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Robust Skin Colour Detection And Tracking Algorithm

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Abstract

Here concept of skin detection & robust skin color detection algorithm is discussed. Three colour spaces RGB, YCbCr, HSV and their histograms are of main concern. We have combined three colour spaces to get an effective skin colour detection algorithm which gives better performance and accuracy. Experimental results show that the proposed algorithm is good enough to detect a human skin in an image. Skin detection is related in tasks like hand detection and tracking, face detection and tracking, people retrieval in databases and Internet, , naked people detection, pornographic image filtering, facial expression analysis, human computer interaction, security systems, human pose modelling, personal identity, verifications video surveillance, image retrieval, image editing. etc. However, skin detection is not robust enough for dealing with some real-world conditions. The main problems with the robustness of skin colour detection are (1) it varies between individuals (2) dependence on the illumination condition, and (3) skin colour is not unique i.e. many everyday life objects are skin colour like. Skin detection is the process of finding skin-colored pixels and regions in an image. This algorithm is based on testing database containing many of human images. A skin detection system is never perfect and different users use different criteria for evaluation. Skin colour is often used because it is invariant to orientation and size, gives an extra dimension compared to gray scale methods, and is fast to process. The objective of proposed algorithm is to improved skin colour detection.

1. Introduction

Skin region detection plays a vital role in wide range of image processing applications. The skin colour is often used as a cue for detecting, localization and tracking targets containing skin, like faces and hands in an image. It is often not enough to separate skin objects from non-skin objects like wood, which can appear to be skin coloured. Therefore, skin is often combined with other cues like motion, texture and edge features. The goal is to divide the pixels of the image into skin coloured and non-skin coloured.The simplest methods define skin colour to have a certain range or values in some co-ordinates of a colour space. Detecting human skin tone is of utmost importance in numerous applications such as, video surveillance, face and gesture recognition, human computer interaction, human pose modelling, image and video indexing and retrieval, image editing, vehicle drivers' drowsiness detection, controlling users' browsing behaviour (e.g., surfing indecent sites) and steganography. Detection of human skin tone is regarded as a two-class classification problem, and has received considerable attention from researchers in recent years [1, 2]

The preliminary steps in skin detection are the representation of image pixels in color spaces, suitable distribution of skin & non skin pixels, & after that skin color modeling. According to skin color's distribution characteristics on color space, skin color pixels can be detected quickly with skin color model. However it is difficult to detect skin color more accurately, because there exists many differences about skin color space distribution, which is affected by different race and different illumination [3]. By using skin color model we can described skin colour characteristic. Usually, researcher has to face two problems: colour space selection and how to use the color distribution to establish a good skin color model. Color information is an efficient tool for identifying skin areas if the skin color model can be properly adapted for different lighting environments.

In images, skin color is an indication of human and human like existence. Therefore, in the last 20 years extensive research have focused on skin detection in images and its uses in detecting face and non-face like features. Skin detection using color information can be a challenging task as the skin appearance in images is affected by various factors such as illumination, background, camera characteristics, and ethnicity. Numerous techniques are presented in literature for skin detection using color. Skin-color detection in visible spectrum can be a very challenging task as the skin color in an image is sensitive to various factors such as:

1) There is color constancy problem that means indoor, outdoor, shadows; highlight produces a change in the skin color of images. So it is very important problem which seriously affect the performance of skin detection task.

2) Skin color also varies from person to person belonging to different ethnic groups and from persons across different regions

3) The skin-color distribution for the same person differs from one camera to another depending on the camera sensor Characteristics.

4) Individual characteristics such as age, sex and body parts also affect the skin-color appearance.

5) Different factors such as subject appearances (makeup, hairstyle and glasses), background colors, shadows and motion also influence skin-color appearance [4].

