Analysis of Face Recognition using YCbCr and CIElab Skin Color Segmentation Methods

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Abstract: Skin Color segmentation plays an important role in various applications such as face recognition, gesture recognition, human computer interaction etc. Face recognition is of main concern in skin color segmentation. There are various color models used for skin color segmentation (YCbCr, HSV and CIELAB) but appropriate method should be used for skin color segmentation. In real time the main problem is different light condition due to different backgrounds. In this paper,we propose the skin color segmentation with various color model algorithms, separate the face portion from real time video, analyze the results of segmentation of CIELab color model and match the face gesture in real time video with stored face gestures in memory. It is shown by various experiments that CIELab color space is better than other color spaces.

Keywords— CIELab, face recognition, image segmentation, skin color segmentation, YCbCr.

I. INTRODUCTION

A. Image Segmentation:

Image segmentation is the process of partitioning a digital image into multiple segments. The goal of segmentation is to simplify and/or change the representation of an image into something that is meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves etc.).The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image .Each of the pixel in a region are similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic(s)[1].

Segmentation process aims to classify the input image into regions by discovering suitable characteristics for these regions to easily recognize the regions of interest. Two properties can be applied to direct the segmentation process: discontinuity and similarity.

Discontinuity refers to sudden change in image intensity which represents the edge of the segmented regions, while similarity refers to the similar intensity values between neighboring pixels in the same region[2].

B. Skin Color Segmentation:

In recent years there has been a growing interest in the problem of skin segmentation, which aims to detect human skin regions in an image. Skin segmentation is commonly used in algorithms for face detection, hand gesture analysis, and objectionable image filtering . In these applications, the search space for objects of interest, such as faces or hands, can be reduced 0through the detection of skin regions [3].

The automatic detection of skin color in images is also beneficial for consumer applications, such as image content filtering, content-aware video compression, and real-time face recognition system embedded in a smart home environment. It is very challenging to recognize a face from an image due to the wide variety of face and the uncertain of face position [4][5].

Skin-color segmentation, particularly useful for its orientation and size invariance, is usually used for localization in early stages of these higher-level systems Skin has the advantage of being non-sensitive to directions, so we can separate skin regions from other parts of the color images and segment face regions accurately through post-processing[7][8].

C. Color Models:

A color model is an abstract mathematical model describing the way colors can be represented as tuples of numbers, typically as three or four values or color components. When this model is associated with a precise description of how the components are to be interpreted (viewing conditions, etc.), the resulting set of colors is called color space[9].

Many color spaces are available for representing the color images, each has different characteristics and they share some properties. The main color spaces are RGB, HSI/ HSV/ HSL, YIQ/ YUV/ YCbCr, and CIE Lab/ CIE Luv.

a. RGB Color Model: The RGB model is also called the additive model. The RGB color model is a projected color space and is the type produced by computer monitors and TVs. This color space is device dependent - meaning the same signal or image can look different on different devices. Images are created using the Additive color primaries, Red, Green, and Blue. RGB is additive because when these primary colors are combined at a value of 100% for each, they produce white light.

When one of the components has the strongest intensity, the color is a hue near this primary color (reddish, greenish, or bluish), and when two components have the same strongest intensity, then the color is a hue of a secondary color (a shade of cyan, magenta or yellow). A secondary color is formed by the sum of two primary colors of equal intensity: cyan is green+blue, magenta is red+blue, and yellow is red+green. Every secondary color is

the complement of one primary color; when a primary and its complementary secondary color are added together, the result is white: cyan complements red, magenta complements green, and yellow complements blue[10].

Table I 100% RGB Color Bars

	Nominal Range	White	Yellow	Cyan	Green	Magenta	Red	Blue	Black
R	0-255	255	255	0	0	255	255	0	0
G	0-255	255	255	255	255	0	0	0	0
B	0-255	255	0	255	0	255	0	255	0

