Recognition of Nostril Position Based on Skin Color Distribution

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Keywords: Facial feature points, RGB color, Human interface, Measurement

Abstract. This paper proposed a new detection method for a face features point, based on the skin color distribution ratio. Here we selected the nostril part as a feature point due to the fact that its shape is stable compared with other parts. Human's face was observed by the camera in real time and the skin color was utilized to detect the face domain. After the binalization image obtained from the camera was changed to a connection ingredient by processing labeling. In order to detect the nostril position, we focused on the skin color distribution ratio, whose value around the nostril was lower than any other facial parts. The proposed system narrowed down the candidate of the nostril as a facial feature point by checking the skin color distribution ratio, the aspect ratio between the width and the height of the connection ingredient.

1. Introduction

In recent years, the automatic face detection technology[1] has been developed and it has been used on home optoelectronics device, such as digital video recorder, camera, or smartphone, as a matter of course. Such recognition technique has been remarkably developed since the Viola-Jones method[2,3] had been proposed. This method can find a human face from the obtained image very easily. However, it had been constructed on the assumption that a front-facing is roughly kept. Therefore, the side face cannot be recognized. To solve this problem, the author has proposed a new method of face detection, based on facial feature color [4]. As a same approach, improvements in Viola Jones algorithm using both skin and eyes colors has been proposed to detect the tilted face detections [5]. Here, we used only rough skin color information to detect the nostril position. The proposed system could narrow down the candidate of the nostril by checking the color, area, and aspect ratio.

2. Measurement system

The flow and constitution of these systems disposal is showed in Fig.1. An USB camera (Logicool HD Webcam C615) was connected to a PC, converting the photographed image into

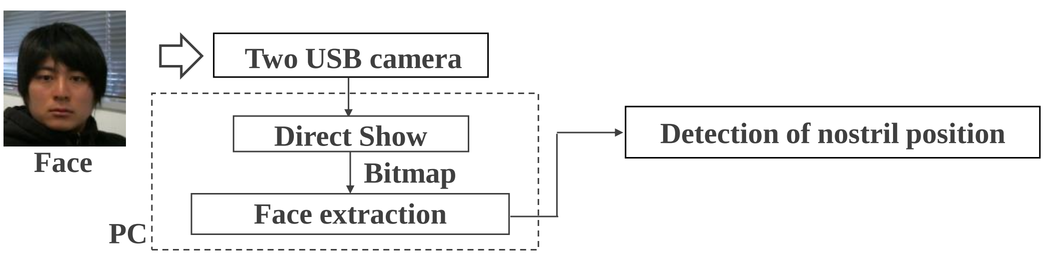


Fig.1 System construction

bitmap image in real time. Then, the nostril after the detection with the face of the user by image processing as a facial feature point was detected realizing a position measurement in the three dimensions space by using the difference of the coordinate between the obtained two images. Microsoft Visual C# 2015 for the construction of the control program was used to develop the system.

3. Detection of nostril position

3.1 Skin Color

Fast of all, RGB values of the facial image was analyzed. Eight image parts such as facial skin, nostril, lip, hair, pupil, white of the eye, eyebrow, and background, were selected to investigate special feature of RGB color. In this subsection, the color information of feature points was considered to detect the face of the obtained image. Fig.2 shows RGB color information of image. In this figures, the relationship of the RGB level about each feature point was plotted on graph. It is confirmed that ingredient of R on the skin, nostril, and lips are stronger than other domains. As for these three parts, the relation of $R > G > B$ was satisfied regardless of brightness. Above all, the differences between R and B could be seen remarkably. Furthermore, it is said that each ratio of RGB color about the skin, nostril, and lips is almost certain value. From the obtained value, a condition to distinguish a pixcel of skin was defined as follows;

$$\tilde{R} < 160, \tilde{G} < 120, \tilde{B} < 90 \tag{1}$$

Where, $(\tilde{R}, \tilde{G}, \tilde{B})$ was a RGB pixel colors. In addition, the following circumstances between the two color components were added.

$$\tilde{R} < \tilde{G}, 2\tilde{R} < 3\tilde{B}, \tilde{G} > \tilde{B} \tag{2}$$

The above is a magnitude correlation among RGB colors. Furthermore, the following circumstances among the three color components were also set.

$$\begin{cases} 0.38 < \dfrac{\tilde{R}}{\tilde{R}+\tilde{G}+\tilde{B}} < 0.6 \\ 0.27 < \dfrac{\tilde{G}}{\tilde{R}+\tilde{G}+\tilde{B}} < 0.49 \\ 0.02 < \dfrac{\tilde{B}}{\tilde{R}+\tilde{G}+\tilde{B}} < 0.3 \end{cases} \tag{3}$$

