Fast Method for Multiple Human Face Segmentation in Color Image

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Extended Abstract

Location detection and segmentation of human face is an important process for face identification. Also there are a lot of other applications requiring face segmentation, for example face tracking, video surveillance and security control system, human computer interface, etc. Those applications require human face which has been segmented and ready for processed. Until now detection and segmentation of human face is an active research area. Many things influencing success of detection and segmentation of human face, between it, complex color background, condition of illumination, change of position and expression, rotation of head, distance between camera and subject, etc. Many methods has been developed for segmentation of human face, using neural networks [2, 5, 6], eigen faces with background learning [5], statistical approach [6], fuzzy pattern matching [11], color information and geometric knowledge [7, 8, 9, 10, 12, 13].

In this paper we propose fast method for human face detection and segmentation. The method consists of two parts, first part is face position detection and second one is facial feature extraction. Face position detection is the part to obtain face candidates region which later will be applied to next process. Facial feature extraction is part to get area of facial feature like two eyes and one mouth.

Face Position Detection

Initial process to get location of face candidates is skin color detection. In the process of skin color detection, analysis process will be done in two colors model, that is normalized RGB (Red, Green, Blue) and HSV (Hue, Saturation, Value). In general, a color from a pixel obtained from combination between values R (Red), G value (Green), and value B (Blue), where each the valuable component in the range of between 0 and 255. Normalization value from every obtainable color component by the way of as follows:

$$r = \frac{R}{I} \quad g = \frac{G}{I} \quad b = \frac{B}{I} \tag{1}$$

r, g, b = normalized color of red, green and blue respectively.
R, G, B = original color of red, green and blue respectively.

Hereinafter, analysis process also is done in HSV (Hue, Saturation and Value) format. HSV color model selected to be used in analysis process because it assumed to be nearest with human perception for a color, in this case is skin color. For conversion from RGB color model into HSV color model, we used equation (2).

$$H1 = \cos^{-1}\left\{\frac{0.5\left[(R-G)+(R-B)\right]}{\sqrt{(R-G)^2+(R-B)(R-B)}}\right\},$$
$$H = \begin{cases} H1, & if\ B \le G \\ 360° - H1, & if\ B > G \end{cases} \tag{2}$$
$$S = \frac{Max(R,G,B) - Min(R,G,B)}{Max(R,G,B)},$$
$$V = \frac{Max(R,G,B)}{255}$$

From the result of analysis by using combination between two color models, we can determine from such part of a picture which is including skin-color and which is not. Acceptable boundaries for human skin color are as follows [12]:

$$0.36 \le r \le 0.465, \quad 0.28 \le g \le 0.363, \quad 0 \le H \le 50, \quad 0.20 \le S \le 0.68, \quad 0.35 \le V \le 1.0 \tag{3}$$

After determine the skin color, the next process is grouping or merging the parts to form face candidate region by using *8-connectivity neighbourhood* [13]. For every face candidate region found, we keep the region coordinate for later processing.

Facial Feature Extraction

Facial feature extraction is phase to obtain candidate region from facial feature, in this case is region for candidate of two eyes and mouth. Eyes and mouth are selected as facial feature because they have different characteristic compared to other part of face. Eyes have circular form and their colors are darker compared to human face skin color, and also mouth has form like ellipse and its color differing from skin color. After get some regions for eye and mouth candidates, there will be selection process to determine real eye and mouth region. The facial feature extraction will be done for each face candidate region found in the face position detection phase. Before extract the facial feature, we apply convex hull algorithm to the face candidate region to get the facial feature extraction process faster.

To do the facial feature extraction, first we use thresholding process in the face region detected to get binary image of the face candidate. Next, to get the eye or mouth candidate, it can be applied by algorithm for seeking elliptical area. We apply the mask of elliptical that represent eye and mouth to the face detected to get eye or mouth candidate.

The next process is to select the real eye and mouth from the candidates. The selection process is done by calculate the triangle weight of two eyes and one mouth [9]. The combination between two eyes candidates and one mouth candidate that have the biggest triangle weight will be selected. And the face candidate region has those selected combination of two eyes and mouth candidate will be selected as real human face area.

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