YCbCr 색 좌표계의 모든 요소를 고려한 3-channel 피부 검출 알고리즘

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Three channel Skin-Detection Algorithm for considering all constituent in YCbCr color space

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요 약

화상 통신과 보안 시스템에서 얼굴 인식을 위한 얼굴영역을 검출하는 연구가 대두되며, 이러한 연구의 전 처리 단계로써 YCbCr 색 좌표계에서 색 정보를 이용하여 피부영역만을 검출하는 알고리즘을 제안한다. CbCr 색 정보를 이용한 기존의 피부 영역 검출 알고리즘의 경우, 실외나 카메라 플래시를 사용하였을 때 반사광에 의해 밝게 나타난 피부 영역에서 검출 손상이 발생하는 문제점이 나타났다. 따라서 본 논문에서는 어떠한 환경에서도 피부색만을 정확하게 검출하기 위해 기존의 알고리즘을 개선하여 Cb, Cr 뿐만 아니라 Y(Luminance) 값까지 모두 고려한 3-channel 구조의 피부 검출 시스템을 제안한다.

ABSTRACT

Skin detection research is important role in the 3G of mobile phone for video telephony and security system by using face recognition. We propose skin detection algorithm as preprocessing to the face recognition, and use YCbCr color space. In existing skin detection algorithm using CbCr, skin colors that is brightened by camera flash or sunlight at outdoor in images doesn't acknowledged the skin region. In order to detect skin region accuracy into any circumstance, this paper proposes 3-channel skin detection algorithm.

Keyword

YCbCr color space, Skin detection, skin region boundary

Ⅰ. INTRODUCTION

Skin detection has emerged as an research topic in several practical applications. Skin detection is applied to pre-treatment stage of face recognition that be easy to approach than the information of living body and be minimized a compulsive data collection.

Moreover, this skin detection is applied to correct the person information. If the skin color of persons in video and still images is damaged, we decide that the quality of images are more degraded than when background is damaged. In order to solve the problem and to improve image quality, we revise kernels for skin detection [1].

A number of color spaces have been considered, such as YCbCr, normalized RGB, and HSI, for the feature space to discriminate between skin and non-skin classes. We use YCbCr color space used in digital video. In this space, we can easily separate a single component, the luminance (Y), from color information. Moreover, there are two color-difference components, Cb and Cr. Component Cb is the difference between the blue components and a reference value, and component Cr is the difference between the red component and a reference value [2]. Based on the YCbCr color space, we show two algorithms and evaluate the performance of those. The one which is based on 2-channel, Cb and Cr, has the weak points to skip the bright areas of human skin, so we propose the advanced algorithm to consider 3-channel, Y, Cb, and Cr.

The paper is organized as follows. Section 2 presents the existing algorithm, and section 3 describes th details of the proposed algorithm. Section 4 shows experimental results, and section 5 gives conclusions.

II. EXISTING ALGORITHM

Existing skin detection algorithm is based on YCbCr color space, so RGB color space of test images must be converted into YCbCr color space [3].

$$\begin{bmatrix} Y \\ Cb \\ Cr \end{bmatrix} = \begin{bmatrix} 0.257 & 0.504 & 0.098 \\ -0.148 & -0.291 & 0.439 \\ 0.439 & -0.368 & -0.071 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} + \begin{bmatrix} 16 \\ 128 \\ 128 \end{bmatrix} \quad (1)$$

Equation (1) is the transformational matrix of RGB to YCbCr. Two Dimension skin detection sets skin region using only Cb and Cr. In order to compose skin region, we project various sample data from each ethnic group on the YCbCr color space. Figure 1-(a) shows the distribution of skin region of African, Caucasian, and Asian skin types from test images. Figure 1-(b) shows the contour, ⓐ, from the figure 1-(a) and includes all 3 races [4].

