

Study on the Method and Implementation of Face Location

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Abstract. The face recognition technology is to analyze the target image and detect the characteristic information of the face. It is used widely in peoples life and its' basis is face location technology. In this study, several methods of face location technology are analyzed and compared. A face location method based on skin color clustering is analyzed in detail. The realizing process is given and the experiment is carried out. The results indicated that this method can realize the function of face location and can lay foundation for subsequent processing of face images.

Introduction

Face recognition is a biometric identification technology and the principle is to identify the human's face by analyzing the characteristic information from the face. It need to collect a face image using camera, and then to get the face location from the image [1]. It can analyze the characteristic information and recognize the identity.

Nowadays, the technology of face recognition can be used in many fields in our life, such as anti-terrorism, policeman hunting, room security, polling, and so on. The technology of face recognition can judge out the human's identity exactly with high efficiency and good rate [2].

The process of face recognition is divided into four steps, acquisition of face images, image preprocessing, and extraction of facial features, analysis and identification of face identity. Among them, the extraction and detection of facial features from the images is to locate face. Based on the analysis of face location methods, the method of skin color clustering is used to locate face.

Methods of Face Location

Nowadays, the technology of face location has already got mature. There are a variety of ways to detect the face location.

Face Location Based on Generalized Symmetric Transformation

The symmetry is divide into point symmetry and central symmetry, and it is an important way for object recognition. The characteristic of human face is obviously, especially the symmetry feature. A normal human face can fully show symmetrical beauty. The organs in the face are symmetrical, such as eyes, nose and mouth. So, the generalized symmetric transformation can be used for face location. In other words, the geometric distribution of characteristic and central point of human face can be determined by analyzing the eyes symmetrically [3]. This way has good robustness because it is not sensitive to the face deflection and light variation. However, the generalized symmetric transformation is not be used widely, since it can only describe the symmetry of each point. Besides, the method should compute in large fields, and it need too much computation.

Face Location Based on Feature Extraction

The key of the face location method based on feature extraction is to analyze the face characteristics. The first step is to get a face image and analyze it. Ant then, the characteristics of the face are extracted out which are compared with standard features vectors. The detection range of the

face can be decreased which can improve the efficiency of face location [4]. This method can detect the face exactly, but the process is too complex.

Face Location Based on Deformable Template

The face location based on the feature extraction is to detect the face location by analyzing the face characteristic. But, in order to improve the location precision, it can add a algorithm for nose location. It is the deformable template method and it can be seemed as the improved method for the feature extraction. The basic thinking is to design an organ model with adjustable parameters is designed and define an energy function. The energy function can be minimized by changing the model parameters. The model parameters are the geometric characteristics of the organ. An evaluation function can be computed for each set of object which may be considered as a combination of face features. If the function value is greater than the allowable threshold range, it can be seemed as a face. However, it is difficult to locate the feature points under the condition of poor imaging conditions. The accuracy of feature point location is one of the keys in the process of face recognition.

Face Location Based on Feature Space

The key of this method lies in the space conversion and the sample acquisition. The main idea is to get a face image, and convert the image into another space which can be significantly distinguished between face and non-face features, so that it can distinguish the area and locate the position of face and non-face. The method of space transformation uses PCA method (principal component analysis), which is a very practical method [5]. It does the orthogonal transformation based on the statistical characteristic, and clears the intrinsic vector component. After transformation, the characteristic vector which corresponding Eigen value is decrease progressively can be got. The difficulty of this method is that the non-face area is very difficult to locate and the sample is difficult to get.

The Face Location Method Based on Skin Color Clustering

The process of face location is often corrupted because of the complex background of the face image. That is why the area of the face and non-face are so difficult to be distinguished. The background analyzing makes obvious influence on the realization of face detection and the relevant processing of face image.

The face detection method of this project is to adopt the color space conversion method based on skincolor. Firstly,the system gets the image by a camera, and then the image are analyzed and preprocessed by using the software of Matlab [6].The process of face location based on skin color clustering and image processing is given, as shown in Fig. 1.

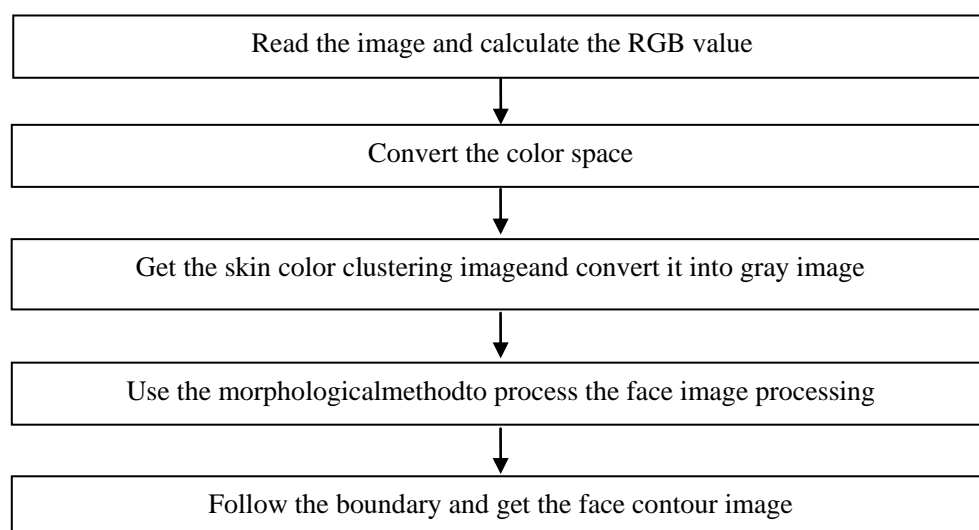


Fig. 1 The face location process based on skin color clustering

Morphological Image Processing

Morphology is a strong mathematical theory, and it is a new useful method for image processing and it is contacted closely with reality.

