Skin Detection in YCbCr Color Space

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ABSTRACT

Skin detection is the process of finding skin-colored pixels and regions in an image or a video. This process is typically used as a preprocessing step to find regions that potentially have human faces and limbs in images. Several computer vision approaches have been developed for skin detection. Skin detectors typically transform a given pixel into an appropriate color space and then use a skin classifier to label the pixel whether it is a skin or a non-skin pixel. In this paper, an efficient method for skin color segmentation on color photos is implemented. This case has been suggested that the first color image from input color space to RGB color space and then transferred into YCBCR. After this transformation we have applied edge detection method to separate skin region and non skin region.

General Terms

Your general terms must be any term which can be used for general classification of the submitted material such as Pattern Recognition, Security, Algorithms et. al.

Keywords

Adaboost, Color segmentation, Color space, image processing, RGB, YCbCr

1. INTRODUCTION

In the past decade the large amount of face detection applications has been developed in order to enhance the human computer interaction with new nontraditional interfaces. Whole variety of techniques was developed using various features that represent face. In our work we focus to the skin color. Color is the most significant feature which we can use to differentiate between face region and background region in the head-and-shoulders image of the human individuals.

There are image regions that, when observed out of their whole context, appear as face-like regions. In spite of this, it is worth to note that the number of false-positives can be reduced by searching only the image regions where it is likely to find face pixels. Skin color filter is considered as an important method for removing non-face pixels [2]. Skin color filters can rapidly remove non-skin color pixels, which reduce the search region for the face detection step.

In this work a pre-processing method uses color segmentation to achieve high performance in face detection. First, it consists of skin color information collection and segmentation. After skin color detection next step is to finding face candidate among skin color detected region. For removing noise in an image we are using morphological operations.

1.1 Color Spaces for Skin Detection

Color is an important feature of human faces. Skin-color is used as a feature for tracking a face has several advantages.

Processing of color is much faster than processing other facial features for identification of face. Although the skin color for human observer is easy to find, but for machine processing the task is more difficult. In computer vision it is important to choose the right color space which can provide full blast the necessary information about skin color distribution in image. Most of the research in skin color based face localization and detection is based on RGB, YCbCr and HIS color spaces.

1.2 RGB Color Space

The RGB model simplifies the design of computer graphics systems but is not ideal for all applications. The red, green and blue color components are highly correlated.

RGB color space is the most commonly used color space in digital images. It encodes colors as an additive combination of three primary colors: red(R), green(G) and blue(B). RGB Color space is often visualized as a 3D cube where R, G and B are the three perpendicular axes with red, green and blue at the corners on each axis. Black is at the origin. White is at the opposite end of the cube. The gray scale follows the line from black to white.

For example in a 24-bit color graphics system with 8-bits per color channel, red is (255, 0, 0) and on the color cube, it is (1, 0, 0).

1.3 HIS, HSV, HSL Color Space (Hue Saturation Intensity (Value, Lightness))

Hue-saturation based color spaces were introduced when there was a need for the user to specify color properties numerically. HSI (I-Intensity) and HSL (L-Lightness) color spaces are derived from HSV. The intensity, value and lightness are related to the color luminance. Hue is generally related to the wavelength of a light. Saturation is a component that measures the “colorfulness” in HSV space. The intuitiveness of the color space components and explicit discrimination between luminance and chrominance properties made these color spaces popular. Hue defines the dominant color (such as red, green, purple and yellow) of an area, saturation represents how pure the color is and intensity determines brightness.

