the color by which no luminance consideration but only the hue consideration should be taken to lessen the light impact on the image information. Then the skin color region separated by the nonlinearly skin color segmentation in the Cb-Cr space is close to ellipse that can be denoted as the below equation (3) [9].

$$\frac{(x-ec_x)^2}{a^2}+\frac{(y-ec_y)^2}{b^2}=1 \qquad (3)$$

where $\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} C_b - cx \\ C_r - cy \end{bmatrix}$, the constants are cx = 109.38, cy = 152.02, Θ=2.53,ec_x = 1.60 ec_y= 2.41, a = 25.39, b = 14.03.

The skin color region in the image can be detected via the above formula.

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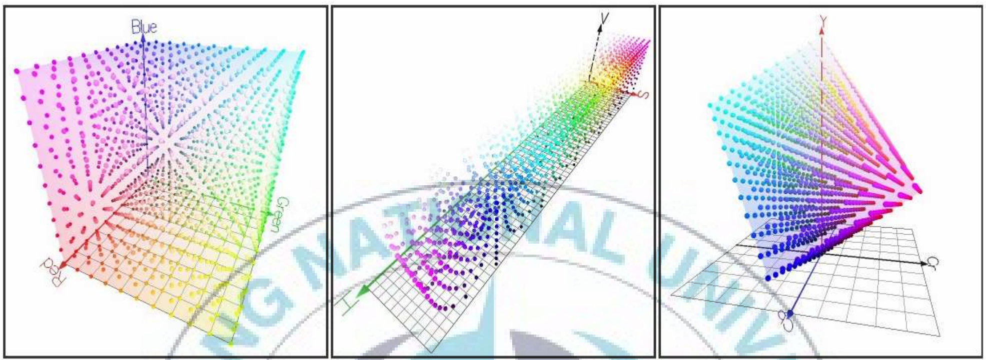
3. Difference Method in YCbCr Space

3.1 Color Space

The space modes for the image gathering devices are RGB, HSV, YCbCr color space and so on. As shown in Fig. 4,



(a) (b) (c)

Fig. 4. Color space (a) RGB color space. (b) HSV color space. (c) YCbCr color space

HSV respectively represent Hue, Saturation, and Value, YCbCr respectively represent Y = Luminance, Cb = blueness, Cr = redness. These color space have good characteristic capability of separating the luminance from color[10]. Thus HSV and YCbCr color space are more adopted in most of the color separation methods as it can well decrease the disturbance of light during the processing of separating the skin color from other colors[11].

3.2 YCbCr Color Space

In RGB space when the color changes by light, the corresponding value of R, G and B changes simultaneously. However, if the same color value is transformed into YCbCr space, the color doesn't change but only the luminance changes. As shown in Fig. 5, when the color becomes dark under the effect of light, the RGB values are changed gradually from RGB (210,210,210) to RGB (170,170,170). In the corresponding YCbCr color space only the luminance value of Y is changed from 210 to 170, but the other color values, Cb and Cr keep the same value as 128. Thus the isolated threshold value can be given to the luminance Y when the difference method is adopted to YCbCr space.