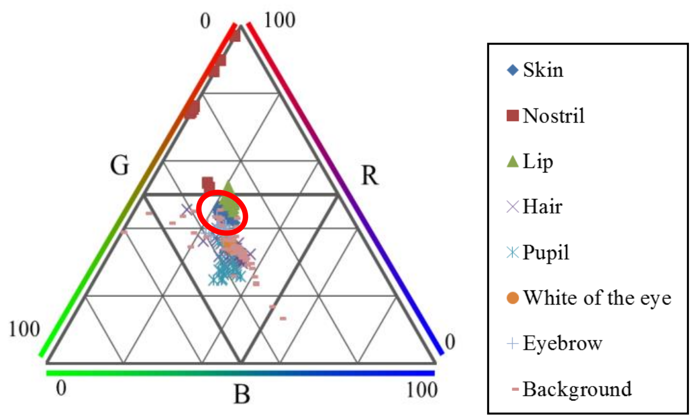


Fig.2 The RGB color of eight facial parts

3.2 Rough nostril position

Here, we focused on the fact that the brightly-colored facial area is distributed around the nostril while the dark-colored facial area is distributed around the eye, the mouth and the jaw. As shwon in Fig.3(a), when the face width is x pixcel, the ocupied ratio for skin color at position y is defined as;

$$w[y] = \frac{\sum_{i=1}^{x} g[i, y]}{x} \tag{4}$$

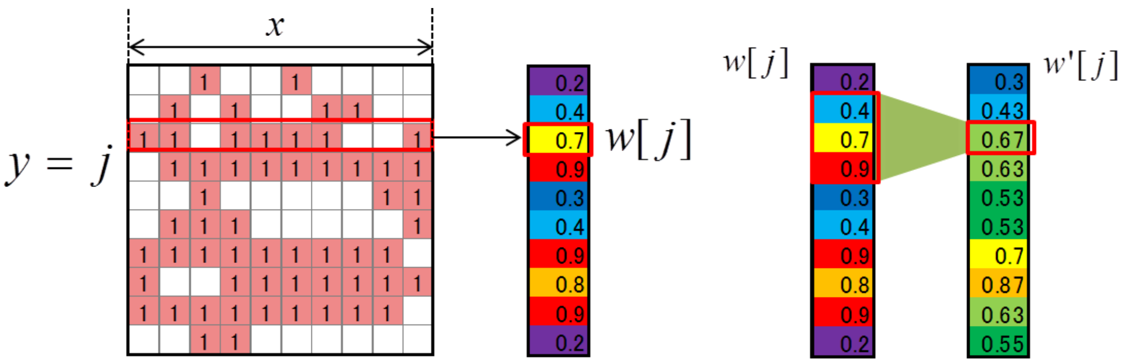
In addition, the noise was eliminated as shown in Fig.3 (b) by smoothing procedure as follows;

$$w'[y] = \frac{\sum_{i=y-n}^{y+n} w[j]}{n} \tag{5}$$

Where, n was a smoothing range and this value was set 0.0125 times with respect to the height of the face domain. Furthermore, the evaluation function for the connected part m and n was defined as;

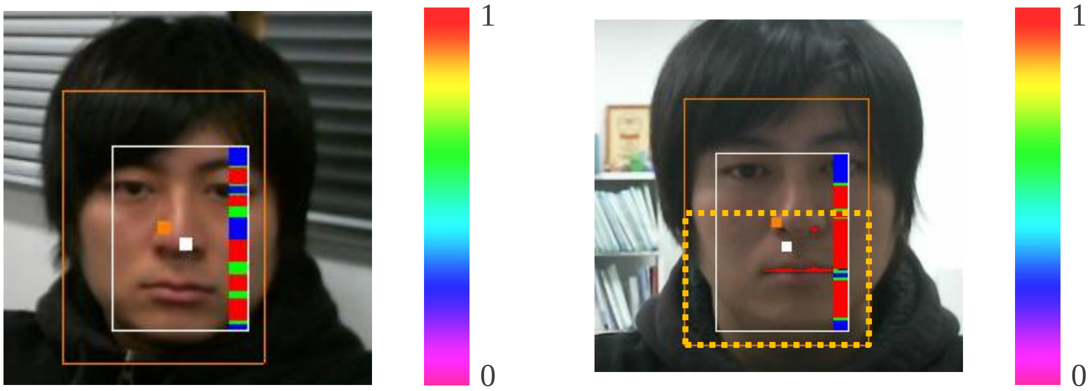
$$e[m,n] = (10\left|\frac{\Delta y}{\Delta x}\right| + d) \times (1 - w[y_m]) \times (1 - w[y_n]) \tag{6}$$

Where, the candidate of the nostril was detected by finding the combination of m and n for the minimal value of $e_{\min} = e[m,n]$. The above algorithm was applied to the face domain. The result of process1 and 2 are shown in Fig.4 (a) and (b), respectively. The red part expresses the high possibility area for the nostril. Through the process 1 and 2, we could see that the skin value was higher around the nostril and mouth compared with any other special feature such as eyes or hair.



