

AN APPROACH OF FACE DETECTION USING GEOMETRICAL DEFINITION OF HUMAN FACE

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Abstract: Human face can be identified by different biometric features, which are genetic properties of a human being. If the biometric features can be extracted from a facial image then they can be used for face recognition. We propose a new method of face detection by using human face geometry. We conducted our experiment with 25 face images which are captured from CCD camera under the varying condition of illumination, pose and expression. Our experiment has shown that our method is better than neural network based face detection method in detection time and accuracy.

Keywords: face detection, face edge image, candidate block.

1. INTRODUCTION

Face recognition is a field of biometrics together with fingerprint recognition, iris recognition, and speech recognition and so on. Automatic extraction of human head and face boundaries and facial features are critical in the areas of face recognition, criminal identification, security, surveillance systems, human computer interfacing, and model-based video coding. In general, the computerized face recognition includes four steps [1]; first, the face image is enhanced and segmented. Second, the face boundary and facial features are detected. Third, the extracted features are matched against the features in the database. Finally, the classification into one or more persons is achieved. In order to detect faces and find the facial features correctly, researchers have proposed a variety of methods which can be classified into four categories[1]: knowledge based method[2], invariant feature based method[3,4,5,12], template matching method[6,7] and appearance based method[8,9,10,11,13].

Knowledge-based methods attempt to describe all the face patterns using rules based on human knowledge such as that all faces have two eyes and a mouth. Template-based methods represent the face class by templates with allowable deformations which rely on the alignment of feature points. Feature invariant methods are hard to use in detecting faces in real images as it is difficult to find features that are truly invariant with respect to all faces and large perturbations in lighting, pose, and expressions. Appearance-based methods provide several key advantages and are widely used in face detection. Especially, as they allow one to learn the models

from training data, the large amount of intra-class variation, expression, and pose can be accounted for in training by using a large training set.

2. EXTRACTION OF FACE EDGE IMAGE

This phase is a first part of preprocessing of face detection algorithm. Fig.1 shows block diagram of face edge image extraction.

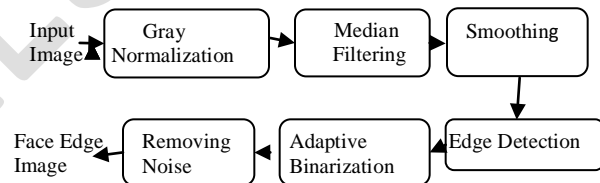


Fig 1: Block Diagram of Face Edge Image Extraction

2.1 Gray Normalization

Given input gray image $I(i, j)$ normalized image $I'(i, j)$ is computed by the following equation.

$$I'(i, j) = \begin{cases} M_0 + \sqrt{\frac{V_0 \cdot (I(i, j) - M)^2}{V}}, & I(i, j) > M \\ M_0 - \sqrt{\frac{V_0 \cdot (I(i, j) - M)^2}{V}}, & I(i, j) \leq M \end{cases} \quad (1)$$

Where, M, V: mean and variance of inputted image $I(i, j)$ & M_0, V_0 : Mean and variance of destination image $I'(i, j)$

2.2 Edge detection

In order to find face edge image, we apply 3×3 mask (see Fig.2) to median filtered and smoothed image. In this system, we assume that human head is up-straight in range of equation (3) (see Fig.3). Fig.3 shows camera-face interface condition of our system.

2.3 Adaptive binarization

Given M_1 mean of edge detected image $I(i, j)$, binary image $I'(i, j)$ is computed by the following equation.

$$I'(i, j) = \begin{cases} 0, & I(i, j) \leq T_B \\ 255, & \text{others} \end{cases}$$

Where, $T_B = M_1 * P_B / 100$ ----- (2)

$$\text{Where, } \left. \begin{aligned} 0^\circ \leq \varphi_x, \varphi_y, \varphi_z \leq 15^\circ \\ 0.3m \leq l_z \leq 0.7m \end{aligned} \right\} \text{----- (3)}$$

2.4 Removing Noise

In this phase, when the pixel number of black-connected blocks in white region are less than T_S , we remove all them. For convenience, we call black-connected block to block briefly.