In figure 1-(b), we add the square boundary, ⓑ, for a more precise depiction of human skin, because the contour has both human skin and background color as follows equation (2).

$$\begin{Bmatrix} 70 \le Cb\_ⓑ \le 145 \\ 130 \le Cr\_ⓑ \le 197 \end{Bmatrix} \quad (2)$$

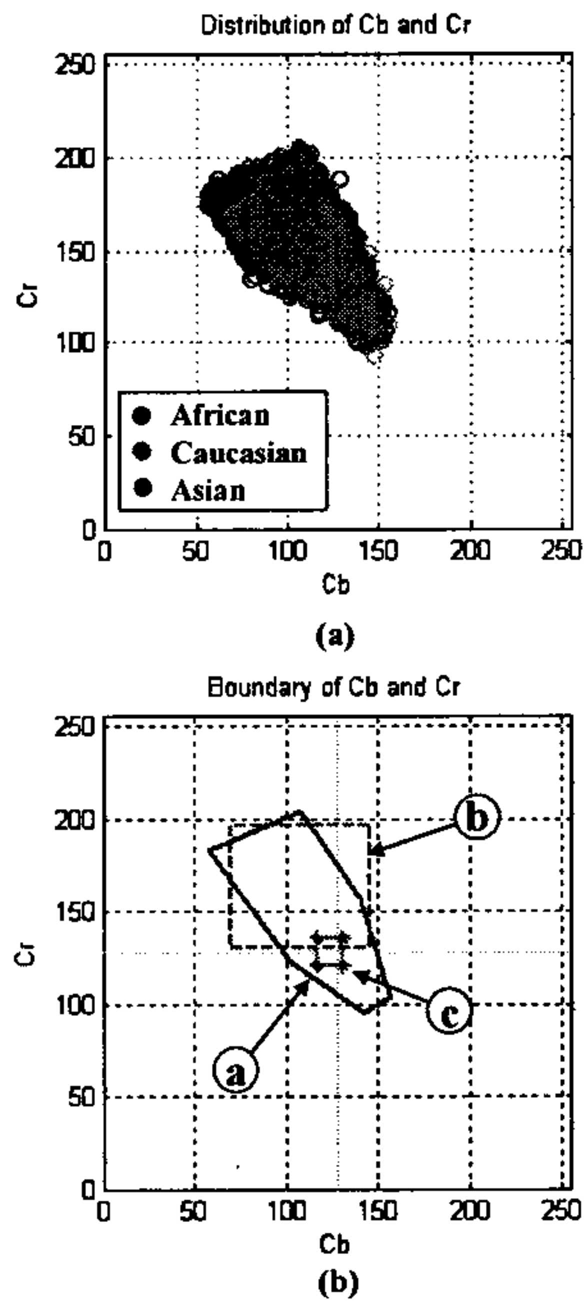

Figure 1. Skin region by Cb and Cr, (a) Distribution of aces, (b) Contour from 3 races

(a) (b)

Figure 2. The detects of 2-D skin detection, (a) original image, (b) result of 2-D skin detector

Moreover, it has an additional boundary for eliminating the light colors, as a result, it causes problems that does not recognized the skin region to be reflected light by camera flash and the sunlight. Therefore, we add another square boundary, ⓒ as follows equation (3).

$$\begin{Bmatrix} 117 \le Cb\_ⓒ \le 131 \\ 121 \le Cr\_ⓒ \le 135 \end{Bmatrix} \quad (3)$$

In order to minimize the side effects, the existing algorithm uses the optional mode selections [4]. In spite of this options, some image are ineffective by that thrown light. Figure 2 shows the problem of images by reflected light.

The marked two parts of figure 2-(a) are brighter than other skin regions due to camera flash. Existing skin region detection algorithm applies to some cases such as figure 2. Figure 2-(b) shows the defects of skin region, because errors occur in skin region of images.

III. PROPOSED ALGORITHM

In order to solve the problem that is sensitive for light in skin region, we propose all constituent of YCbCr color space. Figure 3 shows distribution of skin colors of 3 races, African, Caucasian, and Asian on 3-D. This is, z axis is Y, x axis and y axis are each Cb and Cr. Skin region by Cb and Cr around Y-minimum and Y-maximum is more narrow than the skin color around Y-middle value. In order to detect the skin region with above mentioned specific characteristics, we are not using only CbCr but also Y.