(a) Process 1 (b) Process 2

Fig.3 weighting procedure



(a) Process 1 (b) Process 2

Fig.4 Image example

Consequently, the orange dotted rectangle area was picked up as a high possibility area of locating the nostril.

3.3 Detection

In order to detect the nostril position, the candidates were checked. The labeling procedure was performed to assign the peculiar label to every connection ingredient as shown in Fig.5. Let the center of gravity and area about the ingredients $G_i = (G_{xi}, G_{yi})$ and S_i. At first, the candidate, whose aspect ratio was less than 0.3 or more than 3.0, was eliminate because its vale of nostril is approximately 0.5. After that, the distance of each connection ingredient interval afterwards was confirmed. The distance between centers of gravity could be derived by the following equation.

$$d_i = \sqrt{(G_{xi} - G_{xj})^2 + (G_{yi} - G_{xj})^2} \ (i = 1,2,\cdots,N,\ j = 1,2,\cdots,N-1) \qquad (7)$$

Where, N is the number of the ingredient. In cases where the distance from the camera to a target object is approximately 300 mm, the value of d_i is approximately less than 50. In this figure example, the candidate was narrowing down and $G_1 = (G_{x1}, G_{y1})$ and $G_2 = (G_{x2}, G_{y2})$ were consequently detected as the nostril as shown in Fig.6. If the system could not find two candidates of the nostril, the ingredient located at higher position within the estimated area of the rough nostril position was regarded as a nostril. Fig.7 shows the results of Open CV and the proposed method. In this case, only one nostril could be viewed because the face was directed to the side. As shown in Fig.7(a), the detection by the OpenCV library mistook the ear for the face. On the method, in Fig.7(b), we can see that the proposed method could recognize the face and detect the nostril position even though the face was directed to the side.

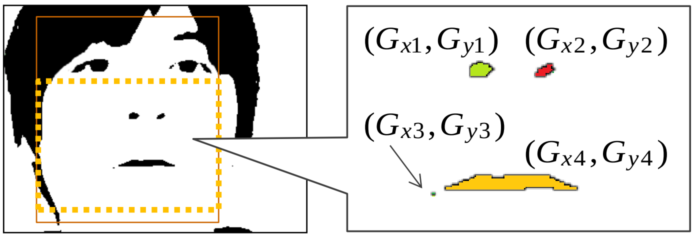


Fig.5 Narrowing of the nostril candidate

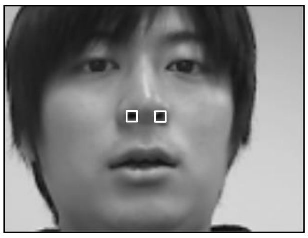
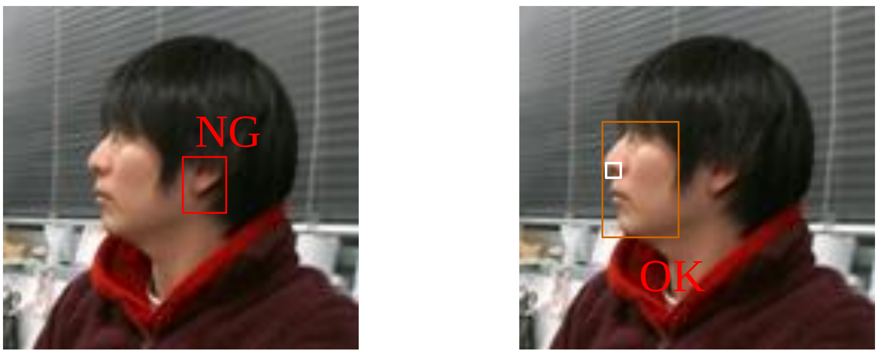


Fig.6 Detection of the nostril



(a) Open CV (b) The proposed method

Fig.7 Recognition example

4. Conclusions

This paper proposed a new detection method for the nostril location, based on the skin color distribution ratio. Fast of all, the circumstance of the RGB values was clarified to pick up the facial location from the obtained image. Next, the rough nostril position was estimated by the skin color distribution. Here, we focused on the fact that the brightly-colored facial area is distributed around the nostril while the dark-colored facial area is distributed around the eye, the mouth, and the jaw. Consequently, it was confirmed that the proposed system could narrow down the candidate and find the nostril location even though the face was directed to the side.

Acknowledgements

This research was partially supported by the Ministry of Education, Science, Sports and Culture, Grant-in-Aid for Scientific Research (C), 2015-2017, No.15K05888.

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