b. **YCbCr Color Model:** YCbCr is one of the popular color space in computing. Y is luma component which represent the luminance and computed from nonlinear RGB and Cb and Cr represent the chrominance component. It is obtained as weighted sum of RGB values. Cb is difference between blue and luma component and Cr is the difference between red and luma component[6].
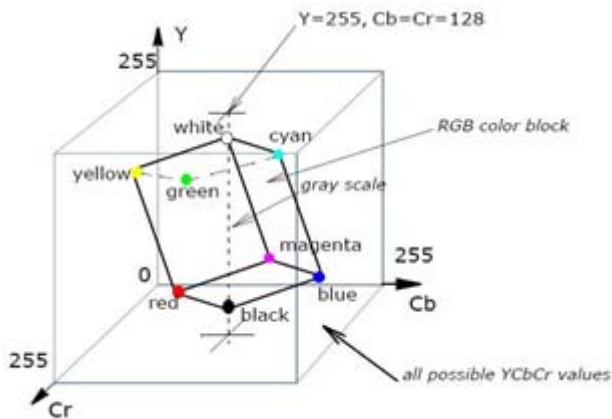

Figure 1. YCbCr Color Space

A value expressed as YCbCr is predictable only if standard RGB primary chromaticities are used

$$\begin{bmatrix} Y \\ Cb \\ Cr \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.144 \\ -0.159 & -0.332 & 0.050 \\ 0.500 & -0.419 & -0.081 \end{bmatrix} x \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

c. **CIE:** The most universally accepted system for color measurement is the CIE system, developed in 1931 by the International Commission on Illumination - abbreviated CIE from its French title Commission Internationale de l'Eclairage. In an effort to better refine color measurement, CIELAB was developed in 1976[11].

CIELAB model is primarily used for reflective color. Properly designated L*A*B*, this color space is used to define color values mathematically. L* represents lightness. The A* value represents the position on a magenta-green axis. The B* value is the position on a yellow-blue axis.

In CIE*lab or CIElab, the three component l represent luma component that is illumination information and ab represent the chroma information. l*=0 provide the black color and l*=100 provides white color .The a*, the values a*<0 that indicate green while the values a*>0 indicate magenta. The b*, the values b*<0 that indicate blue and values b*>0 indicate yellow.The Lab color space has been created to serve as a device independent.
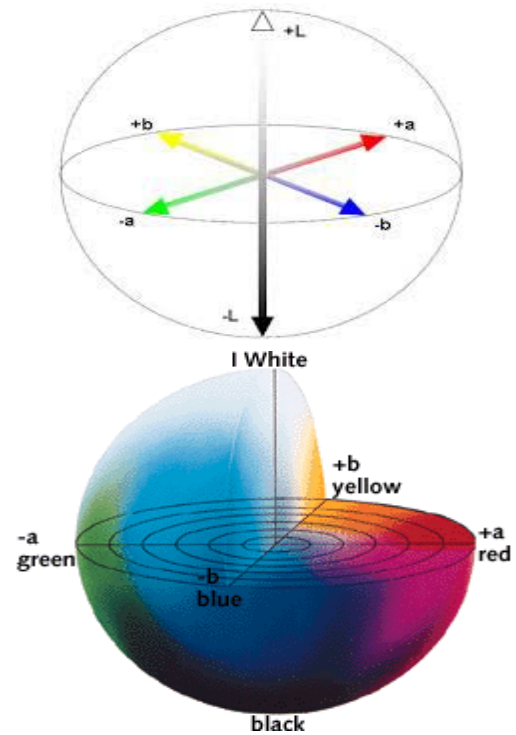

Figure 2. The CIELAB Color Space

a) *CIE- L*a*b* Coordinates*

$a* = 500 [(X/X_0)^{1/3} - (Y/Y_0)^{1/3}]$

$b* = 200 [(X/X_0)^{1/3} - (Z/Z_0)^{1/3}]$

$$L* = \begin{cases} 116(Y/Y0)1/3 - 16 & \text{for } Y/Y0 > 0.01 \\ 903(Y/Y0) & \text{otherwise} \end{cases}$$

$X_0 Y_0 Z_0$ = coordinates of reference white
L – Luminance
a – ranges from green to red, b – ranges from blue to yellow
L – ranges from 0..100 with 50 average gray and 100 reference white.
a,b – unbounded but usually between -120 to +120
Colors are relative to a reference white point[12].