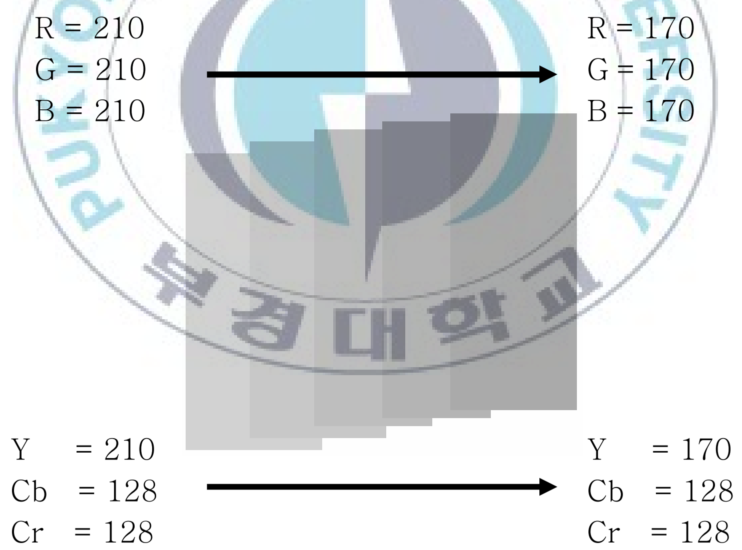


Fig. 5. The color values of RGB and YCbCr affected by light

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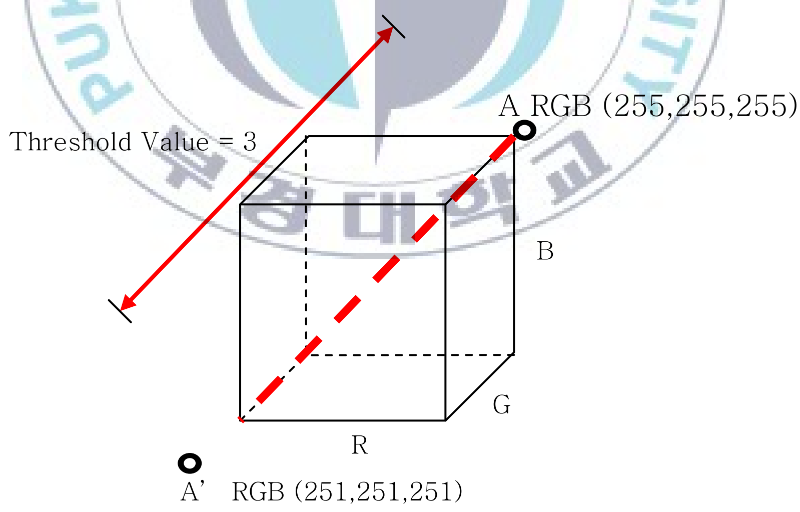
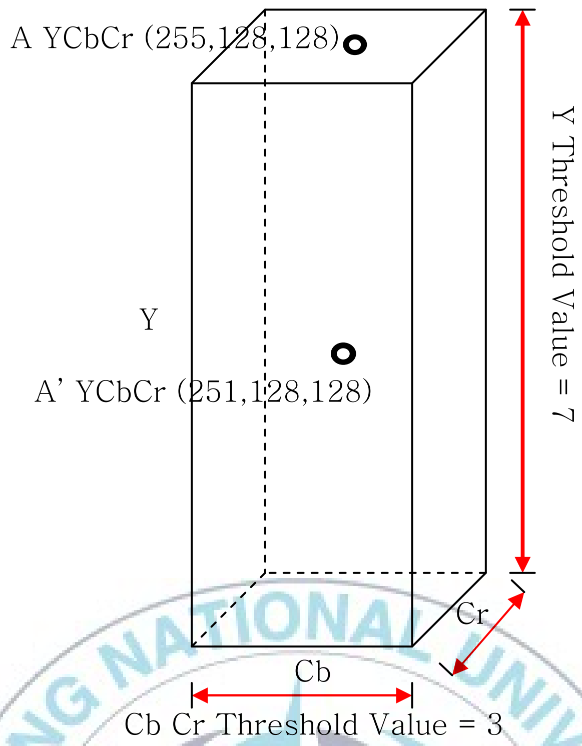
On subtracting between color A (R, G, B) and color A'(R', G', B') in the same location of two images, the threshold in RGB space are set as R-R' < 3, G-G '< 3 and B-B'<3 at threshold value = 3, and the two dots can be determined as the same color. In the case of Y-Y'<7, Cb-Cb'<3 and Cr-Cr'<3 in YCbCr space, the two dots can be determined as the same color. For instance, as shown in Fig. 6, if dot A (255,255,255) is changed into A' (251,251,251) under the effect of light, then the difference between dot A (255, 255, 255) and dot A' (251,251,251) is obtained in RGB space. If the difference |A-A'|, the results of R-R', G-G', B-B' are greater than the given threshold value of 3, then it is determined as the different colors. However, if the color value of the corresponding two dots are A (255,128,128) and A' (251,128,128) in YCbCr space and the difference between Y and Y' = 255-251 < threshold value 7, then it is determined as the same color.



(a)



(b)

Fig.6. Enactment of different threshold for difference method (a) The two dots with different colors at the threshold value 3 in RGB space. (b) The two dots with the same color at the luminance threshold value of 7 and the color threshold value of 3 in YCbCr space

Dot A and dot A' are determined as the same color in the YCbCr just because a broader threshold value can be adopted independently to the luminance Y. That's also the reason why YCbCr space has a character of eliminating effect of light. Because the luminance and color can be divided, different threshold value can be given to luminance and color value.

Although the character of luminance and color separation is existing in the HSV color space, it has a complex transformational relation with RGB space and is not favorable for the calculation. The transformation relation of the RGB and HSV color system is as the following equation (4).

$$H = COS^{-1}\left(\frac{\frac{1}{2}((R-G)+(R-B))}{((R-G)^2+(R-B)(G-B))^{\frac{1}{2}}}\right)$$

$$S = 1-\frac{3}{(R+G+B)}(\min(R,G,B)) \tag{4}$$

$$V = \frac{R+G+B}{3}$$

The transformation relation of RGB color system and the YCbCr color system is as the following formula (5).

$$\begin{bmatrix} y \\ Cb \\ Cr \end{bmatrix} = \begin{bmatrix} 0.229 & 0.587 & 0.114 \\ -0.1687 & -0.3313 & 0.5 \\ 0.5 & -0.4187 & -0.0813 \end{bmatrix}\begin{bmatrix} R \\ G \\ B \end{bmatrix} + \begin{bmatrix} 0 \\ 128 \\ 128 \end{bmatrix} \tag{5}$$

And it also can show the advantages of the YCbCr color space by transforming the speed and can be more easily transformed with RGB.

