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Face Detection using Skin Colour Model and distance between Eyes

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ABSTRACT

Face detection is one of the challenging problems in Computer Applications. The main part is to detect the face portion from the entire image. In this paper, we used YCbCr to detect the skin color of humans by setting appropriate thresholds. The reason for using this color model is to remove the illumination component, Y. We have proposed and implemented a method to locate the face portion of human by determining the number of holes in the skin region using Euler's method and also by taking eye distance. The result of this entire system is shown in the figures and also their accuracies.

Keywords: Skin Color, Color Transformations, Euler's number, Eye distance, Holes, Connected Components.

1. INTRODUCTION

Face detection is one of the important computer vision techniques which is further used in the authentication process in many applications. There are various algorithms used in the detection process right from the skin colour detection to the estimation model. In recent years, skin colour detection has become a hot topic between domestic and foreign researchers, and great progress has been made in this field. Nowadays, there are variety of applications using skin colour detection like detecting and tracking human faces and gestures, filtering web image contents and retrieving people in databases and Internet, even diagnosing diseases [1, 2, 3, 4].

Using the colour space of YCbCr, different algorithms for skin color detection have been proposed. Researchers mainly focus on the transformation of RGB color space to the small color space of YCbCr. The reason for this can be found from the papers that are discussed in this section.

2. LITERATURE REVIEW

Wang [5] removed luminance Y component information to establish Gaussian model. Y channel contributed much towards the effect of illumination. R. Hassanpour et al. [6] proposed a segmentation process not considering Y component to build an efficient Gaussian Mixture Model for the detection of skin color.

M. Elmezain et al. [7] ignored Y channel in order to reduce the effect of brightness variation and then use only the chrominance channels which are fully representing the color. They thought that luminance and chromaticity were explicitly separated, and the YCbCr color space was a favourable choice for skin detection. Thus the influence of luminance was ignored, these experiments were performed after neglect luminance Y information. And these skin colour model only be used when the standard light source evenly exposures.

Huynh-Thu et al [8] proposed a method to detect skin in varying illumination change and complex background. They used an automatic and adaptive multi-thresholding technique for detecting human skin color using GMM and image segmentation. In [9] Phung et al. proposed a Bayesian decision theory for detecting skin color. They proposed an adaptive skin segmentation technique which employed the texture characteristics of the human skin. Cho et al [10] also presented a skin-color filter that was capable of adaptively adjusting its thresholds box in HSV color space and effectively separating skin-color regions from similar background-color regions.

This paper gives clear details of the color models that are used in the detection of human skin and also locating the face portion in the image. Organization of this paper is done in five sections. The first section gives the introduction as discussed. Second section gives the color spaces that are used in this paper. Third section gives a brief discussion on our proposed algorithm. Fourth section gives the experimental results and fifth section concludes the paper.

3. OUR PROPOSED ALGORITHM

The proposed model for face detection using skin color filter is shown in the figure 1. The input RGB image is taken as input for the detection process. To detect the human face, the first and the foremost process is to detect the skin color. The pixel value of our skin color is unique. That's why using appropriate color filtering, proper skin detection can be done efficiently.

YCbCr is used extensively for the detection of skin color. Because, as it is explained, the color channel Y, which gives contribution to the illumination can be separated out. Also, using another algorithm, Y channel is normalized to get a proper skin color model. [11]Normalization of Y channel gives the lightening compensation instead of removing it

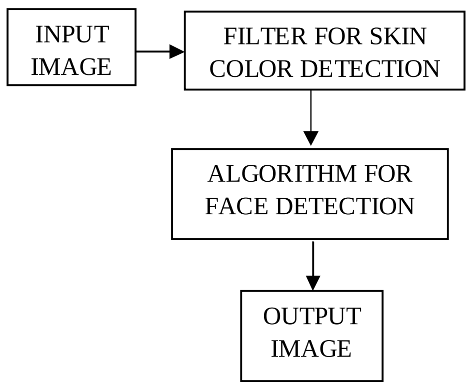


Figure 1: Face detection Model

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.

YCbCr [12] is a family of color spaces used as a part of the color image pipeline in video and digital photography systems. Y is the luma component and CB and CR are the blue-difference and red- difference chroma components. Y (with prime) is distinguished from Y which is luminance, meaning that light intensity is non-linearly encoded using gamma correction [13].

The Y in YCbCr denotes the luminance component, and Cb and Cr represent the chrominance factors. In YCbCr, the Y is the brightness (luma), Cb is blue1 minus luma (B _ Y) and Cr is red minus luma (R _ Y). If R, G and B are given with 8 bit digital precision, then YCbCr from ‘‘digital 8-bit RGB’’ can be obtained from RGB [14].

When representing the signals in digital form, the results are scaled and rounded, and offsets are typically added. For example, the scaling and offset applied to the Y component per specification results in the value of 16 for black and the value of 235 for white when using an8-bit representation. The standard has 8 bit digitized versions of Cb and Cr scaled to a different range of 16–240[15].