II. PROPOSED ALGORITHM

Steps of system are given below:
Step 1: Take the video or image and get the image in RGB color space and process it.
Step 2: Apply the skin color segmentation algorithm of different color models and convert it into the binary image.
Step 3: After this we get noisy image ,we apply the morphological operations on the image and for further refined image we apply the median filter.
Step 4: According to those results we will see that for face recognition of different country people which skin color segmentation method is better.
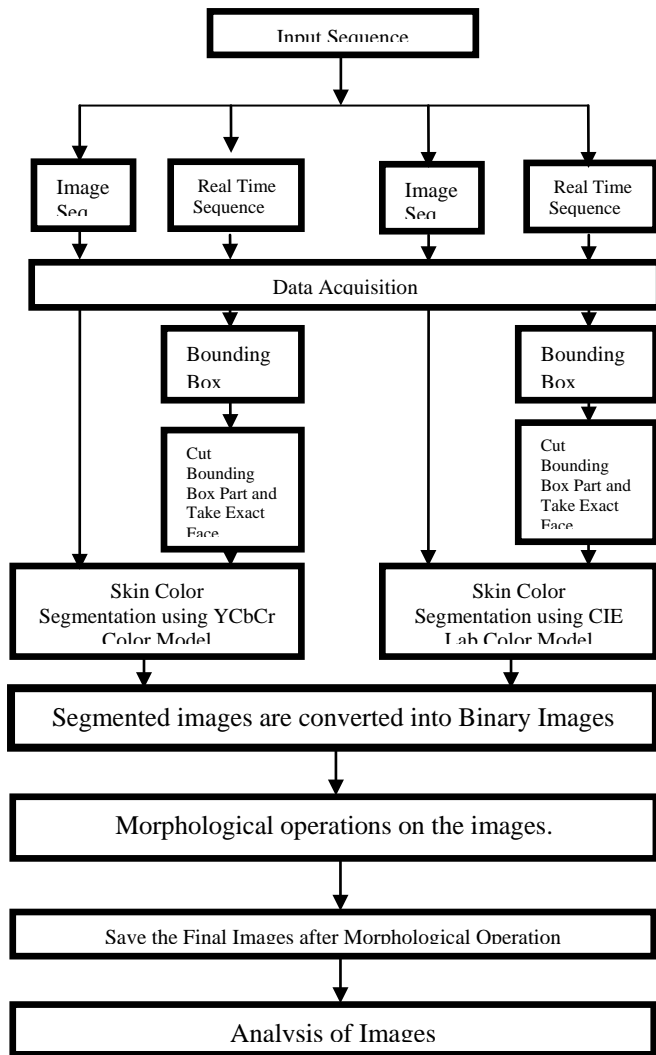
Figure 3. DFD of Research Methodology

III.   EXPERIMENTAL RESULTS

A.   *Skin Color Segmentation of Image With CIElab Color Space:*

The results of skin color segmentation of image using CIelab color space are shown below:
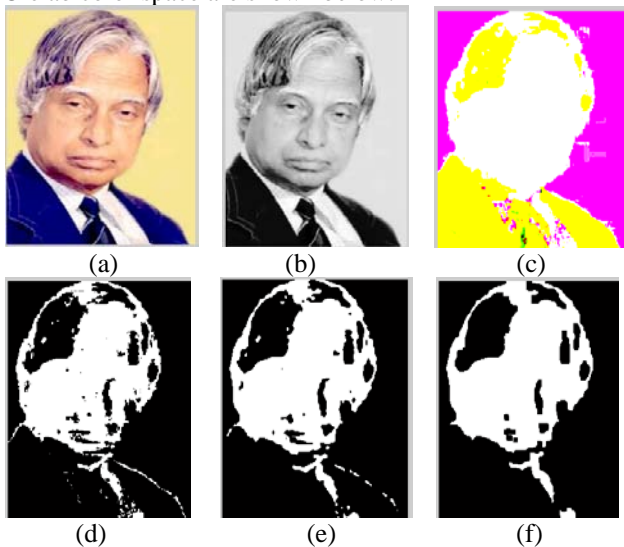

Figure 4. (a) RGB Image (b) Grayscale Image (c) Skin Detection (d) Binary Image (e) Noise Removal Image (f) Image after Morphological Operation

As shown in fig 4, RGB image is converted into gray image. CIELab color space detects the skin color and converted it into binary image. The binary image has some noise, by applying the morphological operation and median filter, noise is removed and refined image is obtained.