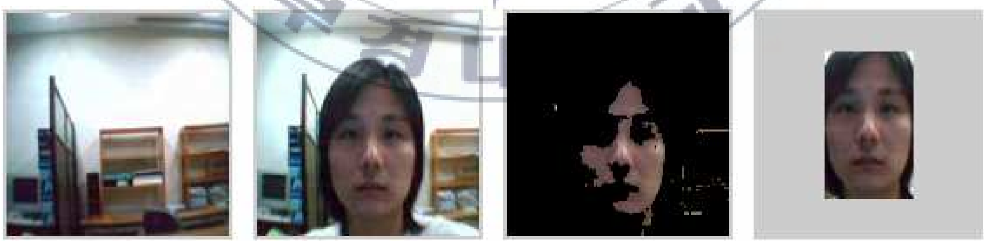
In order to eliminate the impact of light, the difference method is adopted to the YCbCr space in this thesis because of its advantages of luminance separation. The ellipse clustering method in the following section is also adopted to the YCbCr space, thus the transformation for colors space isn't required and we can save the computation time.

When the image gathered by the image gathering devices is RGB color, it is transformed into the YCbCr color according to the formula (3) and the difference method is processed in this space. If the gathered image is YCbCr color, the difference method is just processed.

3.3 The Realization of Difference Method in YCbCr

The plan for presetting the background is to store a background without human's face image and then make subtracting between the face image shot by the camera and the background to identify the general body location and finally to test the face location. The image processing consists of mainly 5 steps as the follows.

(1) Project the background Fig. 7.(a) and test image of Fig. 7.(b) into the YCbCr color space.



(a) (b) (c) (d)

Fig. 7. The gathered general face region using difference method in YCbCr space (a) Background image. (b) Test image. (c) Face color region. (d) Face region

(2) Make subtraction between the background Fig. 7.(a) and the image of Fig. 7. (b).

(3) Extract the margin of the binarized image on the basis of the difference. If determination of the skin color is done, the skin color region can be detected more easily. As is shown in Fig. 7, it is the detection of skin color region based on realization. Thus the coming processing can be implemented more exactly.

(4) Ascertain the correct face location via the vertical projection first and then horizontal projection.

(5) Mark the face by the rectangle frame via the projection result, as shown in Fig. 7 (d).

Make a statistic for the number of none-zero pixel dot of some section in each row and column in the face image. The key point of horizontal is to find the location of the head top via the none-zero pixel and the head feature. Suppose the $f(x,y)$ binary image with a size of N ×M and none-zero pixel of T, and the number of none-zero pixel dots in the ith column is px[i], the number of none-zero pixel dot in the section from right to left in the jth row is py[j], and the equations are as the follows (6).

$$\begin{cases} px[i] = \sum_{j=0}^{M-1} f(i,j)/T & i = 0,1,\cdots,N-1 \\ py[j] = \sum_{i=left}^{right-1} f(i,j)/T & j = 0,1,\cdots,N-1 \end{cases} \tag{6}$$

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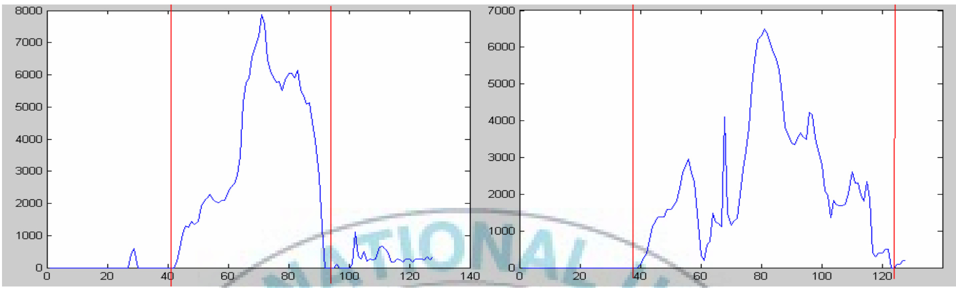
Fig. 8 is the vertical and horizontal projections of Fig. 7. (c). The image region after the difference can be identified via the tiptop of the wave crest and the bottommost wave crest of the two ends of the curve. The region that marked by red line is a general facial region. The left and right curve of beyond the red line represents noise and can be ignored.



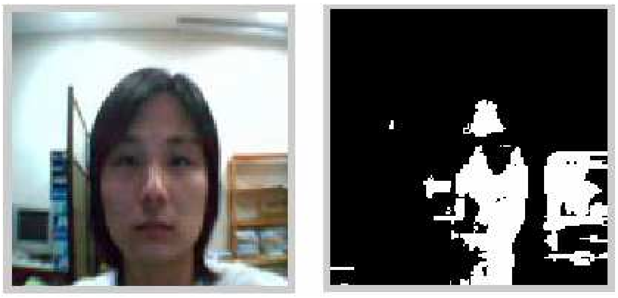
(a) (b)

Fig. 8. Projection of face region (a) Vertical projection. (b) Horizontal projection

As shown in Fig 7. (d), most of the background image is removed and the facial region is extracted. This facial region image is used in the ellipse clustering method for getting the skin color information and the related computations are considerably reduced because of no background image.