1.4 YCbCr Color Space

YCbCr color space has been defined in response to increasing demands for digital algorithms in handling video information, and has since become a widely used model in a digital video. It belongs to the family of television transmission color spaces. The family includes others such as YUV and YIQ. YCbCr is a

digital color system, while YUV and YIQ are analog spaces for the respective PAL and NTSC systems.
These color spaces separate RGB (Red-Green-Blue) into luminance and chrominance information and are useful in compression applications however the specification of colors is somewhat unintuitive. The YCbCr color space is commonly used in image processing as it separates the luminance, in Y component, form the chrominance described through Cb and Cr components. Several definitions of this transformation exist. In this paper, the luminance Y is constructed as a weighted sum of RGB components, and the Cb and Cr components are obtained by subtracting Y from respectively blue and red RGB components, as [3]:

$$Y=0.299R+0.587G+0.11B$$
$$Cb=B-Y$$
$$Cr=R-Y$$

The Cb and Cr components are used to characterize the skin color information [4]. The formulae for converting from RGB to YCbCr are given below.

$$Y = 0.299R + 0.587G + 0.114B$$
$$Cb = -0.169R - 0.332G + 0.500B$$
$$Cr = 0.500R - 0.419G - 0.081B$$

The YCbCr space was chosen for Following reasons:

1. Bitmap images used the R-G-B planes directly to represent colour images. But medical research proved that the human eye has different sensitivity to colour and brightness. Thus there came about the transformation of RGB to YCbCr.
2. The luminance component (Y) of YCbCr is independent of the color, so can be adopted to solve the illumination variation problem and it is easy to program.
3. According to (Hsu et al, 2002), the skin color cluster is more compact in YCbCr than in other color space.
4. YCbCr has the smallest overlap between skin and non-skin data in under various illumination conditions.
   YCbCr is broadly utilized in video compression standards (e.g., MPEG and JPEG) (Garcia and Tziritas, 1999).
5. YCbCr is a family of color spaces used in video systems. YCbCr was defined for standard-definition television use in the ITU-R BT.601 standard for use with digital component video.
6. YCbCr is one of two primary color spaces used to represent digital component video (the other is RGB).
7. The difference between YCbCr and RGB is that YCbCr represents color as brightness and two color difference signals, while RGB represents color as red, green and blue.

2. ALGORITHM CONTROL FLOW BLOCK DIAGRAM

Our Method focuses on the use of skin color model. Face detection is done through color-based identification. Firstly we have to resize an input image and then if needed we will perform some color balance operation for better detection rate. Further we also used canny edge detection algorithm to reduce the amount of data in an image, while preserving the structural properties to be used for further image processing. Several algorithms exists, and this paper focuses on a particular one developed by John F. Canny (JFC) in 1986 [6]. Even though it is quite old, it has become one of the standard edge detection method used in research [7] [5].

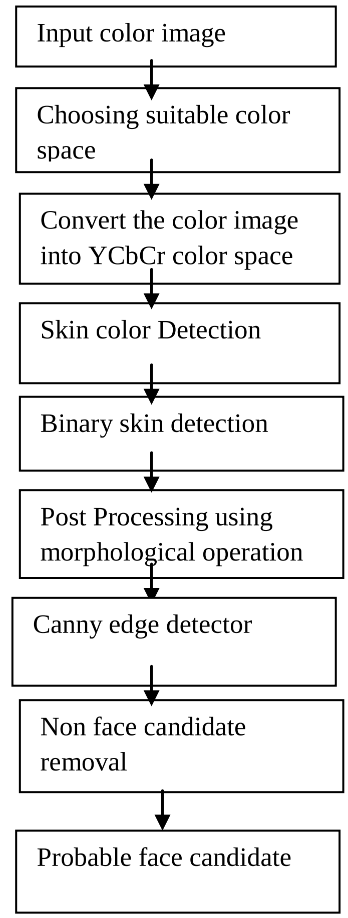


Figure 1: Block diagram of skin detection algorithm

3. BINARY IMAGE PROCESSING

The next step is to separate the image blobs in the color filtered binary image into individual regions. The process consists of three steps. The first step is to fill up black isolated holes and to remove white isolated regions which are smaller than the minimum face area in training images. The threshold (170 pixels) is set conservatively. The filtered image followed by initial erosion only leaves the white regions with reasonable areas.
Based on the Cb and Cr thresholding, a resulting black and white "mask" is obtained with all the faces in addition to some artifacts (body parts, background). This mask is then refined through binary morphological operations to reduce the background contribution and remove holes within faces. The outputs of image segmentation using binary image processing are images that represent probable faces and nonfaces.

