Face Detection of Monoeye Character

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In this paper, we designed new face detection method for monoeye character, under assumption that characters has similar skin color and sclera color with human. Since monoeye characters are expressed to have large eye, our method focused to iris detection for face detection. Our method showed 17 true positives, 44 false positives, and 22 false negatives from 34 samples which contains 39 faces total, and showed better F_1-measure than related researches.

I. Introduction

Face detection is image processing technique which detects face of human or character in image of movies. There are many methods to detect faces of human and to detect faces of characters, but there are no any methods to detect face of monoeye characters. Since monoeye characters have only one eye, it is hard to use approaches which made for non monoeye character.

II. Related Works

There are several methods to detect face of ordinary character. Face detection method is often classified by two approaches; feature-based approach and image-based approach. Feature-based approach finds intrinsic features of faces, such as eye and mouth[1]. On the other hand, image-based approaches generates criteria of face from large data set, and uses generated criteria to detect face.

III. Method

Since our main purpose is face detection of monoeye character, we should consider characteristics of monoeye character. Monoeye characters has only one eye, and

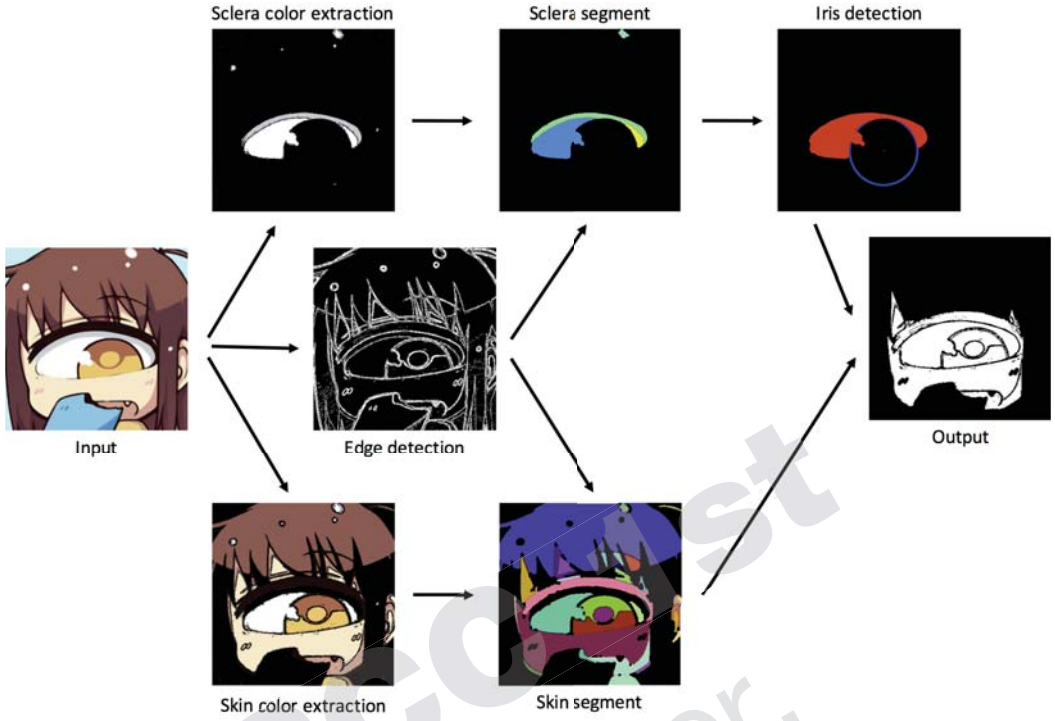

FIGURE 1. Flow of face detection of monoeye character

often expressed very large. So, our face detection method will use this characteristic to detect face. And also we will assume that skin and sclera color of character is similar with human, and skin and sclera color is not too similar. First step of our method is extraction of face color and sclera color, and edges of image. Second, our method will make segments of face and sclera. Third, our method will use circle regression to detect iris and eye. Last, our method will find face using detected eye and face regions.