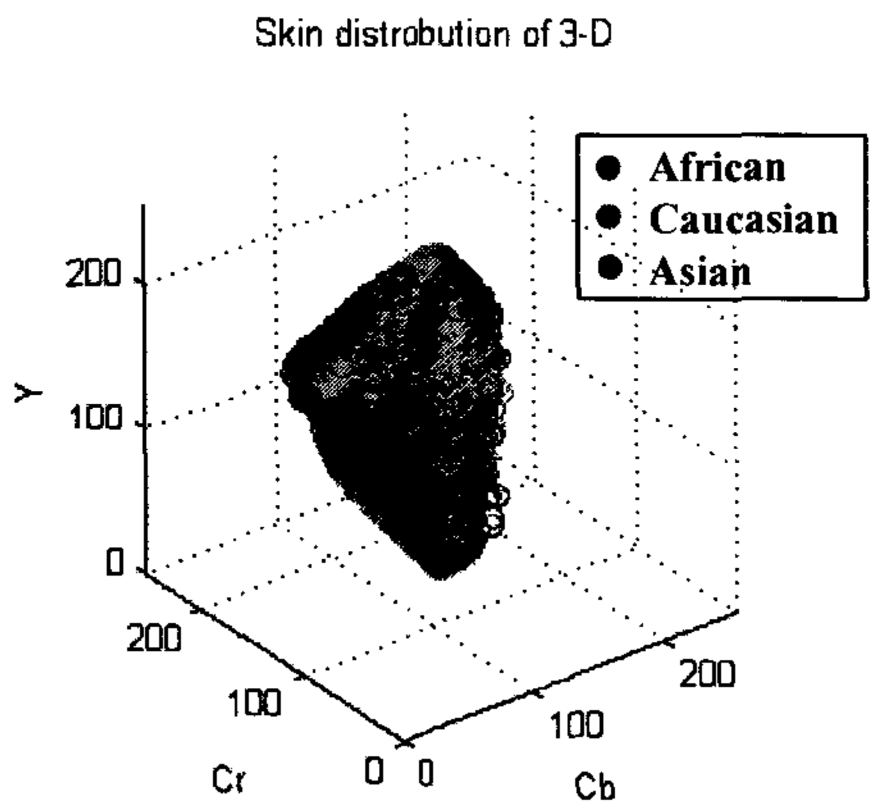

Figure 3. Three dimension skin region

It is difficult to design 3-D skin region, so we detect skin region by adding novel mask to consider Y component. Figure 4-(a) is distribution for Cb and Y components, and figure 4-(b) is distribution for Cr and Y components. We generate the slope and intercept by substituting vertex for linear equation. Finally, we transform distribution from figure 4 to tangent boundaries of the figure 5. Figure 5-(a) shows the boundary lines of Cb and Y components, and figure 5-(b) indicates those of Cr and Y components. We separate the skin boundary within the six vertex into four sections to compare inputted Cb, Cr, and Y with fixed Cb, Cr, and Y.