4. Face Extraction Using Ellipse Clustering Method in YCbCr Space

In the third section, ellipse clustering methods of Anil K. Jain and others has been introduced and the result is as shown in the fig. 9:



(a) (b)

Fig. 9. Skin color region extraction by ellipse clustering method (a) Original image. (b) Skin color region

This method has a good impact on the skin color separation. However, as shown in Fig. 9, in actual processing of the skin color information, it is easy for us to make a mistake about thinking the region of lower luminance as the skin color, but thinking the skin color of higher luminance as the none-skin color region. If there is the color region that closes to or the same color as the skin color in the background of image, it's mean that it can be projected into the red region of Fig. 3. (b), thus it makes the detection and extraction of face information more difficult and complex. If we can promote the color mode of the YCbCr space on this basis, the detection and extraction of the facial skin color can be realized with the consideration of the pixel number of connected region, Erosion, Dilation, Opening, Closing of mathematic morphology which cause difficulty for calculation.

4.1 Skin Color and Its Statistics in YCbCr Space

Considering Fig. 9 (b), the statistics of Cb and Cr ranges are obtained in YCbCr space under natural environment including the exposures caused by deficient light or abundant light. Taking account of the influence of light, the luminance is divided into three regions of 0 ~ 80, 80 ~ 200, and 200 ~ 255, and the ranges of skin color CbCr values in the environment are changed under the influence of light:

Table 1. The ranges of Cr Cb under the different luminance

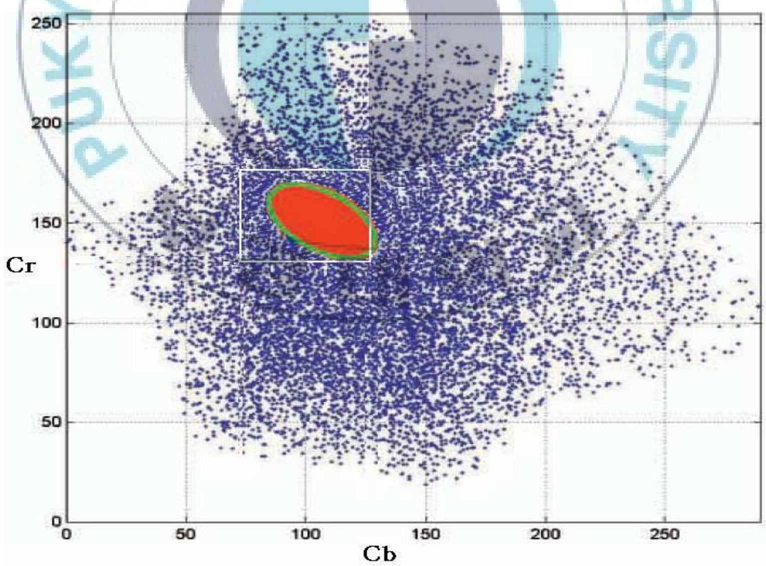
Range of luminance	Range of Cb	Range of Cr
0 ~ 80	$77 \le Cb \le 127$ to $120 \le Cb \le 132$	$133 \le Cr \le 173$ to $128 \le Cr \le 135$
80 ~ 200	$77 \le Cb \le 127$	$133 \le Cr \le 173$
200 ~ 255	$77 \le Cb \le 127$ to $116 \le Cb \le 131$	$133 \le Cr \le 173$ to $128 \le Cr \le 135$

(1) When the luminance is in the range of 80 ~ 200, the range of skin color value are $77 \le Cb \le 127$ and $133 \le Cr \le 173$

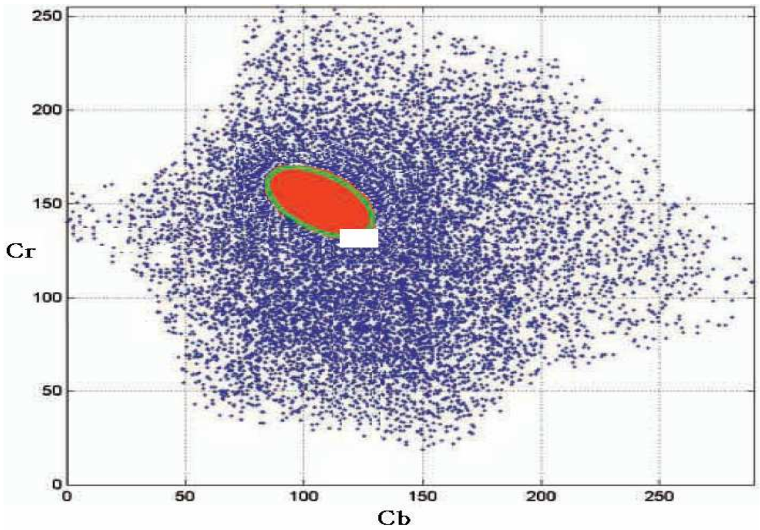
(2) When the luminance is in the range of 0 ~ 80, the range bounds of skin color value are changed gradually from $77 \le Cb \le 127$, $133 \le Cr \le 173$ to $120 \le Cb \le 132$, $128 \le Cr \le 135$. These ranges form a stereoscopic inverted trapezia as Fig. 11 (c).

(3) When the luminance is in the range of 200 ~ 255, the ranges of skin color are changed gradually from 77≤Cb≤127,133≤Cr≤173 to 116≤Cb≤131, 127≤Cr≤148, and form a stereoscopic trapezia as Fig. 11 (a).