3. FACE DETECTION ALGORITHM

Fig.4 shows flowchart of our face detection algorithm. As shown in Fig-4, the input of our face detection algorithm is binary face edge image extracted above.

- Extraction of candidate mouth block

For any block of face edge image, if the following condition is satisfied, then we select it as candidate mouth block.

$$\left. \begin{aligned} T_{\min}^{xy} \leq \Delta y / \Delta x < T_{\max}^{xy} \\ T_{\min}^x \leq \Delta x < T_{\max}^x \end{aligned} \right\} \text{----- (4)}$$

Where $\Delta x, \Delta y$: width and height of block, $T_{\min}^{xy}, T_{\max}^{xy}$: minimum and maximum of ratios of block width and height,

T_{\min}^x, T_{\max}^x : Minimum and maximum of width of block.

- Extraction of candidate face region

For any candidate mouth block extracted above, we calculate candidate face region according to human face geometry by referencing literature [14].

- Calculation of face score

Here, we don't discuss about face score calculation (See literature [14]).

- Extraction of face orientation

In our system, we extract the orientation of line that passes on center of mouth and is perpendicular to two eye connected line as face orientation. (See Fig.5)

4. EXPERIMENTAL RESULTS

Thresholds of face detection algorithm used in our experiment are as follows.

$$M_0 = 120, V_0 = 70, P_s = 98, T_s = 60 \\ T_{\min}^{xy} = 1.0, T_{\min}^x = 96, T_{\max}^x = 200, N_m = 50$$

We conducted our experiment with the 25 data of face images which are captured from CCD camera (Logitech) under the varying condition of illumination, pose of head and expression of face, with the computer Pentium-III(CPU 650MHz, Memory 128MB).

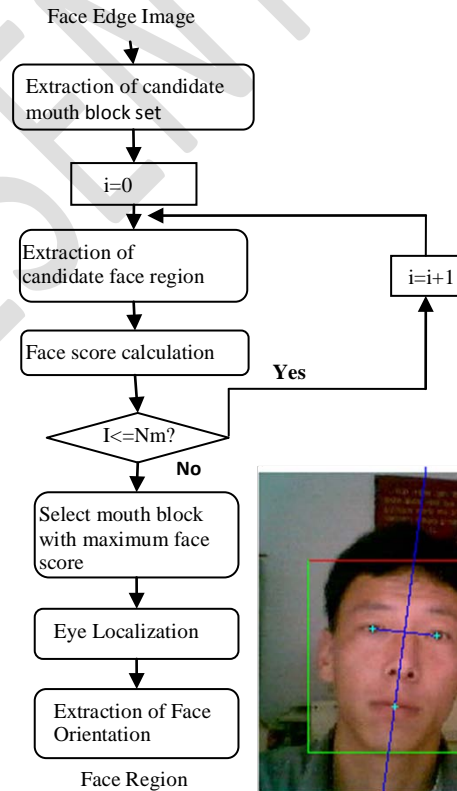
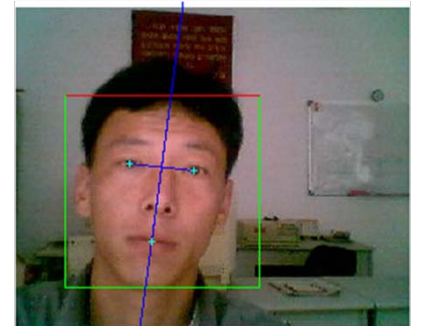


Fig 4: Flow Chart of face detection algorithm



Face Orientation =84 deg
 Fig 5: An example of Face Orientation Extraction

Table.1 shows the comparison result of detection time and detection rate between our method and proceeding method [9].

Table.1 A comparison result of mean face detection time and mean detection rate

Method	Mean Detection	Mean Detection Rate
Method[9]	82ms	92.75%
Our Method	76ms	94.25%

5. CONCLUSION

In this paper, we have presented a new method of face detection by using human face geometry. Our study has shown that our method is better than the neural network based eye detection method in detection time and accuracy. The full face detection algorithm on face image of any pose, scale and illumination will be our future task.

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