B.   *Skin Color Segmentation With CIElab Color Space in Real Time:*

In the skin color segmentation using CIElab color space in real time, the same process is followed as in segmentation of an image using CIElab color space except the image is tasken in real time not manually.
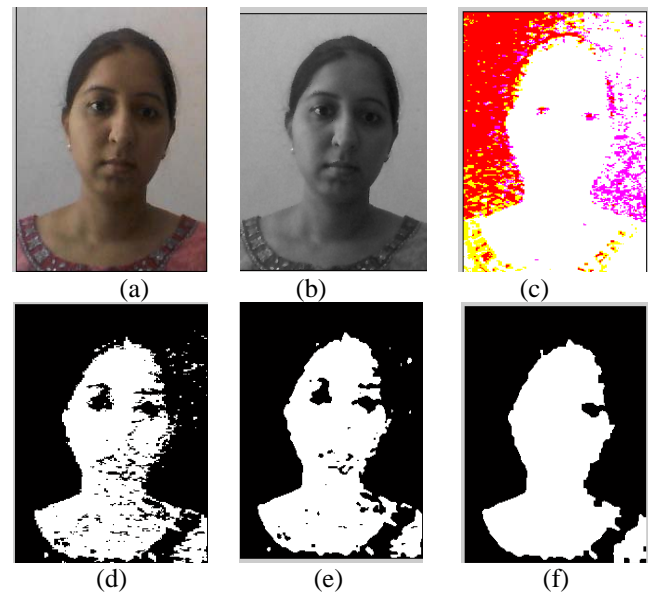

Figure 5.(a) RGB Image (b) Grayscale Image (c) Skin Detection (d) Binary Image (e) Noise Removal (f) After Morphological Operation

C.   *Skin Color Segmentation Of Image With Ycbcr Color Space:*

The results of skin color segmentation of an image using YCbCr color space are shown below:
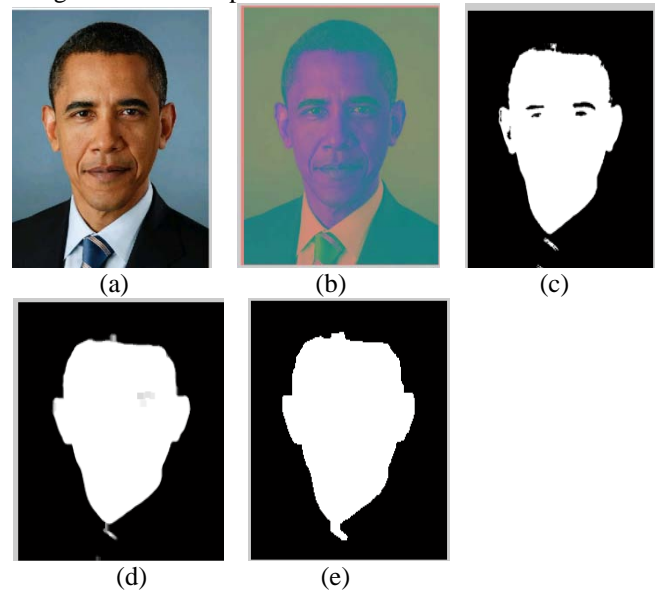

Figure 6. (a) RGB Image (b) YCbCr Image (c) After Skin Color Segmentation (d) After Noise Removal (e) After Morphological Operation

As shown in fig 6, RGB image is converted into YCbCr color space and binary image is obtained, by applying the

morphological operation and median filter, noise is removed and refined image is obtained.