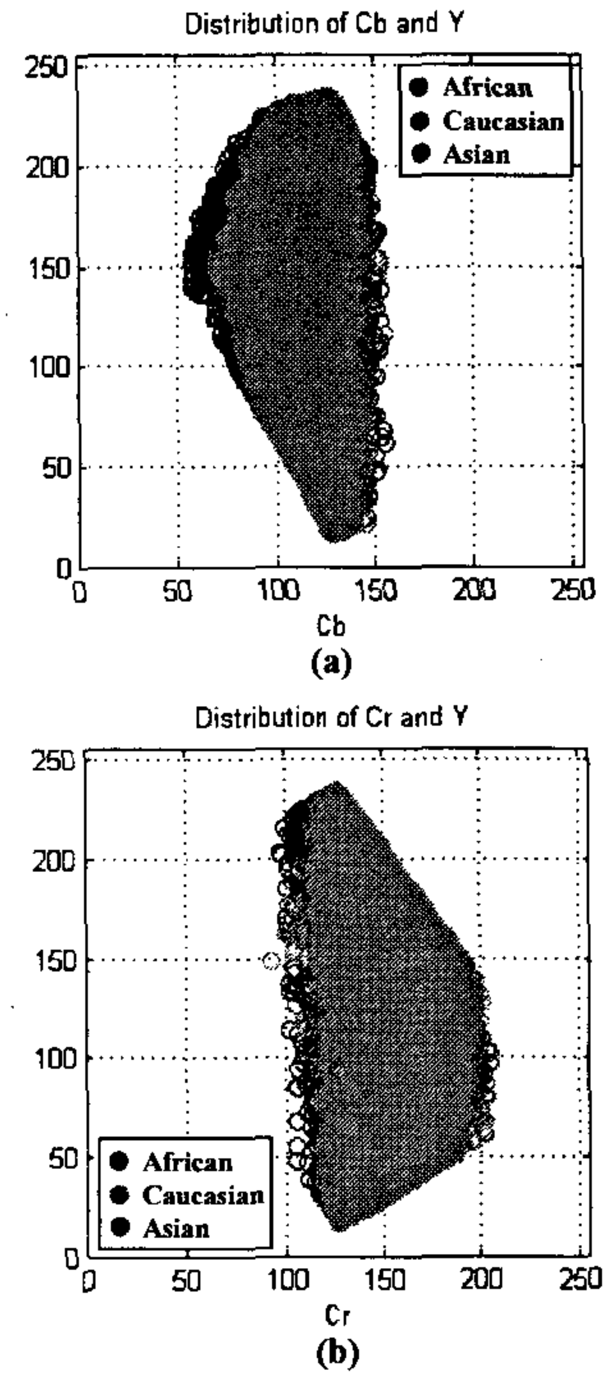

Figure 4. Distribution of 3 races, (a) Cb,Y components, (b) Cr,Y components

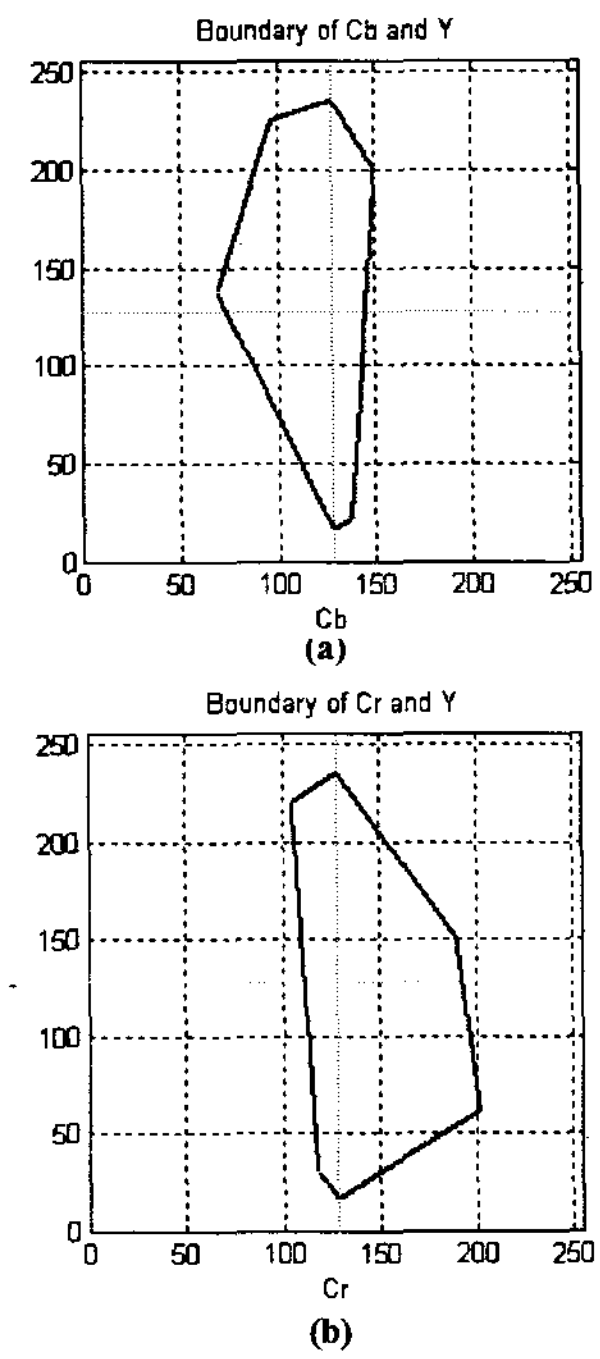

Figure 5. Boundary line of skin region (a) Cb,Y skin region, (b) Cr,Y skin region

Inputted Cb and Cr are judged in which section's range they are included, and pixel that is included fixed Cb and Cr of Y is compared with fixed Y in the section. If any pixels are included in the boundary of the figure 1-(b) without ⓒ, the figure 5-(a), and the figure 5-(b), they are included in skin region; otherwise, the pixels which are excluded in these boundaries should be perceived as non-skin region.

Figure 6. Result of 3-D skin detection

Figure 6 shows the result image by proposed skin detection algorithm. We can know that performance of skin detection is enhanced 3-D skin detector, through the result.

