Skin Segmentation Using RGB Color Model and Implementation of Switching Conditions

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ABSTRACT

Skin color segmentation is a technique of discrimination between skin and non-skin pixels of an image. But when we are talking about robust techniques for detection of skin pixels, there are always some difficulties as skin segmentation is still an ongoing hard problem to be sorted out by the researchers. In order to segment human skin regions from non-skin regions, a reliable skin model is needed who is adaptable to different colors and light conditions. In this paper, implementation and extraction of skin pixels in RGB color model is being presented and depicted that there is a requirement of switching color models by observing the effect of noise, light etc. The color spaces that are frequently used in studies are HIS, HSV, TSL and YUV. The presence of light, shadows, noise etc can affect the appearance of the skin color. However an effective skin segmentation algorithm should be capable to detect skin pixels efficiently by overriding these effects. In this research study, a RGB based skin segmentation technique is being presented for extraction of skin pixels. Therefore, for robust skin pixel detection, a dynamic skin color model that can cope with the changes must be employed. We present the automated system for switching of color models automatically in different color space such RGB into HSV or vice-versa to get the better visible image pixels. The experiment result shows that, the algorithm gives hopeful results.

Keywords-**Skin Segmentation, Image Processing, MATLAB, color models.**

I. INTRODUCTION

The application of skin segmentation is being used widely in all areas of computer science and its applications. [1], [2]. Detecting and tracking face and hands are important for gesture recognition and human computer interaction. The goal of skin detection is to extract the skin pixels from an image by applying the good class of skin segmentation algorithm. Here skin segmentation is a process of segmenting the pixels of an image into skin and non-skin regions. The algorithm should be capable enough to make decide about a particular pixel into skin-regions or non-skin skin regions. In any given color space, how intelligently classify and extract the skin related pixels depend upon the correctness of the algorithm. After extracting the skin-pixels from a regions of an image, then there is must condition to switch into different color models if the quality if an image is not good enough, in the context of skin segmentation, the classifications of skin pixels into the skin regions is very important and false positive rates should be as lower as possible. There is always a possibilities that a skin pixels is been detected in non-skin regions or the visualization of an image is not good enough which determine to apply the switching condition to switch it different color models. In this study, we first apply skin segmentation to extract skin-pixels from an image. Secondly based on some observations and by seeing the effect of various parameters, we apply the switching condition. In the context of implementation, we tried to put some threshold value to decide the switching conditions. Our procedure is based on skin color segmentation and human face features (knowledge-based approach). In this study, we used RGB, YCbCr, HSV, HSV, HIS, and nRGB color models for skin color segmentation. These color models with thresholds, help to remove non skin like pixels from an image. We tested each skin region, that skin region is actually represents a human face or not, by using human face features based on knowledge of geometrical properties of human face. The experiment result shows that, the algorithm gives hopeful results.

RGB Color Space and Skin Detection [3]:

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. One main advantage of the RGB space is its simplicity. However, it is not perceptually uniform, which means distances in the RGB space do not linearly correspond to human perception. In addition, RGB color space does not separate luminance and chrominance, and the R, G, and B components are highly correlated. The luminance of a given RGB pixel is a linear combination of the R, G, and B values. Therefore, changing the luminance of a given skin patch affects all the R, G, and B components. In other words, the location of a given skin patch in the RGB color cube will change based on the intensity of the illumination under which such patch was imaged! This results in a much stretched skin color cluster in the RGB color cube. Despite the some fundamental limitations, RGB is extensively used in skin detection literature because of its simplicity. For example, RGB is used by Rehg and Jones [4] and yield quite satisfying performance.

The **RGB color model** is an additive color model in which red, green, and blue light are added together in various ways to reproduce a broad array of colors. The name of the model comes from the initials of the three additive primary colors, red, green, and blue.

