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Research Article

Face detection system using HSV color model and morphing operations

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Abstract

Skin detection is the process of finding skin-colored pixels and regions in a given image. This process is typically used as a pre-processing step to find regions that potentially have human faces in images. Several computer vision approaches have been developed for skin detection. A variety of color space model are on shelf for deployment. A simple face detection procedure which has two major steps, first to segment skin region from an image, and second, to decide these regions contain human face or not. The procedure is based on skin color segmentation and human face features (knowledge-based approach. For skin color segmentation HSV color model has been used. Various color space model along with threshold, helps to remove non-skin like pixels from an image. Later tested each skin region, that skin region is actually represents a human face or not. Further the morphological operations are used to smooth the object boundary without changing their respective area based on shapes. Operations such as erosion, dilation are used to execute the process of face detection which improves the efficiency rate.

Keywords: *Color spaces, Skin color detection, HSV model, Hue component, thresholding, Morphological operation and Face Detection.*

1. Introduction

Face detection and recognition is a current topic in the field of computer science. Lots of research in this regard is being carried out and many milestones already set up. The first and foremost important step in any of these systems is the accurate detection of the presence and the position of the human faces in an image. This is the most awaited technology, which can be applied to many aspects of daily life, especially to some of the departments which are relatively dependent on this technology. Detection of the human face is an essential step in computer vision and many biometric applications. The application which most people associate with biometrics is security. A biometric system can be either ‘identification’ or a 'verification' (authentication) system. Identification - For example, consider a crowd with a camera and using face detection and face recognition technology, one can determine matches against a stored database.

Verification - For the identified face let the process of V & V (verify and validate) be applied to achieve the object.

The main challenges encountered in face detection is to cope with a wide variety of variations in the human face such as posture and scale, face orientation, facial expression and skin color. External factors such as occlusion, complex backgrounds inconsistent illumination conditions and quality of the image may also contribute significantly to the overall problem. Face detection in color images has also gained much attention and notice in recent years. Color is known to be a useful cue to extract skin regions and it is only available in color images. This allows easy face localization of potential facial regions without any considerations of its texture. Most techniques up to date are pixel-based skin detection methods, which classify each pixel as “skin” or “non-skin” individually and independently from its neighbours (Sayantan Takur et al, 2011).

This paper presents an image conversion and thresholding at simple level prospect and direction of development. Since each method has its own pros and cons, it is hard to find a perfect solution in application, needing to identify with a variety of methods. Moreover, no matter which method to use, its detection rate and speed requires to be further improved and perfect. In terms of applications, face detection is quite important for the face recognition problem, as a pre-processing step. Face detection is the first step in face recognition. Apart from this face detection also has potential applications in:

- Human-Computer Interface,
- Surveillance Systems
- Content Based Image Retrieval.

2. Face detection system:

Face detection is a field which integrates the technique

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such as:
(i) Computer vision,
(ii) Computer graphics,
(iii) Physiology,
(iv) Evaluation.

The face detection steps are:
1) Acquire image,
2) Pre-processing,
3) Extraction of unique features,
4) Processing algorithm,
5) Final result.

The first step of face detection is to acquire an image. After acquisition of image, pre-processing operation is carried out. The unique features of the image are extracted with the help of different image processing algorithm. They are explained in following sessions:

a) Color spaces selection:

Colors play an important role for object detection, tracking and recognition, etc. Different color spaces have been proposed for skin based face detection such as RGB, normalized RGB, HSV, and YCbCr. Generally HSV and YCbCr color spaces are helped to retrieve from the intensity variations (S.Chitra et al, 2012).

b) Skin pixel:

As skin colour pixels play an important role in detecting faces in colour images, skin chromaticity values of different colour spaces can be effectively used to segment the input image. It helps to identify the probable regions containing faces. Considering only the probable regions containing the faces for detection process reduces the search space. Skin color classification aims at determining whether color pixel has the color of human skin or not. This type of classification should overcome difficulties like different skin tones (white, pink, yellow, brown and black), scene illuminations, and the fact that background pixels can have the same color as skin (Yogesh Tayal et al, 2012).