The range statistics of skin color are projected into the Cb-Cr subspace. The ranges of skin color in the nature environment are larger than the ranges shown in Fig. 10 (a). In which the square region confined by the white lines is the region of skin color in nature environment. From this image if the color in real environment isn't considered and the nonlinear segmentation is adopted for CbCr sub-space directly, the color in real environment that is similar to the skin color is easily determined as the skin color. That is also the reason why the bookshelf in Fig.9 is determined as the skin color.



(a)



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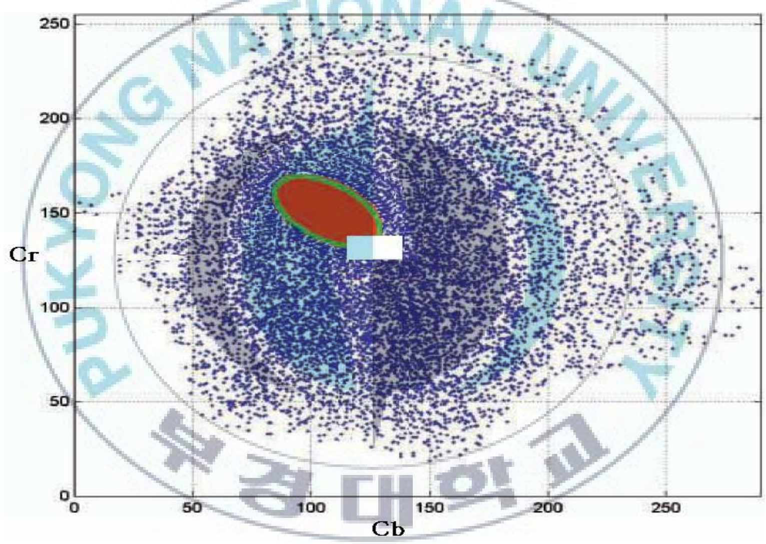
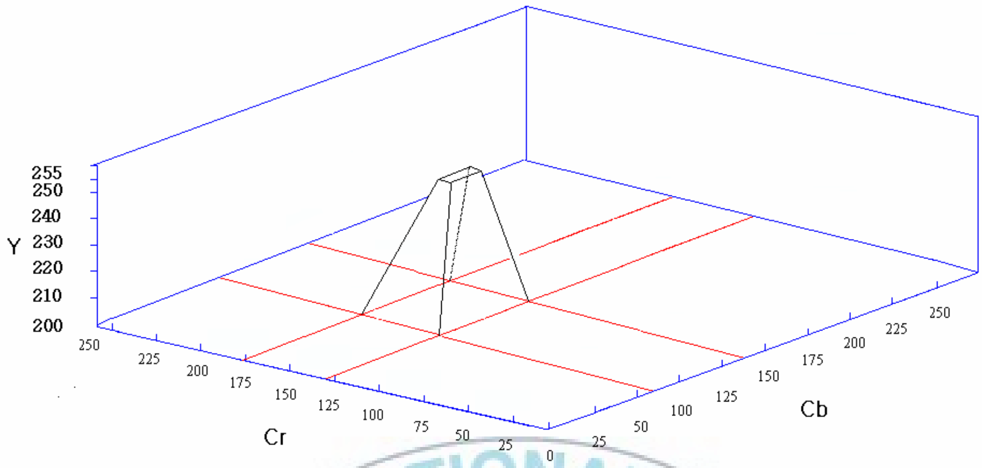


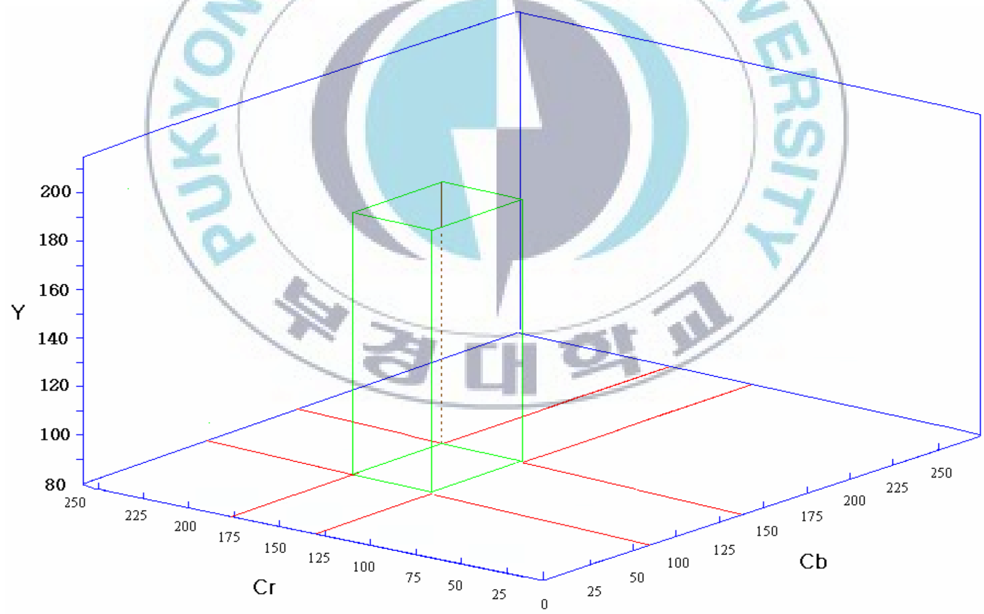
(c)