The basic idea of mathematical morphology is simple: the basic characteristics of an image can be described by a whole set of algorithms. The algorithm is based on differential geometry and stochastic set theory, which is different from the frequency domain and airspace algorithm. The morphology consists of two basic transformations: expansion and corrosion. The expansion is to fill image defect by expanding the boundary. The corrosion is the dual operation of the expansion and it is to eliminate make the small and meaningless object by shrinking the boundary.

The Face Location Based on Skin Color Clustering Method

YCbCr is a widely used color space. In this space, 'Y' means the brightness of the color, 'Cb' means the chrominance of the blue color, 'Cr' means the chrominance of the red color. The YCbCr color space is very outstanding in skin color clustering [7]. But the RGB space is affected greatly by brightness than the YCbCr space, so the RGB space can be converted into the YCbCr space while detecting the face location. The relationship between the two spaces are given, as shown in Eq. 1 and Eq. 2.

RGB is converted to YCbCr:

$$\begin{bmatrix} Y \\ Cb \\ Cr \\ 1 \end{bmatrix} = \begin{bmatrix} 0.2990 & 0.5870 & 0.1140 & 0 \\ -0.1687 & -0.3313 & 0.5000 & 128 \\ 0.5000 & -0.4187 & -0.0813 & 128 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \\ 1 \end{bmatrix} \quad (1)$$

YCbCr is converted to RGB:

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 1 & 1.40200 & 0 \\ 1 & -0.34414 & -0.71414 \\ 1 & 1.77200 & 0 \end{bmatrix} \begin{bmatrix} Y \\ Cb-128 \\ Cr-128 \end{bmatrix} \quad (2)$$

The face images of different people have different distribution in color space. It is just because the brightness of color is different, but the difference in chrominance is small. Thus, the skin color is also clustering in a certain range. According to the prior knowledge, the 'Cb' value of skin color space clustering is about 150. The gray image can be got by using the discriminate formula and the morphology processing method. The implementation method is given, as shown in Eq. 3.

$$\begin{cases} (R, G, B) = (255, 255, 255) & \text{if } Cr \in (80, 120) \text{ and } Cb \in (133, 165) \\ (R, G, B) = (0, 0, 0) & \text{if } Cr \notin (80, 120) \text{ or } Cb \notin (133, 165) \end{cases} \quad (3)$$

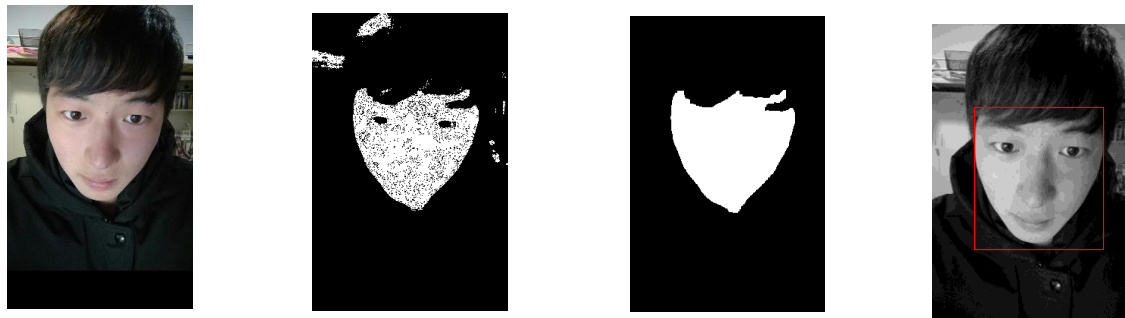
Implementation of Face Location

In this experiment, the face image is colorized, one of the color images is given, as shown in Fig. 2 (a).

By analyzing the face image, the values of 'R', 'G' and 'B' can be got, and the values of 'Y' and 'Cb' are calculated by using the transformation relation between YCbCr color space and RGB color space. Because 'Cb' is gathered around 150. In order to produce a dual-value matrix, the clustering range is set to (33, 65). The image conducted by using the skin color clustering method is gotten, as shown in Fig. 2 (b).

It can be seen that the face area has been detected basically by skin color clustering method, but some color in the image which is similar to the skin color also be treated as the skin because the value of 'Cb' is a range. The interference area stays in the image. In another aspect, because of the existing of eyes, mouth, nose and eyebrow, the face region is not a completely connected region.

In order to make the face area be extracted, the morphological processing method is used to process the image further and to get the face location. The face contour is gotten by the operation of corrosion and expansion, as shown in Fig. 2 (c). Finally, the exact location of face in the image is captured, as shown in Fig. 2 (d).



(a)Original face image (b) Clustering image (c) Face contour(d) Face location

Fig.2 The implementation of face location

Summary

In this project, the existed methods of face location are introduced briefly, and the advantages and disadvantages of various methods are compared. A new of face location based on skin color clustering method is brought out. This method uses the prior knowledge of face skin color range. This project adopts the software Matlab to calculate and analyze the face images. The experiment shows that this method can detect the face location rapidly and accurately. It can lay foundation for subsequent processing of face images.

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