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Face Recognition Based on Sparse Features

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Abstract:
Face recognition is a challenging task nowadays in spite of many techniques evolved. Although many approaches are proposed to done this case, but sparse feature based methods attracted more interests. It depends on the suitability of color space chosen, sparse feature modelling and classification of face and non-face pixels under varying illumination conditions. Near all of these methods have tried to find best match intensity distribution with face pixels based on popular color spaces such as RGB, CMYK or YCbCr. In this paper, a new feature extraction is created which facilities face recognition. Our experimental result shows the proposed method can help any face recognition strategy to gain better performance.

Keywords: Face recognition, sparse coding, new color space.

1. Introduction

A new scientific tool which is used to automate any applicable and industrial process is image processing. Some of these popular projects are face recognition [1], human tracking [2, 3], Human identification, visual tracking for surveillance, hand gesture recognition, searching, image retrieval and filtering image contents on the web and many others. One the most stages which should be used in these cases, is skin detection. In this respect, many approaches have proposed to detect skin which provide high detection rate. Some of them are used RGB color space to solve this problem such as [4, 5] and [6]. Some of the researchers used other color spaces such as YCbCr [7, 8], HSV [9], CIE LUV [10], and Farnsworth UCS [11]. As a common algorithm, near all of them tried to find the channel intensities which are too match by skin pixels in images. Also, in some methods the researchers used texture analysis approaches. Wu et al. used wavelet filters to done it accurately [11]. There are very various kinds of skins such as white, black, red, approximately green and etc. one of the most important mentions in this case is to detect all kinds of skins accurately. Also insensitivity to illumination and noise are some other problems in this case. There are many techniques for skin color segmentation, such as the Gaussian Mixture Model, color histogram, and thresholding. Some of the skin detection methods that adopt the threshold manner will be discussed in this paper. Sobottka and Pitas [3] presented a method for skin color segmentation based on HSV color space using fixed threshold values to extract the face region. Due to the variation in light conditions, they adopted shape features to enhance the face recognition feature. Jusoh et al. [4] introduced an approach for skin color detection, which is based on HSV and RGB color spaces, to improve the segmentation process by using two thresholds.

The first threshold is applied to the hue channel, and the second threshold is applied to the RGB model. Another method that combines two color models (HSV and YCgCr) was proposed by Ghazali et al. [5] for extracting the face region. It is based on thresholding techniques. Segmentation by combining more than one color model improves the accuracy of skin detection. Ghotkar and Kharate [6] described a hand segmentation method by using a threshold technique for hand gesture recognition. They made a comparison between three color spaces (HSV, HSL, and HTS) and found that the last one gave better results than the others. Jagadesh et al. [7] presented an approach for skin segmentation using the bivariate Pearsonian Type-IIb Mixture Model. They used the hue and saturation components of HSV color space to distinguish the skin and non-skin pixels, which they based on the threshold values and the Likelihood method, to enhance the accuracy of the results. However, using HSV color space in skin segmentation is time consuming due to the time it takes for non-linear transformation to occur between the RGB and HSV color models.

Chai and Ngan [8] suggested a method for extracting the face region from an input image using the thresholding technique. The color space used in this approach is the YCrCb color model. It was used due to its efficiency for modeling skin color and for its use in video coding. Another method that uses YCbCr color space with fixed thresholding to extract the face region is described by Marius et al. [9]. It applies morphological operations to reduce the unwanted regions. However, skin detection using the YCbCr color model in the previous methods is unsuitable for some races, such as black people.

The rest of the paper is organized as follows: section second focuses on the related work done previously. Third section gives the detailed proposed idea and the interpretation made on the results obtained by implementing the research work is discussed in fourth section. Finally, the conclusion about whole research work has been made in the last section.

2. *Related work*

Work done in the skin detection process has been rapidly and effectively increased in the previous years. As it is the preliminary step of most of the application so the yielded results should be more accurate in order to enhance the effectiveness of the applications like face recognition, human computer interaction, etc. As human skin color has its unique property from rest of the other features of human faces, it is commonly used to locate the human faces in still and video images by identifying skin and non-skin pixels [5]. Various researches have tried to make the skin detection automatic but still some challenges are still to be resolved. The accuracy of skin classification depends on the selection of color spaces as well as skin color model. Using the skin tone color information, Ibrahim et al. [1] has proposed a dynamic skin detector that would dynamically detect the adaptive thresholds using Viola Jones face detector algorithm. Selection of color space is based on the percentage of accuracy it will produce for particular task under given conditions. YES color space is used by Hsin-Chia et al. [8] for face recognition and eye localization. Nowadays, researchers are very much interested in the concept of fusion mixture of methods to enhance the detection rate of human skin region [9]. Skin detection methods are commonly classified into two categories: pixel-based and region-based. In pixel based skin detection method, the pixel information of the images are used for the human skin classification, whereas in region based, the concept of texture are used for the classification. Using the pixel information, skin detection methods are further classified into following sub-categories: explicitly defined skin region method, parametric method, nonparametric method, and semi-parametric method [6]. In explicitly defined skin region method, skin cluster is identified by finding the appropriate threshold that bound the human skin color during the training process using set of images for training. In parametric method, skin model requires much storage space and their performance directly depends on the representativeness of the training image set. This includes single and mixture Gaussian models. In non-parametric method, estimation is the key idea for skin color distribution from the set of images used for training without deriving an explicit model of the skin color. This method includes Bayesian model which performs fast computation and independent to the shape of skin distribution theoretically [7]. To deal with the performance of color spaces and their possible combination of two color spaces, explicitly defined skin region method is considered. It is the simplest method among all the other methods. It also produces good performance under different illumination conditions like different skin races, and different illumination conditions so this skin model is taken into account to perform the experimental computations.