2. Colour Spaces

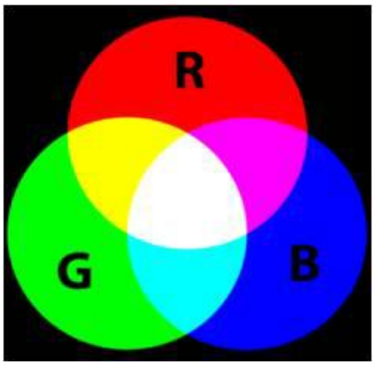
Many different color spaces are employed in literature including RGB, normalized RGB, HSI, HSV, YCbCr, YES, YUV, CIE Lab. The primary step is the selection of a suitable color space, i.e. a color space in which one can easily discriminate between skin and nonskin pixels. The choice of the color space affects the performance of any skin detector and its sensitivity to changes in illumination conditions [4]. The proposed algorithm based on skin color model in YCbCr chrominance space and HSV color space. A thorough out survey of different color space is carried out by Veznevets [3] HSV and YCbCr color spaces help to a greater extent in handling intensity variations.

2.1. RGB (red, green, and blue)

The primary process in skin color modeling & classification is color space selection. For most of the color images, in figure1.RGB represents the default color space used for storing and representing digital images RGB is a. from a linear or non-linear transformation of RGB, we can get any other color space. The color space transformation is used to decrease the overlap between skin and non-skin pixels. The choice of appropriate color space is often guided by the skin detection methodology and the application. It is to be noted here that the evaluation of color space goodness for skin modeling cannot be performed because different modeling methods react very differently on the color space change. Normalized RGB is a representation that is easily obtained from the RGB values by a simple normalization procedure,

$$r = \frac{R}{R+G+B} \quad g = \frac{G}{R+G+B} \quad b = \frac{B}{R+G+B}$$

As the sum of the three normalized components is known (r+g+b = 1), the third component does not hold any significant information and can be omitted, reducing the space dimensionality. The remaining components are often called ”pure colors”, for the dependence of *r* and *g* on the brightness of the source RGB color is diminished by the normalization. A remarkable property of this representation is that for matte surfaces, while ignoring ambient light normalized RGB is invariant [3]

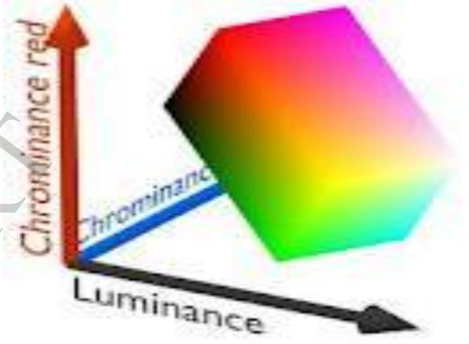


“Figure1.RGB color space”

2.2. YCbCr (luminance, chrominance)

YCrCb is an encoded nonlinear RGB signal shown in figure2. It used by European television studios and for image compression work. Two difference chrominance values Cb & Cr formed by subtracting luminance from blue & red components. Because of separation of luminance & chrominance components, this color space is effective for skin color modeling. The transformation simplicity and explicit separation of luminance and chrominance components makes this color space [5] The YCbCr space is one of the most popular choices for skin detection The equation for RGB conversion to YCbCr can be seen in equation (1).

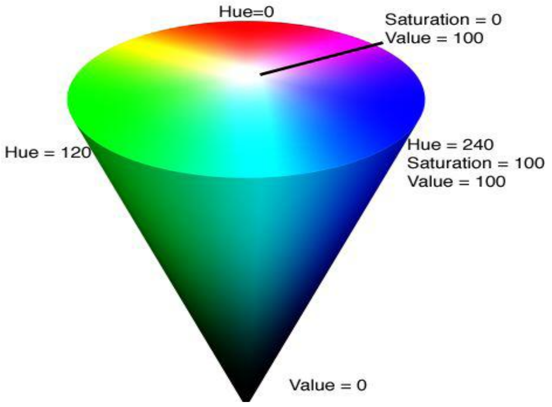
$$\begin{aligned} Y &= 0.299R + 0.587G + 0.114B \\ C_r &= R - Y \\ C_b &= B - Y \end{aligned} \tag{1}$$



“Figure 2.YCbCr color space”

2.3. HSV (Hue Saturation Value)

In Figure 3, Hue indicates the dominant color of an area; saturation calculates the colorfulness of an area in proportion to its brightness. Value indicates the color luminance. Separation between chrominance & luminance makes this color space popular in the skin color detection. The transformation of RGB to HSV is invariant to high intensity at white lights, ambient light and Surface orientations relative to the light source and hence, can form a very good choice for skin detection methods.