Chai and Ngan in [16] first proposed YCbCr algorithm, which is comprised of a skin segmentation step followed by a set of regularization processes to reinforce those skin regions that are more likely to belong to the facial regions.

The conversion of RBG to YCbCr is done by the equation given as in equation (2):

$$\left.\begin{array}{l} Y = 0.299R + 0.587G + 0.114B \\ Cb = B - Y \\ Cr = R - Y \end{array}\right\} \quad (2)$$

The skin segmentation step thus employed exploits the 2D chromatic subspace to reduce the dependence of illumination. A skin color map is derived and used on the chrominance components of the input image to detect pixels that are of skin color. According to the authors the most suitable ranges of Cb and Cr that can be used to represent skin color pixels are shown in equation (3) as:

$$77 <= Cb <= 127;\ 133 <= Cr <= 173 \quad (3)$$

This filter was tested against a set of pictures obtained from the World Wide Web and also against pictures obtained from Compaq database for skin Segmentation [17] and was found to be useful for possible inclusion in File Hound.

So after detecting of the skin color region, the next main step is to locate the face portion in the image. This is the backbone of the face detection algorithm. To detect the face portion, we need to consider some of the features that are present in our face only. So, in our case we have considered eyes, mouth, moustaches, and eyebrows as features for the location of the face.

When the image is converted into a binary image, these features are considered to be holes. Human eyes and mouth are the major holes for detecting human face. For the skin region which doesn't contain any holes then, we can say that this portion is not skin and we can discard this region. This rejection is done by using Euler number method [18]. The equation to determine Euler number is given by equation (5):

$$E = C - H \quad (5)$$

E is the Euler number, C is the no. of connected components in the skin region and H is the no. of holes in that region.
This Euler number computation is done for different skin regions like hands, legs or the face portion. The condition for determining whether the region is a face or not can be given as:

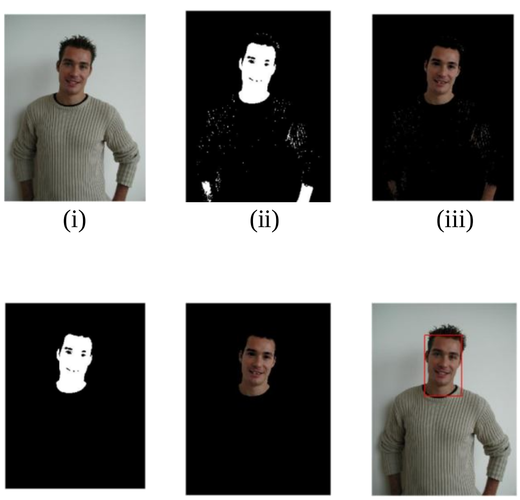
If E<1, the skin region is a human face portion.
If E>1, the skin region is not a human face portion.

Not only the Euler number, we have also considered the distance between two eyes. For that, we have taken average distance between our two eyes. And by setting up an appropriate threshold, it can be determined that if the distance between the two holes in the skin detected region lies in the range of threshold, then this portion is surely a face portion.

So to detect face, the features that we have taken are Euler number and distance between two eyes.

4. EXPERIMENTAL RESULTS

In this section, a brief description about the experimental results is done. The programming environment used is Matlab2011a. First, the experiment is performed to detect the color of skin using skin color detection. We have performed the experiment for both single and many persons and achieved a satisfied result as shown in the two tables below. Results for detecting single person are shown in the Figure 2.



(i) (ii) (iii) (iv) (v) (vi)

Figure 2: Detecting single person

Figure 2: (i) Original Image of a single (ii) Skin Color Detected Binary Image with holes (iii) Skin Color Detected RGB Image (iv) Binary Image of the Face Portion (v) RGB Image of the Face Portion (vi) Detected Face from the entire image

As seen from the above results, it is seen that in the second image, the skin color is detected using YCbCr color transformation. The fourth image is the binary image of the detected face by determining the Euler number.

From the results shown in the above figures, face portion is detected using Euler number. We have done the experiment on 100 and 200 images containing persons having different background situations of size 150 × 100. This algorithm works efficiently giving the accuracy of 95% and 96% respectively for single persons and an accuracy of 92.67% for many persons.

Table 1:Accuracy of the system for single person

No. of images	Positive Detection	Accuracy
100	95	95%
200	192	96%

Table 2: Accuracy of the system for more than 1 persons.

No. of Persons	Positive detection	Accuracy
150	139	92.67%

5. CONCLUSION

The algorithm that we have proposed for Face detection gives a good accuracy as it can be seen from the above table. We have proposed a novel algorithm for detecting the face portion from the entire image and hence we have got positive result for the algorithm. Our future scope is to select the features from the detected face portion and further using these features to develop an efficient face recognition system.

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