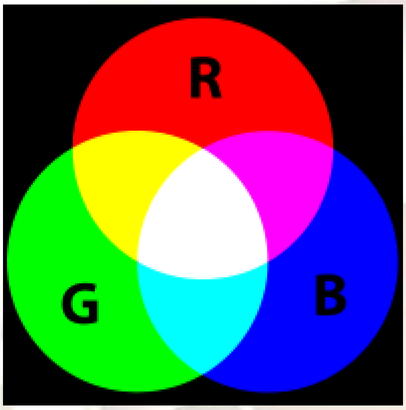

Figure 1: RGB color space [5].

The main purpose of the RGB color model is for the sensing, representation, and display of images in electronic systems, such as televisions and computers, though it has also been used in conventional photography. Before the electronic age, the RGB color model already had a solid theory behind it, based in human perception of colors. [5]

Perceptual Color Spaces and Skin Detection:

Perceptual color spaces, such as HSI, HSV/HSB, and HSL (HLS), have also been popular in skin detection. These color spaces separates three components: the hue (H), the saturation (S) and the brightness (I, V or L). Essentially, HSV-type color spaces are deformations of the RGB color cube and they can be mapped from the RGB space via a nonlinear transformation. One of the advantages of these color spaces in skin detection is that they allow users to intuitively specify the boundary of the skin color class in terms of the hue and saturation. As I, V or L give the brightness information, they are often dropped to reduce illumination dependency of skin color. These spaces have been used by Shin et al. [6] and Albiol et al. [7].

During the research and implementation, we have used Matlab [8] which is a high-level language and interactive environment for numerical computation, visualization, and programming. Using MATLAB, you can analyze data, develop algorithms, and create models and applications. The language, tools, and built-in math functions enable you to explore multiple approaches and reach a solution faster than with spreadsheets or traditional programming languages, such as C/C++ or Java™.

During the course of this research study, we used most widely used color models, and try to implement the switching condition in case one color model is good enough for the representation of the skin pixels into skin and non-skin regions. There are several color models and each has specific work field and strength. We used four color models for skin color segmentation; these are RGB, YCbCr, HSV, and LAB color models. After skin like pixels detection, we convert this segmented image into binary form. This binary image contains skin regions, but we don't know that, where is human face in segmented image. Next step of face detection after segmentation is based on knowledge of human face. Work of next step is to remove non-human face skin area from segmented image, by using Knowledge-based methods or human face features.

Color is a useful piece of information for skin detection [9]. The skin detection is the most common and first approach for detecting meaningful skin color, skin color detection may avoid exhaustive search for faces in an entire image [14]. In this step, we describe that how non skin color is rejected from an Image so that the image may contains only skin like areas, which will be our skin color segmented image for further processing. From different type of color models, in HSV color model, Hue (H) is not reliable for the discrimination task when the saturation is low, Also in YCbCr color model, the distribution of skin areas is consistent across different races in the Cb and Cr color spaces, the RGB color model is lighting sensitive so Therefore, when we use different color models under uncontrolled conditions, and we get consequently result for skin color detection. The accuracy of skin detection depends on both the color model and the method of skin pixels classification or detection. Hence, the challenge problem is how to select color models that are suitable for skin pixel classifications under different varying conditions. In this thesis, there is various color models are used for skin color segmentation or detection of skin pixels. These are RGB, YCbCr, and HSV and color models. The combination of these color models overcomes all varying lighting conditions and changes in illumination, and it gives better result than individual color model result.

This report majorly concerns itself to techniques used to segment skins. In different lighting conditions it becomes of paramount importance to switch to different color space rather than traditional RGB (Red, Green, and Blue) color space to achieve greater efficient in pixel detection rate.

Color spaces analyzed so far include RGB, YCbCr, HSV, HSV, HIS, nRGB. Lighting Conditions have been kept to as most vary as can be. The format of the remaining paper is as: section 2 depicts some background information in the context of performed literature study. Section 3 deliberate the framework design and discuss the implemented solution and algorithm. Section 4 conclude about the research and suggest some future directions.