“**Figure 3**.HSV color space”

3. Skin Colour Detection

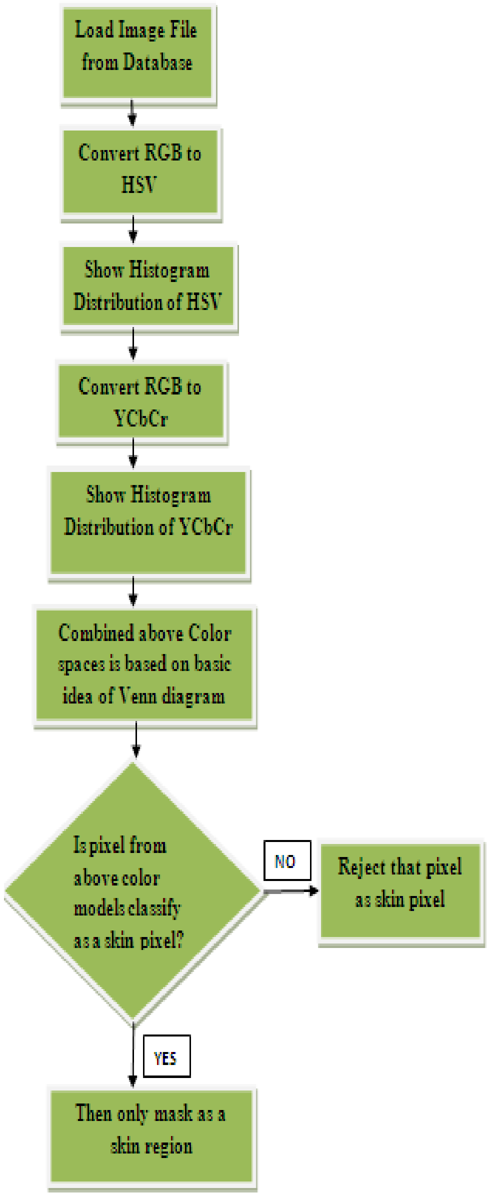
Lot of research is going on in the area of human skin detection at present. Different methods addressing the problem of skin detection has been proposed by many researchers. Methods of Skin Detection-1) Pixel-Based Method-Classify each pixel as skin or non-skin individually, independently from its neighbors. Color Based Methods fall in this category.2) Region Based Methods-1) Try to take the spatial arrangement of skin pixels into account during the detection stage to enhance the methods performance. Additional knowledge in terms of texture etc is required. The combination of all the above color spaces like RGB, HSV, and YCbCr gives the better skin detection performance. Once we choose the color space then next step is skin color modeling. In this approach there are two main steps- Classify the skin region in the color space, apply threshold to identify the skin region.

3.1. Skin Detection Algorithm in RGB, YCbCr, and HSV color space

The pixels for skin region can be detected using a normalized color histogram, and can be further normalized for changes in intensity on dividing by luminance. And thus Converted an [R, G, B] vector is converted into an [*r*, *g*] vector of normalized color which provides a Fast means of skin detection. Skin color model based on the Cb and Cr values can provide good coverage of different human races. [Cra, Crb] and [Cba, Cbb] are the chosen threshold values. If the values [Cr, Cb] fall within the thresholds then it identifies as a skin color. Skin color classification in HSI color space is the same as YCbCr color space but here hue & saturation are responsible values instead of Cb,Cr, [Ha, Sa] and [Hb, Sb] are the chosen threshold values. If the values [H, S] fall within the thresholds then it identifies as a skin color.