Fig. 10 The range of skin color CbCr values in the region of difference luminance (a) The range of skin color CbCr with a luminance is in the range of 80 ~ 200. (b) The range of CbCr when the luminance is in the range of 40 ~ 50. (c) The range of CbCr when the luminance is in the range of 245 ~ 255. The region confined by white square

Thus, the skin color model is divided into the three YCbCr spaces as shown in the Fig.11 for the above case.



(a)



(b)

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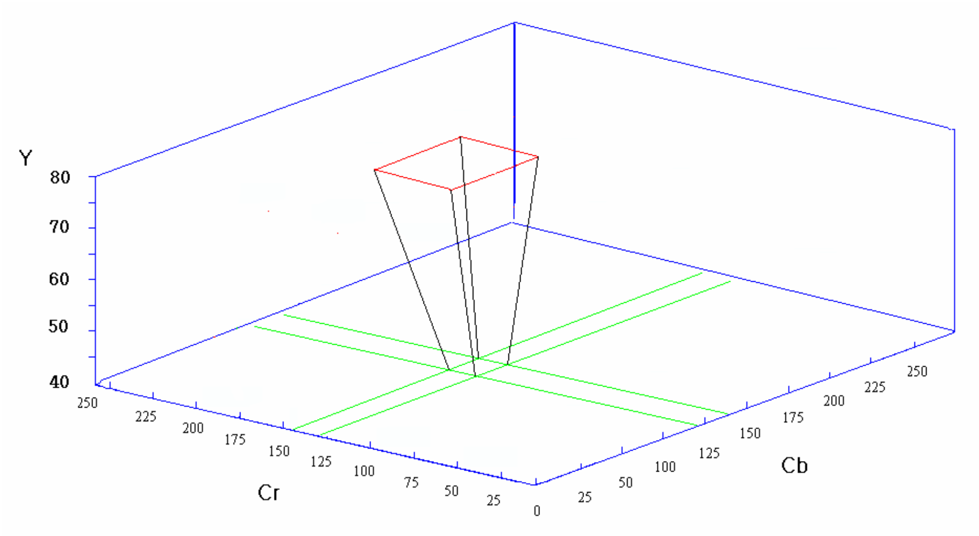


(c)

Fig.11 Skin color region in region of different luminance values (a) The luminance is in the range of 200 ~ 255. (b) The luminance is in the range of 80 ~ 200. (c) The luminance is in the range of 40 ~ 80

When the luminance is less than 40, the image becomes ash black and isn't able to use for face extraction. However, the eyebrows, eyeballs, hair, and so on are always in these regions. Thus, these regions can be determined as none skin color region.

YCbCr space only with skin color is divided into three spaces. Thus the face color information can be finally extracted via different none-linear segmentation in these three spaces.

First of all the difference method is applied to Fig. 7.(b) and then the ellipse clustering method is applied to Fig. 7.(d), this sequence leads to get a better data for the second method. Fig. 9. (b) is extracted from Fig. 9. (a) with complex background by using ellipse clustering method that makes a wrong judgment because the extracted image includes some useless image data. If we project Fig. 7.(d) in YCbCr space, the impact occurred from complex background on the whole face detection process can be completely eliminated. This means that the red region of Fig.3. (a)(b) doesn't include complex background and color information similar with the skin color , by which most of the information in YCbCr space is all the color information of human body.

At the moment, we can just concentrate on the lowest luminance region such as hair, eyeballs, eyebrows and the highest luminance region like the white parts of eyes, and then we can well separate the skin color information and other information via the method of ellipse clustering. Only by amending a little bit the constant of the formula (3) we can extract the color information of facial region and finally the skin color.

5. Procedure for Extracting Face Color Information

The procedure to get the face color information from the original image is as follows.

[Step 1] Apply the difference method to the original image for getting the facial region. And eliminate human body by projection method

[Step 2] Apply the ellipse clustering method to the facial region got at [step 1] and separate the skin color and the other color information in Cb-Cr space.

(1) When the luminance is in the region of 80~200, Amend the coefficient of formula (3) as follows: a=28.39, b=16.03, cx=124.38, cy=152.02, radian Θ is kept the same.

(2) When the luminance is in the region of 40 ~ 80, expand the major and minor axis of ellipse formula (3) by 1.2 times

(3) Judge the pixels unit that the luminance 40 below as none skin color region (namely these are eyebrows, eyeballs and hair, eyes excluding white parts)

(4) When the luminance is in the region of 200~255, expand the major and minor axis of ellipse formula (3) by 1.3 times

[Step 3] Project the color information of the skin region onto the new image.