3. *Proposed method*

We used a 3×3 transform matrix to create new color space. This matrix is defined as bellow,

$$\begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} w_{11} & w_{12} & w_{13} \\ w_{21} & w_{22} & w_{23} \\ w_{31} & w_{32} & w_{33} \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \qquad (1)$$

Where, w_{ij} in Eq.1 are the transforming weights and (X_1, X_2, X_3) are the new color space.

In the proposed method, two clusters and two scenarios are followed and made an objective function.

Two clusters are the skin cluster and non-skin cluster which collected manually from some color images and two scenarios are respectively: 1) minimizing similarities between members of each cluster 2) maximizing the distance between different clusters.

Hence, our proposed objective function is defined as bellow,

$$Obj(W) = \frac{\sum_{j=1}^{N} \|\alpha_j\|_2^2 + \|\beta_j\|_2^2}{\|\eta\|_2^2} \qquad (2)$$

where α_j, β_j are the distance of j[th] sample from the center of skin cluster, and non-skin cluster in new color space. η is the distance between two center in new color space. We minimize $Obj(W)$ subject to the bellow constraints.

$$\begin{aligned} 1 &= w_{11} + w_{12} + w_{13} \\ 1 &= w_{21} + w_{22} + w_{23} \\ 1 &= w_{31} + w_{32} + w_{33} \end{aligned} \qquad 0 \le w_{ij} \le 1 \qquad (3)$$

As indicated in Eq.2, although both of the numerator and dominator are defined in convex space, but minimizing such equation is hard due to the presence of variable in dominator part. For this reason, we used a auxiliary variable as bellow and convert Eq.2 to Eq.5;

$$\frac{\sum_{j=1}^{N} \|\alpha_j\|_2^2 + \|\beta_j\|_2^2}{\|\eta\|_2^2} = \delta \qquad (4)$$

$$Obj(W) = \sum_{j=1}^{N} \|\alpha_j\|_2^2 + \|\beta_j\|_2^2 - \delta\|\eta\|_2^2 \qquad (5)$$

Minimizing Eq.5 subject to Eq.3 can be performed using lagrange multiplier as bellow:

$$Obj(W) = \sum_{j=1}^{N} \|\alpha_j\|_2^2 + \|\beta_j\|_2^2 - \delta\|\eta\|_2^2 + \lambda C(W)$$

$$\frac{\partial Obj(W)}{\partial W} = 0, \quad \frac{\partial Obj(W)}{\partial \delta} = 0, \quad \frac{\partial Obj(W)}{\partial \lambda} = 0 \qquad (6)$$

5. *Simulation results*

We used MATLAB 2010 framework for our simulation and applied quadprog function in optimization toolbox to implement our idea. After that we performed our innovation, Space conversion weights are calculated as bellow:

$$W = \begin{bmatrix} 0.3 & -.0714 & -0.183 \\ 1 & -0.6 & -0.3 \\ -1 & 0.6 & 0.2 \end{bmatrix} \qquad (7)$$

Consequently, face recognition is done based on filtering the new transformed imaged by the bellow masking filter and oval template matching stage.

$$Filtered\_Image(i,j) = \begin{cases} 1 & |\mathrm{Im}(i,j) - thr| < \varepsilon \\ 0 & else \end{cases} \qquad (8)$$

Where, thr and ε are respectively center of skin cluster in new color space and a small value. Result of filtering is a binary image which contain skin areas, so we need to template matching for detecting face areas. In this paper, template matching is performed using correlation criterion and with Corr2 tool in Matlab framework. Some of the results for Skin and face recognition are depicted in the bellow,

Fig1: results of our proposed method

6. Conclusion

We used a new color space transforming strategy to detect skin areas in color images. This strategy emphasised to the skin structure and separates them in new space. Appling any face recognition scenario such as template matching on this new color space can verify the better quality of detection.

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