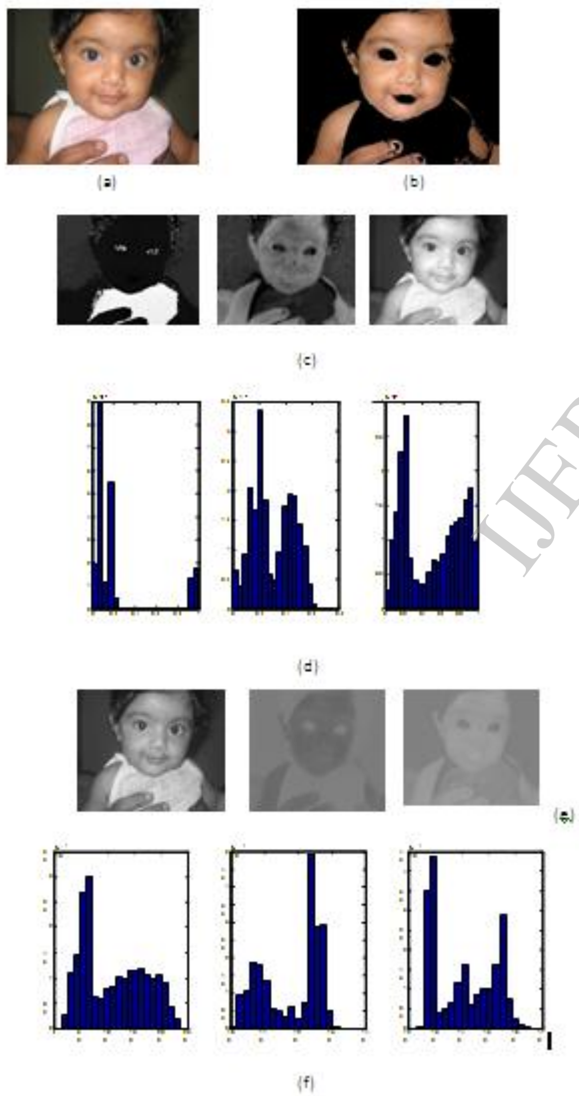
4. Proposed Skin Colour Detection Algorithm

In this paper, skin region is formed by combining the skin identified region from the skin color detection algorithm in RGB, YCbCr, and HSV color space. Thus, the algorithm are combined assuming that their combination gives the skin region from the image if the skin image is detected by one or more algorithm(s) and for the same image other algorithm gives the false result. If we state that the result from RGB color space is “P”, the result from YCbCr color space is “Q” and the result from HSI color space is “R” and if any of the result contains a skin image then the union of the three will surely be a skin image. In this way, we can detect the skin region by using combination of all the three color spaces.



"**Figure 4**.Proposed Algorithm Flowchart"

As shown in Figure 4, first take image from database which having default RGB colour space. Then perform RGB to HSV colour space conversion and show the histogram distribution of HSV so that we can find out threshold for skin colour region using HSV. Similarly, perform RGB to YCbCr colour space conversion and show the histogram distribution of YCbCr by using this find out threshold for skin region. In next step, combined all above colour spaces on based on the basic idea of venn diagram and finally mask the skin colour region.



"Figure 5. a) Original RGB image b) output skin detected image c) HSV colorspace d) HSV histogram distribution e) YCbCr colorspace f) YCbCr histogram distribution"

Figure5. Shows the sample example in which fig.5a is original color image and fig5b.shows skin colour detected image after application of proposed skin detection algorithm using matlab.fig5c.shows HSV color space model of original color image in which we can observe hue, saturation and value.fig5d.is a HSV histogram distribution.fig5e shows the YCbCr color space model of original color image and fig5f.shows it's histogram distribution.

5. Experimental Results

In this section a detailed experimental comparison of the above stated algorithms has been presented. Each algorithm is implemented using mat lab programming language. Each technique is applied on a wide variety of images extracted from internet. Figure 5 shows some sample images which are analyze by skin detected algorithm having good accuracy.

"Figure 6. Sample results of proposed skin detection algorithms"

6. Conclusion and Future Scope

In this paper, we have presented a novel Skin region detection method using combination RGB-YCrCb-HSV Colour model. RGB-YCrCb-HSV model is applied to detect human skin region. Primarily, various factors like Illumination, camera characteristics, is crucial to the success of a robust skin region tracking. The above algorithm was implemented in MATLAB.The algorithm can process different kind of images, as images in different lighting conditions .50 test images which were given as an input to the algorithm directly from the camera output interface to the system. A test to prove the performance of the algorithm was used using different images from Internet. The experimental results showed that our new approach in modeling skin color was able to achieve a good detection success rate & gives satisfactory, better performance. After skin color detection from this method we can track the face, hand & other body parts. Implementing the current algorithm in C/C++ to further improve the processing speeds.5. Second and following pages

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