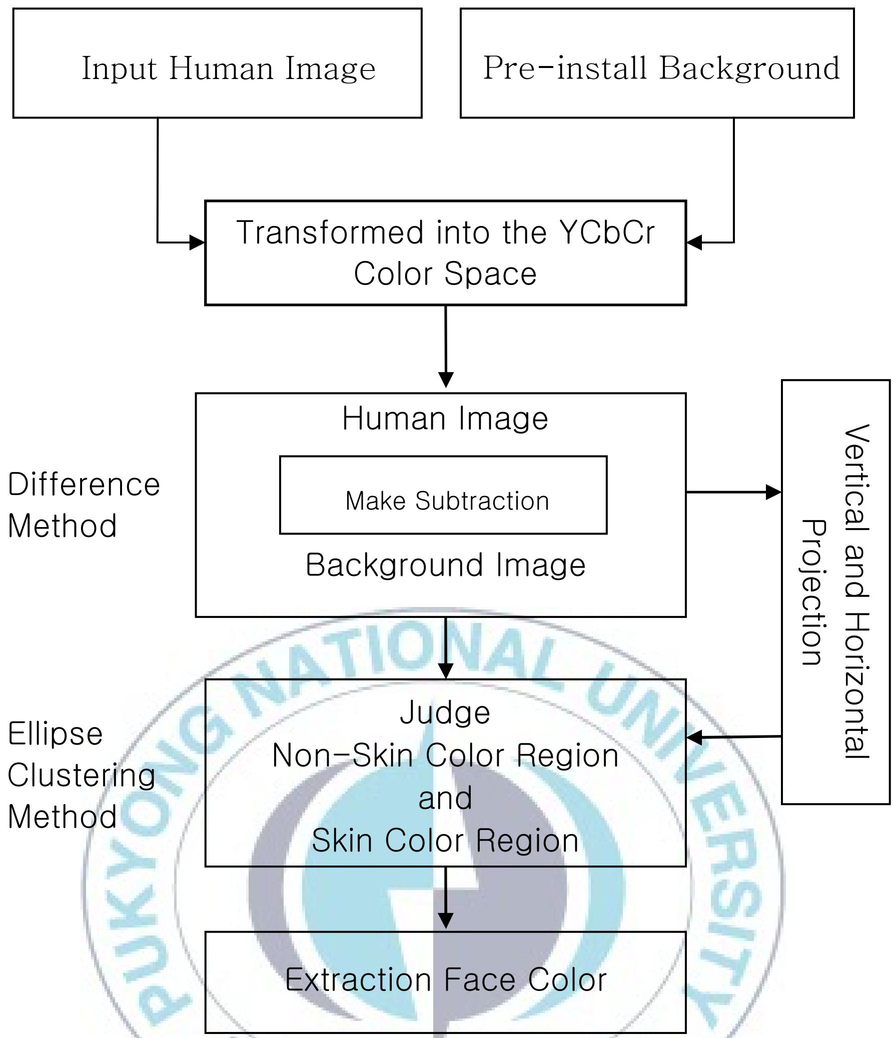


Fig. 12. Overall Process for Face Extraction

In order to eliminate the influence of light, image should be transformed into YCbCr space first and eliminate the background via difference method. Then exactly detect the face location via projection. Finally, divide up the detected face image in YCbCr space and remove human body information, and the face color region is extracted.

6. Experimental Results and Considerations

The image processing was programmed in matlab7.0 in which two images of the same location were used in complex background. The one image background is without human body and the other image has the human body as a “to-be-identified object” with the size of 512× 512 (the 200 images are respectively taken at laboratory of office building in the campus, outside office building in the campus). All the experiments are performed successfully at Windows XP PC. The exact extraction rate is 80%. The experimental results prove that the white light is helpful for increasing the identity rate because the face color information can be easily identified via white color.

Table 2 is the comparison results of the two detection methods under an environment of different light intensities and the same location with an image of 512×512.

These two methods have a pretty good applicability under an environment of enough light. The exact face location can be detected efficiently by using Haar cascade method. However, the wrong determination will arise when the small part that is similar to the skin color exists in the background. But the reason why the proposed method has a wrong determination is that the same color information as the human body information exists behind the human body, the correctness rate of detection is slightly higher than Haar cascade method under an environment of enough light

In an environment of high light intensity, partial skin color of face region changes by the effect of light, for which face location can be detected but can't be correctly detected by Haar cascade method. However, proposed method can be adopted to correctly detect the face location because the hair is black and it is obviously different from the background with high light intensity.

In an environment of low light intensity, the detection correctness rate of Haar cascade method rises, because the surrounding color of the background is obviously different from the skin color. If there isn't any small part (small size of region) that is similar to the skin color, the correctness rate could be 83%. Because the light intensity is too low to use the difference method and only the general location of face region can be detected and the skin color can't be detected via the proposed method, the correctness rate falls.