II. BACKGROUND AND MOTIVATION

A Literature Survey

SKIN SEGMENTATION USING COLOR AND EDGE INFORMATION: *Son Lam Phung, Abdesselam Bouzerdoum, and Douglas Chai, , School of Engineering and Mathematics, Edith Cowan University Perth, Western Australia, AUSTRALIA**, 2012-** presented an algorithm for segmenting skin regions in color images using color and edge information. Skin colored regions are first detected using a Bayesian model of the human skin color. These regions are further segmented into skin region candidates that satisfy the homogeneity property of the human skin. [9]*

D. Brown, I. Craw, and J. Lewthwaite, "A SOM-based approach to skin detection with application in real time systems," *Proc. British Machine Vision Conf., July 2001, pp. 491-500.- describe methods of skin detection using a Self-Organizing Map or SOM, and show performance comparable (94% accuracy) to conventional techniques. We also introduce the AXEON Learning Processor as the basis for a hardware skin detector, and outline the potential benefits of using this system in a demanding environment, such as filtering Internet traffic, to which conventional techniques are not best suited.[10]*

D. Chai and K. N. Ngan, "Face segmentation using skin color map in videophone applications," *IEEE Trans. CCVT, vol. 9, no. 4, pp. 551-564, 1999.* - This paper addresses our proposed method to automatically segment out a person's face from a given image that consists of a head-and-shoulders view of the person and a complex background scene. The method involves a fast, reliable, and effective algorithm that exploits the spatial distribution characteristics of human skin color. A universal skin-color map is derived and used on the chrominance component of the input image to detect pixels with skin-color appearance. Then, based on the spatial distribution of the detected skin-color pixels and their corresponding luminance values, the algorithm employs a set of novel regularization processes to reinforce regions of skin color pixels that are more likely to belong to the facial regions and eliminate those that are not. The performance of the face segmentation algorithm is illustrated by some simulation results carried out on various head-and-shoulders test images. [11]

C. Garcia and G. Tziritas, "Face detection using quantized skin color regions merging and wavelet packet analysis," *IEEE Trans. on Multimedia, vol. 1, no. 3, pp. 264-277,1999.* **-** In this paper, a novel scheme for human faces detection in color images under non constrained scene conditions, such as the presence of a complex background and uncontrolled illumination, is presented. Color clustering and filtering using approximations of the YCbCr and HSV skin color subspaces are applied on the original image, providing quantized skin color regions. A merging stage is then iteratively performed on the set of homogeneous skin color regions in the color quantized image, in order to provide a set of potential face areas. Constraints related to shape and size of faces is applied, and face intensity texture is analyzed by performing wavelet packet decomposition on each face area candidate in order to detect human faces. The wavelet coefficients of the band filtered images characterize the face texture and a set of simple statistical deviations is extracted in order to form compact and meaningful feature vectors. Then, an efficient and reliable probabilistic metric derived from the Bhattacharrya distance is used in order to classify the extracted feature vectors into face or nonface areas, using some prototype face area vectors, acquired in a previous training stage.[12]

SKIN COLOUR SEGMENTATION USING FINITE BIVARIATE PEARSONIAN TYPE-IIb MIXTURE MODEL AND K-MEANS, *Signal & Image Processing: An International Journal (SIPIJ) Vol.3, No.4, August 2012* **-** *In this paper, a new skin colour segmentation based on HSI colour space using bivariate Pearsonian type-IIb mixture model is presented. The model parameters are estimated by deriving the updated equation of EM-Algorithm. The initialization of the model parameters is done through K-means algorithm and method of moments. The segmentation algorithm is obtained using component maximum likelihood under Bayes frame. The experimental results using hue and saturation as feature vector revealed that the developed method perform better with respect to segmentation performance metrics than that of Gaussian mixture model. This method is useful in face detection and medical diagnostics.[13]*
P.Kakumanu, S.Makrogiannis, N. Bourbakis (2007)

*"**A survey of skin-color modeling and detection methods**", Pattern Recognition, vol.40, pp.1106-1122, 2007.* **-** *In this paper, a critical up-to-date review of the various skin modeling and classification strategies based on color information in the visual spectrum is presented. The review is divided into*

three different categories: first, we present the various color spaces used for skin modeling and detection. Second, we present different skin modeling and classification approaches. However, many of these works are limited in performance due to real-world conditions such as illumination and viewing conditions. To cope up with the rapidly changing illumination conditions, illumination adaptation techniques are applied along with skin-color detection. Third, we present various approaches that use skin-color constancy and dynamic adaptation techniques to improve the skin detection performance in dynamically changing illumination and environmental conditions. Wherever available, we also indicate the various factors under which the skin detection techniques perform well.[14]