D. *Skin Color Segmentation With Ycbcr Color Space In Real Time:*

In skin color segmentation using YCbCr color space in real time, the same process is followed as in segmentation of an image using YcbCr color space except the image is taken in real time not manually.
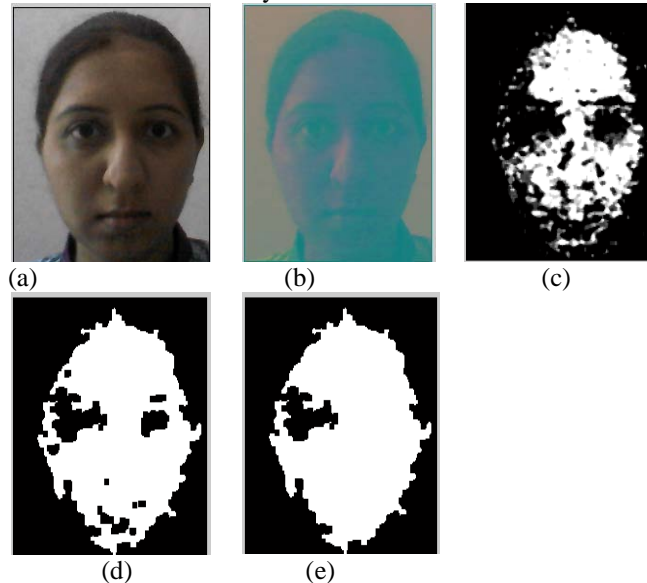

(a)   (b)   (c)

(d)   (e)

Figure 7. (a) RGB Image (b) YCbCr Image (c) Binary Image (d) After Noise Removal (e) After Morphological Operation

E. *Comparison between YCbCr and CIElab color space:*

From the result of skin color segmentation with YCbCr and CIElab, we come on this conclusion that we get more information when we do the skin color segmentation with CIElab color space than YCbCr color space.

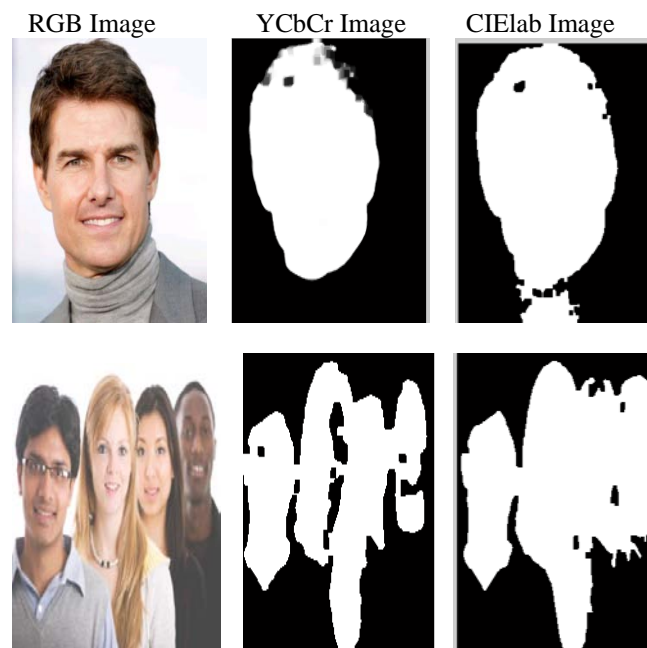

RGB Image   YCbCr Image   CIElab Image

Figure 8. Skin Color Segmentation of different faces with YCbCr and CIELab Color Space

Figure 8 shows the segmentation with YCbCr and CIELab color space with different skin color faces. Some

faces disappear when YCbCr color space is apply for skin color segmentation while CIELab color space do the proper skin color segmentation and no face disappear by applying CIELab color space.

It shows comparison of skin color segmentation with two space color model one with YCbCr and other with CIElab. Fast segmentation is with CIElab color model. Because the CIELab color space is an absolute color space, it defines colors exactly. It does not depend on input devices (camera) or output devices (monitors and printer). CIELab includes more color (even more than the human eye can see) than other color spaces.

IV.   CONCLUSION

This research work presents a method combining skin color segmentation with facial component localization for face detection. The proposed algorithm can automatically detect the components and relations of a face. In summary, the major advantage of our approach integrated skin color segmentation and component-based localization is the elimination of the need for a separate training or learning phase. It can not only be used as face detection, but also integrated into other application easily as pre processing or verification tool.

V.   FUTURE SCOPE

Skin color segmentation has various applications such as face recognition, gesture recognition, human computer interaction etc. After the skin color segmentation, feature extraction can be done which will be helpful to make gesture for human computer interaction. In future work, it is possible to improve the method for detecting multiple faces under various orientations, illuminations and different conditions of light. It is also possible to improve the algorithm for differenciating between the skin color of the background and foreground. The proposed algorithm can be modified further to achieve higher accuracy rate.

VI.   REFERENCES

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