Table 2. The Comparison of Two Methods

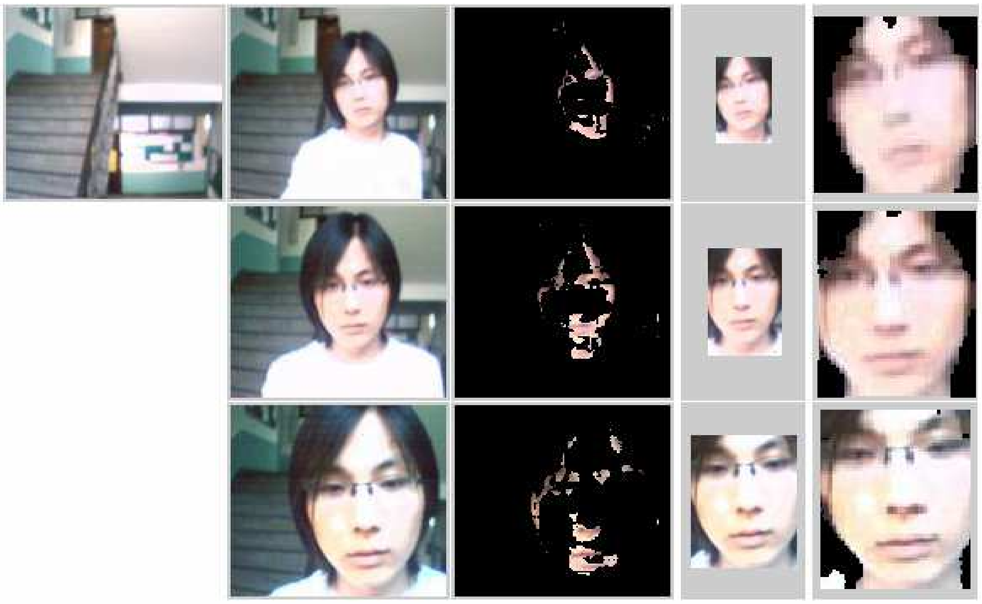
Light Intensity	Correctness Rate(%) of Proposed Method	Correctness Rate(%) of Haar Cascade
High Luminance	88	78
Normal Luminance	84	75
Low Luminance	65	83

The result of the experiment indicates that the proposed method has a pretty good applicability in the environment of high light intensity and general light intensity and it also has conditionality in the environment of low light intensity.

Several groups of experimental processes can show that the intensity of light source has impact on experiment. The experimental environment is as Fig. 13, where Fig. 13.1 is the case of the abundant light source in natural environment. Fig. 13.2 is the case of a stable light intensity of background with a transformative distance between the head and camera from far distance to near distance to very near distance. Fig. 13.3 is the case of multi-tiered transformation of light source of background. Fig. 13.4 is the case of insufficient light source. The steps in experiments are shown in from Fig. 13.1 to Fig. 13.4, where the group (a) is the background image, the group (b) is the to-be-detected face image of this background, the group (c) is the skin color determination of human body region that detected via difference method. (d) is the facial region lined out via method of projection, group (e) is the face color information extracted via the ellipse clustering For a dim light source.

(a) (b) (c) (d) (e)

Fig. 13.1. The case of the abundant light source



(a) (b) (c) (d) (e)

Fig. 13.2. The case of a stable light intensity of background from the different distances

(a) (b) (c) (d) (e)

Fig. 13.3. The case of multi-tiered transformation of light source of background

(a) (b) (c) (d) (e) (f)

Fig. 13.4. The case of insufficient light source

The effect of Fig. 13.4(d) and Fig. 13.4(e) are not obvious and Fig. 13.4.(f) is the image extracted the skin color region from Fig. 13.4(d). Fig. 13.4 (c) is the obtained human body via difference method.

As shown in the Fig. 13.4, The most special case that the facial region color almost can't be detected generally occurs when the face in environment is extremely dark or extremely bright. However, the obtained human body region is almost without any noise via difference method in this case. Thus the facial region can be detected via the projection method that adoptes to this region.

The experiment proves that the face color information extraction using the difference method and ellipse clustering method is effective and feasible. Fig. 13.1, 13.3, 13.4 can prove that this method will not affected by the intensity of the light source. Fig. 13.2 proves that this

In view of the above cases, in the future research, the accurate determination of facial feature including eyes, nose and mouth and so on will be taken into consideration for a better determination of facial region to increase the correctness of detection of this method. and will research on the method of mult-face or multiple objective detection and extraction, optimize of nonlinear segmentation formula.

7. Conclusion

The manner of extracting the face color information from the image via the combination of difference and ellipse clustering methods has been addressed, It belongs to a kind of face detection method that based on linear transformation and non-linear segmentation. It avoids the case that non-skin color is determined as the skin color because of the enlargement of ellipse size when using non-linear segmentation via difference method and it removes the color that is similar to skin color in the background. Thus the color region and non color region can be separated better via the method of non-linear segmentation. Saves the computations and eliminates the complex background via the difference method as well as the skin color extraction via ellipse clustering method. Besides aimed at the characters of YCbCr space, the complexity that the luminance affected on the face detection is eliminated via this method. The difference method makes up the disadvantages of the ellipse clustering method that eliminates none skin color information of human body. Thus the face information is detected and extracted effectively. Compared with the existed methods, it could not only detect the location of the face in the image but also could get the face color information, which provides high-efficient data and application value for face recognition system and face detection system.

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