c) HSV model:

The problem of RGB (Red, Green, and Blue) does not provide the correct information about skin color due to the problem of luminance effects. HSV provides color information as Hue (or color-depth), Saturation (or color-purity) and intensity of the Value (or color-brightness). Hue refers to the color of red, blue and yellow and has the range of 0 to 360. Saturation means purity of the color and takes the value from 0 to 100%. Value refers the brightness of the color and provides the achromatic idea of the color. From this color space, H and S will provide the necessary information about the skin color (S.Chitra et al, 2012).

d) Hue thresholding:

Thresholding is the simplest method of image segmentation. From a grayscale image, thresholding can be used to create binary images Colour images can also be thresholded. Therefore, the HSL and HSV colour models are more often used. Local methods adapt the threshold value on each pixel to the local image characteristics (Devendra Singh et al, 2012).

e) Morphological operation:

Morphology is a broad set of operations that process images based on shapes. The operations of morphological are erosion and dilation used to smooth the object boundary without changing their respective area. The purpose of using erosion and dilation is to improve the efficiency of face detection. The dilation process is to add pixels in the boundary of an object whereas the erosion is used to remove the boundary pixel from an object. Adding or removing the pixel from an object is fully based on the size or shape of the Structuring element, which defines the neighbourhood pixel. First the image is dilated and then eroded by using the same structuring element then this process is called closing operation. The opening operation performs eroded the image and then dilate the eroded image (Smita Tripathi et al, 2011).

3. The proposed algorithm

The human faces have unique color features. Using skin color as a primitive feature for detecting face regions has several advantages. In particular, processing color is much faster than processing other facial features. Later color information is invariant to face orientations. However, even under a fixed lighting, people have different skin color appearance. In order to effectively exploit skin color for face detection, a feature space has to be found, in which human skin colors cluster tightly together and reside remotely to background colors. The complete flow chart of face detection is shown in figure 4.

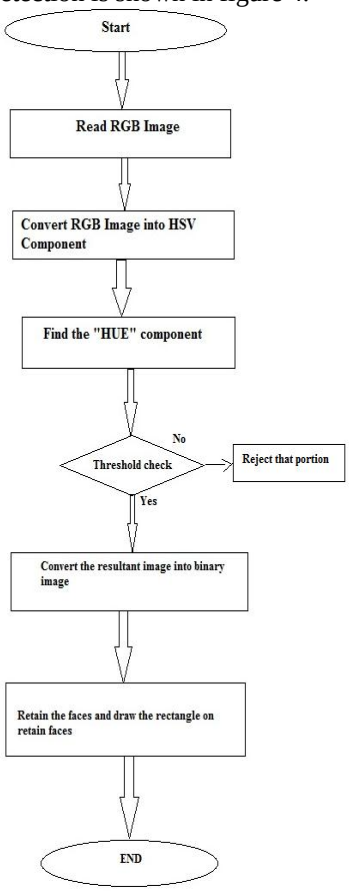


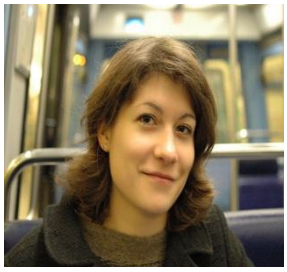
Figure 4: Flow chart of face detection

4. Experimental results

The face detection algorithm is applied on a variety of images taken under different backgrounds. The images also have areas containing skin from other parts of the body such as hands, necks and areas with color very similar to that of skin. These areas get classified as skin. The training set contained skin pixels of people belonging to different races. First of all the algorithm classifies skin pixels and non-skin pixels using H components of the HSV color space that classifies between skin pixels and non-skin pixels. The image after applying morphological operators, the remaining part of the algorithm uses the skin detected image and the hue image, finds the skin regions and checks the percentage of skin in that region. The various steps in the algorithm are explained using two images below:

Step 1: Initially the given RGB images:

a)



b)

c)

d)

Step 2: The RGB to HSV color model. The elements of both colors are in the range 0 to 1.