There are more literatures available which discus the skin segmentations in details but there is hardly discussion of automate switching algorithm between the color models to get skin-pixels efficiently and accurately. Here in this paper, we present the skin pixels segmentation in RGB color models and switching techniques is applied to get the image being presented in different color models.

III. Proposed Framework Design

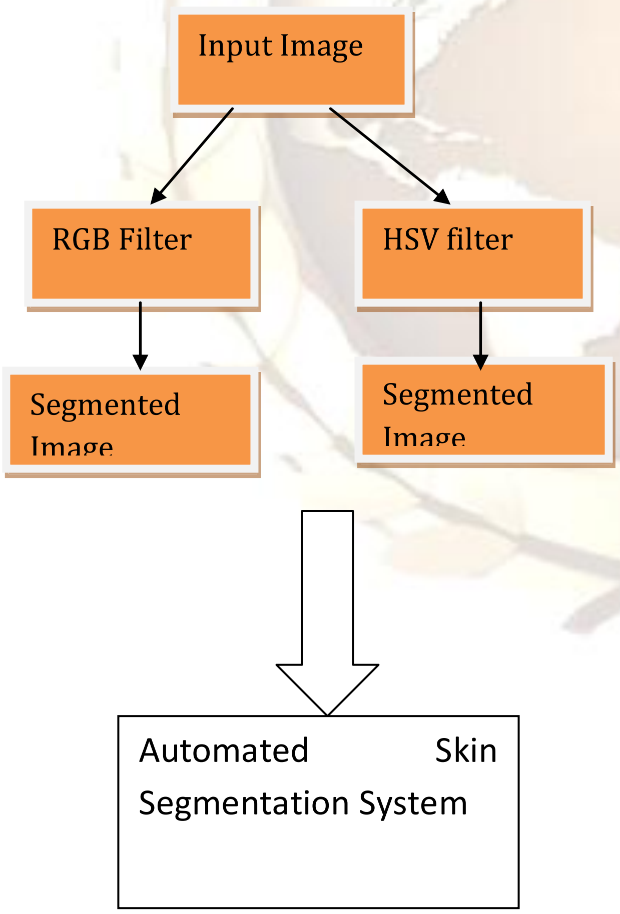

Figure 2: Flow diagram depicting the abstraction of implementation.

Here we discuss the detailed system design including source of image and applied algorithm to segment the pixels of images. We present the automated switching skin pixels segmentation system. Below flow diagram depicts the abstraction of implementation. After getting the imagemap, we apply the filters to get the binary image in RGB color model or HSV color model. Next is our main implemented algorithm for switching between color models. If skin pixels are not visible in one color model, automatically it will get switched into another color model as depicted in the figure.

Problem Statement: Design and Development of skin segmentation using RGB color model and switching condition implementation to switch in different color models based on visibility of skin pixel in RGB color model.

Implemented Algorithm: Below algorithm is being used when imagemap is returned:

Generic Steps of the algorithms:

1. Start
2. Input : Image using RGB or HSV color map
3. For each pixels of the image :
   a. New Pixel : Pi
   b. If Pi match range of pixels
      i. It lies in regions of pixels of image.
      ii. Else Pi does not lie in the regions of images.
   c. Repeat for each image map in various color models.
4. End

Pseudo code of the algorithm:

Function HSV: parameters image map:
Begin
For each pixel {
If: compare: Imagemap (pixel, 1) and range (1)
{
Binary output (pixel) equals 1
}
Else
{
Binary output (pixel) equals 0
}
End
End
Bwmorph: binary output
Median filter: binary output
Matrix multiplies:

As shown in the above figure, there are major modules which lead to a automated skin segmentation system by applying the switching conditions:

- Input Image
- Skin Filters
  - RGB filter
  - HSB filter

- Segmented image
  - RGB image
  - HSV image
- Automated Skin segmentation

- Input Image: For the source of image, we have created the small Mysql database for storage of various image from where we are fetching the images and applying skin filters in various color models.
- Skin filters: for the study purpose, we have created the algorithm which extracts the skin-regions from an image by excluding non-skin pixels. The detail of algorithm is being discussed below.
- Segmented Image: The outcome of the system is a optimum binary image with minimal impact of noise and lights.
- Automated skin segmentation: we have designed an algorithm and written Matlab code for implementation of switching condition to switch in different color models. Then snippet of the code is given below.

Following is the genetic pseducode of the implemented algorithm:

```
Function HSV: parameters image map:
Begin
For each pixel {
If: compare: Imagemap (pixel, 1) and range (1)
        {
                Binary output (pixel) equals 1
        }
Else
{
Binary output (pixel) equals 0
}
End
End
Bwmorph: binary output
Median filter: binary output
Matrix multiplies:
Color output = (binary output). *(imagemap)
Show image
End function
```

Make a start:

RGB Segmentations:

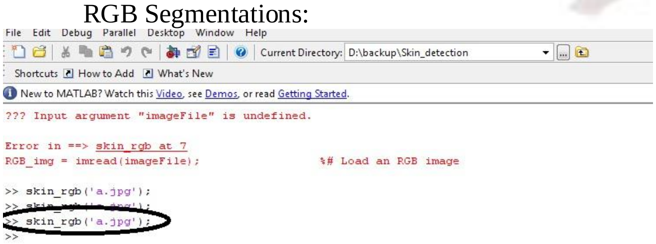

Figure 3: Start function in MATLAB.

#Small Skelton of Implemented Code

```
noOfImages=size(images);noOfImages=
noOfImages(2)
    for i=1:noOfImages
        n=images{i};
        img=rgb2hsv(imread(n));
        RGB_img=imread(n);
        figure(1)
        imshow(RGB_img);
        [
bw1,out1,con1]=skin_hsv(n);
        [
bw2,out2,conn_count,av_h,av_s,avera
ge_value,av_y,av_cb,av_cr,av_r,av_g
,av_b]=skin_rgb(n);

        minval=0.6;maxval=0.67;
%Set the threshold value of change
of color space.

         %         sprintf('average
Hue=%f,\naverage
Saturation=%f,\naverage
Value=%f,\naverage             Y=%f,
\naverage_Cb=%f,    \naverage_Cr=%f,
\naverage_Red=%f,
\naverage_Green=%f,
\naverage_Blue=%f
\n',av_h,av_s,average_value,av_y,av
_cb,av_cr,av_r,av_g,av_b)
         if(average_value<maxval)
            msg=['Average  Value  of
V     for     this      image     ='
num2str(average_value)];

            used='HSV';

msgbox(strcat(msg,'.Color      Space
used is HSV'))

        else
            msg=['Average  Value  of
V     for     this      image     ='
num2str(average_value)];
            used='RGB';

msgbox(strcat(msg,'.Color      Space
used is RGB'))
         end
        sprintf('Color  Space  used
for segmentation : %s',used)
        input('Press  any  key  for
next Image....')
    end
end
```

Methodology Adopted:

Tool/software Used	Version
MATLAB	MatlabR2008a

Base Operating System	Windows Vista

IV. CONCLUSION

During the course of research work, we implement and discuss the skin segmentation in RGB color space and discriminated the skin pixels into skin and non-skin regions. Further we tried to study the effect of various parameters such as light, noise which conclude that there is a requirement of switch in different color model if image is being distorted in one color model.

With the considerations of these effects we conclude that a automated switching system is required by using various color models. Skin detection plays a major role in virtually every field of computer science and by design a good automated system will solve the problem of skin segmentation. In this research study we implement the source code using RGB color model only and try to switch in HSV color model by applying some threshold values on the quality of an image. We will try to implement the other color models and design a good automated system in our future work.

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