Ⅳ. EXPERIMENTAL RESULTS

For performance of 3-D skin detection algorithm, images include skin colors of people from Caucasian, African, and Asian, and under diverse lighting conditions and backgrounds. We test the performance of the algorithm by using images of each different race in simple and complex background, indoor and outdoor.

Figure 7 shows the difference between the results by existing algorithm and those by proposed algorithm. Figure 7-(a), (d), (g) are input images, and figure 7-(b), (e), (h) are result images by 2-D skin detector. Although marked regions are the skin colors, they do not include pixels of skin boundary. As a result, it has declined skin detection efficiency. Input images are applied to 3-D skin detector, as a result, they are well detected skin regions, as shown figure 7-(c), (f), (i).

Ⅴ. CONCLUSION

Existing algorithm has a problem that is deteriorated the efficiency of detection at particular environment. In this paper, we proposed skin detection algorithm in order to detect skin region in specific circumstance. We

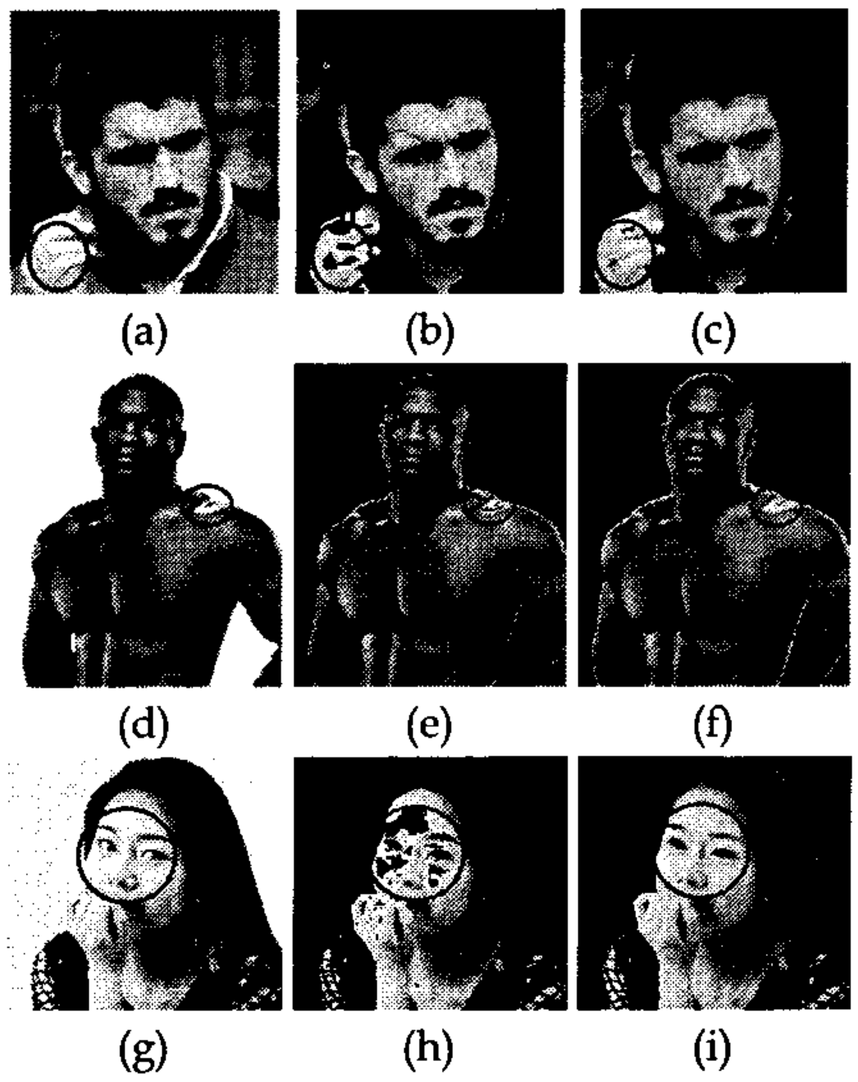

Figure 7. Result of images in Caucasian(a ~ c), African(d ~ f), Asian(g~i), original images(left), 2-D detector(center), 3-D detector(right)

confirm that 3-D skin detection efficiency is improved when comparing the results by 2-D skin detection with the results by 3-D skin detection. Although 3-D skin detection algorithm is limited to detect some images that some colors are similar to skin colors or light has plentiful effects on image, the majority of image has the improved results.

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