A. Edge Detection

Since making closed curve is very important to our method, our method used binarization after convolution with Laplacian operator. Our method uses CIELUV color space because it is perceptually uniform.

B. Skin, Sclera Color Extraction

Jamie and Shaogaog described hue values of human skin colors are concentrated at 6 to 38 degrees[4], and Kohei, Henry and Tomoyuki arranged this condition to hue values in 0 to 40 degrees, and value over than 75%[1]. Our method will use this conditions

to extract skin color. Also, we will use equation 1-4 to detect sclera color[7].

$$\begin{cases} r = \dfrac{R}{R+G+B}, \\ g = \dfrac{G}{R+G+B}, \\ b = \dfrac{B}{R+G+B} \end{cases} \quad (1)$$

$$I_r = (r-0.33)^2,\ I_g = (g-0.33)^2 \quad (2)$$

$$I_c = I_r + I_g - 0.0009 < 0 \quad (3)$$

$$R+G+B > 1.2 * 255 \quad (4)$$

Where maximum value of R, G, B is 255. If pixel satisfies (3) and (4), our method recognizes the pixel as sclera colored pixel.

C. Segmentationing

Our method uses flood-fill approach to generate segment of skin color or sclera color. Skin and sclera segment is extracted from skin color pixel and sclera color pixel, and image edge. Segment is generated from skin or sclera color pixel, and grows until there is no any skin side pixel. And when segment is too small, segments are removed.

D. Iris Detection

Our method detects eye from sclera segment to reduce false positive results. Since circle Hough transform is not effective for ellipse or smudged circle, we designed new method to detect iris. Before to design method to detect iris, we should consider case of position between iris and sclera. There are 3 distinct case between iris and sclera.

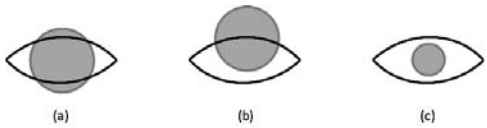

FIGURE 2. Three distinct case between position of iris and sclera; (a) has two intersecting curves, (b) has only one intersecting curve, and (c) has no intersecting curves.

We can generate convex hull from using outermost contour of sclera segment, and the edge of convex hull will be calculated as following;

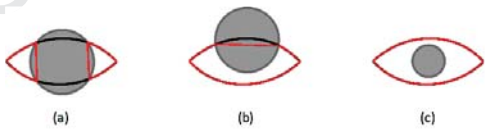

FIGURE 3. Edge of convex hull of outermost contour of Fig. 2

So, we can get the edge of iris partially from differential between edge of original segment of edge of convex hull. To detect iris from partially detected iris edge, we used RANSAC and circle regression which uses modified least squares method[5,6]. Also, our method did verification of iris using standard deviation of distance between detected

iris and each iris pixel. If standard deviation is larger than 20% of iris radius, detected iris is ignored.

IV. Result

We used 34 distinct samples which contains total 39 monoeye characters. First, we analyzed results of our method step by step. The result is following:

	True Positive	False Positive	False Negative
Face Segmentation	36	-	3
Sclera Segmentation	31	-	8
Iris Detection	17	44	22

TABLE 1. Analyzed result of our method

Second, we compared face detection result of our method and other methods for non monoeye characters *TJN*12[1] and *Imager*09[3]. The result is following:

	True Positive	False Positive	False Negative	F_1-measure
Our Method	17	44	22	0.34
TJN12	23	519	16	0.084
Imager09	8	9	31	0.039

TABLE 2. Result of face detection

V. Discussion

Our method showed 27.8% of precision and 43.5% of recall, and 20.5% of false negatives are caused by sclera segmentation, 79.5% of false negatives are caused by iris detection. Since our method makes many false negatives at iris detection, we should improve our iris detection method to improve performance. Also, F_1-measure of our method is larger than other methods, we can think our method is more efficient than other methods at detecting face of monoeye character. SSCC 1st

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