Figure 2a: rgb2hsv

Figure 2b: rgb2hsv

Figure 2c: rgb2hsv

Figure 2d: rgb2hsv

Step 3: Hue component

Figure 3a: Hue component

Figure 3b Hue component

Figure 3c Hue component

Figure 3d Hue component

Step 4: Hue threshold

Figure 4a Hue threshold

Figure 4b Hue threshold

Figure 4c Hue threshold

Figure 4d Hue threshold

Step 5: The graythresh function uses Otsu's method, which chooses the threshold to minimize the intraclass variance of the black and white pixels. It computes a global threshold (level) that can be used to convert an intensity image to a binary image with im2bw. Level is a normalized intensity value that lies in the range [0, 1].

Figure 5a Graythresh

Figure 5b Graythresh

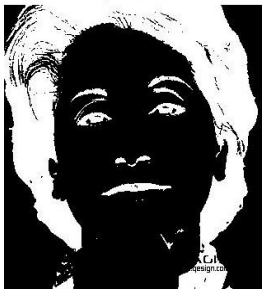


Figure 5c Graythresh

Figure 5d Graythresh

Figure 5a im2bw

Figure 5b im2bw

Figure 5c im2bw

Figure 5d im2bw

Step 6: Morphological operation: After segmentation, morphological operators are implemented with a structuring element. After application of morphological operators, is carried out.

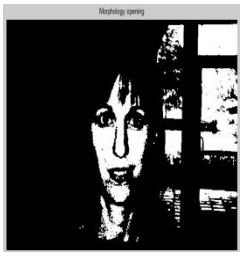


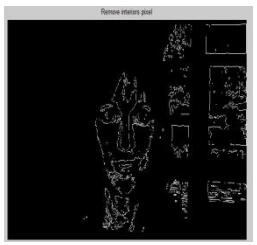
Figure 6a morphological operations

Figure 6b morphological operations

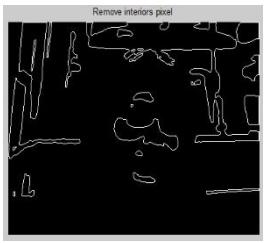
Figure 6c morphological operations

Figure 6d morphological operations

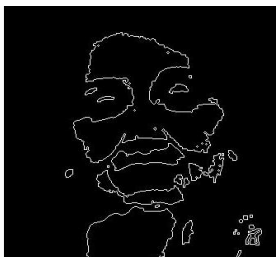
Step 7: Figure 7a, 7b, 7c & 7d showing the removal of interior pixel



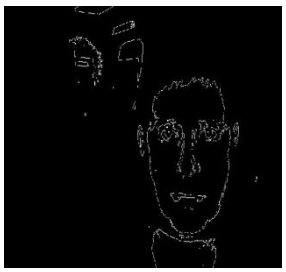
7a



7b



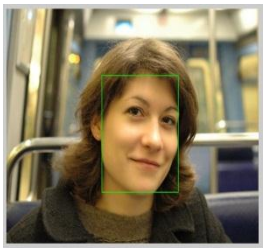
7c



7d

Step 8: Figure 8a, 8b, 8c & 8d showing the final phase of face detection.

8a



8b

8c

8d

Conclusion

Skin detection in color images is a very efficient way to locate skin-colored pixels, which might indicate the existence of human faces and hands. However, many objects in the real world have skin-tone colors, such as some kinds of leather, sand, wood, fur, etc., which might be mistakenly detected by a skin detector. Therefore, skin detection can be very useful in finding human faces and hands in controlled environments where the background is guaranteed not to contain skin-tone colors. Since skin detection depends on locating skin-colored pixels, its use is limited to color images, i.e., it is not useful with gray-scale, infrared, or other types of image modalities that do not contain color information. Experimental results showed accuracy results estimating 80% to 82%. Skin detection can also be used as efficient pre-processing filter to find potential skin regions in color images prior to applying more computationally expensive face.

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