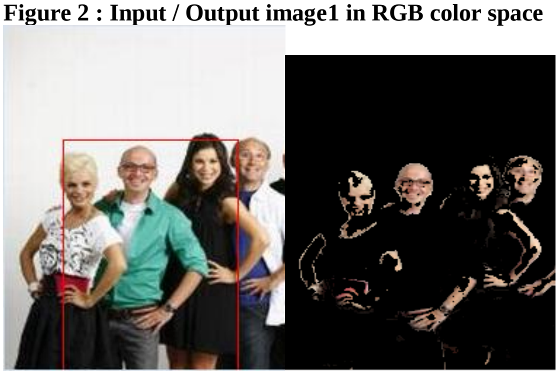
4. EXPERIMENTAL RESULTS

4.1 Results of Skin Color Based Face Detection in RGB Color Space

Results of this experiment show that RGB color space is not very much friendly with face detection based on skin color classification. The accuracy of this experiment is found to be 60.4%. Result also shows that the false detection rate is very high, thus causing very low accuracy in detecting the face.

(a) Input image1 (b) Binary Image of Skin Region

Figure 2 : Input / Output image1 in RGB color space

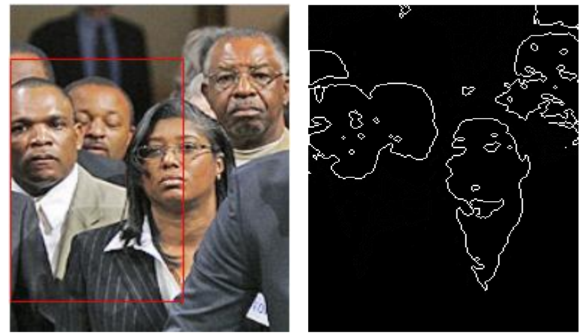


(a) Input image2 (b) Binary Image of Skin Region

Figure 3 : Input / Output image2 in RGB color space

4.2 Results of Skin Color Based Face Detection in YCbCr Color Space :

Similar experiments have been performed on the YCbCr color space as on RGB. The accuracy is found to be 92.0% which is far better than results from RGB color space. Following table shows that the false detection rate is high thus causing a bit low accuracy in detecting the skin region. Quality of input image1 in figure 4 is not very good but our skin model has detected all skin regions with little deviation with respect to expected result. Experiment result also shows that as there is no false positive and no false negative in image2 in figure 5 so detection rate is near to 100%.



(a) Input image1 (b) Binary Image of Skin Region

Figure 4 : Input / Output image1 in YCbCr color space

(a) Input image2 (b) Binary Image of Skin Region

Figure 5 : Input / Output image2 in YCbCr color space

Table 1: Skin color classification rate for YCbCr color space.

No of images	Miss	False alarms	Detection rate(High/Low)
Image1	0	~4%	84.0%
Image2	0	~2%	92.0%

Based on [1] we assume that the skin color is determined mostly by its chrominance components Cb and Cr so the luminance component depends only on lightning conditions. There is also assumption that the skin color of various human individuals and also human skin color types is the same in its chrominance components. The difference is only according to the luminance parameter variation. This implicates that there is no need to trace luminance component probability function in skin color detection in YCbCr color space. Advantage of this method is its simplicity and minor computational costs. The method described in this paper finds it difficult to differentiate when background color of image is similar to skin color (red).

5. CONCLUSION
For skin analysis various color spaces like RGB, HSV, YCbCr are studied and transformations in these spaces are performed. The face detection system presented deals with detection of skin like color regions in the YCbCr plan. Luminance is not taken into binary image segmentation, Canny edge detection and noise removal method.

6. FUTURE WORK
Improvements for more accurate face detection can be made by scanning face candidates using adaboost classifier.

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