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Global Binary Continuity for Color Face Detection With Complex Background

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Abstract: In this paper, we propose a method to detect human faces in color images, with complex background. The proposed algorithm makes use of basically two color space models, specifically HSV and YCgCr. The color segmented image is filled uniformly with a single color (binary) and then all unwanted discontinuous lines are removed to get the final image. Experimental results on Caltech database manifests that the purported model is able to accomplish far better segmentation for faces of varying orientations, skin color and background environment.

Keywords: Global Binary Continuity, color space, face detection, complex background, discontinuous points.

1. INTRODUCTION

Face detection is basically discovering the face out if a very complex image containing many faces and complex background many a times. Segmentation of face images plays a substantive role in numerous face related applications like face recognition, age estimation, expression analysis and construction of 3D facial models. Face segmentation is an essential step of face recognition system since most face classification techniques tend to only work with face images. Thereby face segmentation has to correctly extract only face part of a given large image. However, due to changes in facial pose variation, occlusion, orientation, illuminating condition and facial expression, it generates difficulties for implementing various algorithms.

Segmentation of an image on the basis of skin color mapped on to multi colorspace leads to better or worse skin region identification leading to a false detection thereby reducing the rate of recognition; hence there is a need for further eliminating these pseudo skin regions. A lot of work is happening on modified skin color segmentation used for detection [1].

The most reinforcing point of skin color segmentation is that facial detection can be independently achieved on varying characteristics of face image [2]. The presence of objects of

a skin-like color in the image will produce false positives in the classification of skin and non-skin pixels using only color information [3-4]. Therefore, the face will be partially detected and it will be necessary to combine this segmentation scheme with other techniques (e.g., morphological processes) for adding the occluded or undetected regions to the detected face region, so that the initial results of the segmentation process can be improved [5, 6, 7]. Several color spaces have been proposed, such as RGB, XYZ, CIE-Lab, HSV or YCbCr, for the classification of the pixels in an image into skin and non-skin.

Color is an important parameter of human face. Skin color based segmentation technique has several advantages over other techniques as Color processing is much faster and robust in nature. Also under Certain lighting conditions, color is orientation invariant. Apart from these advantages there are some disadvantages like sensitivity to illumination intensity, different cameras produce significantly different color values even for the same person under the same lighting conditions and skin color differs from person to person. In order to use color as a feature for face tracking, we have to solve these problems. It is also robust towards changes in orientation and scaling and can tolerate occlusion well.

A color space is a method by which we can specify, create and visualise colour. As humans, we may define a color by its attributes of brightness, hue and colorfulness.

In this paper we use color based segmentation technique to detect or localize a face region from a single face image with complex background which also contains skin color regions. There are lots of color space models, which are used to detect a face but for simplicity we will describe only three of them, which are HSV and YCbCr [8,9],YCgCr. Now in case of color based segmentation, choosing an effective color space is very important because this may cause different output. Hence in this paper we have considered the combination of HSV and YCgCr technique to achieve better performance. The algorithm developed was Ease of Use. This paper is organized as follows. section 2 discusses implementation of face segmentation using colour space models such has HSV and YCgCr, and the removal of discontinuity, section 3 discussing the results of the proposed method. Section 4 concludes the paper.

2. PROPOSED TECHNOLOGY

In the proposed method, the goal is to detect the presence of faces in an image using skin color model based on sample chrominance values, skin likely-hood, Segmentation, Morphological operation and Template matching algorithm to detect faces uniform and non-uniform background color of the scene. The first step of face detection is to segment the color image into skin and non skin region. Different color space has different ranges of pixels which represents skin region and non skin region.

Some colour spaces are perceptually linear, i.e. a 10 unit change in stimulus will produce the same change in perception wherever it is applied. Many colour spaces, particularly in computer graphics, are not linear in this way. Some colour spaces are intuitive to use, i.e. it is easy for the user to navigate within them and creating desired colors is relatively easy. Other spaces are confusing for the user with parameters with abstract relationships to the perceived colour. Finally, some colour spaces are tied to a specific piece of equipment (i.e. are device dependent)

while others are equally valid on whatever device they are used. Even though most of digital image acquisition devices produce R, G, and B components, the RGB color space is converted into different color spaces depending on applications

The purpose of colour model is to ease the specification of colour in some standard. In general, a colour model is a specification of a coordinate system; subspace present in colour space is used to represent each colour by a single point.

2.1 Removal of discontinuous points

The color segmented image is further processed to obtain more efficient segmentation output. The color segmented image of Caltech database consists of a complex background with skin color objects. Thus the color segmented image will consists of those regions which do not belong to the human face. These regions cannot be removed using color segmentation. Hence assuming that face region is the largest among all skin color regions, an approach is made to retain only the facial part. The first step towards this approach is to convert the color segmented image into a binary image, where the colored region takes binary value 1(white). The binary image is then scanned row and column wise to find the presence of continuous 1's. A certain threshold to the number of 1's is set, such that if the number falls below the threshold, scanning is shifted to the next row or column based on whichever is being scanned. This is done to obtain only the continuous line of 1's which finally gives us only the face part. First the image scans column wise and counts the number of continuous white points in the column and stops if black point is found, if the count is more than 25; store the points into a matrix. If not, the points are not stored. The matrix thus stores the corresponding column values which have the value 1. This matrix is then scanned to find whether the points are adjacent or not in a square fashion. If it satisfies then the number of 1's in that row is counted and if it exceeds 20 it is stored. Thus discontinuous lines along the row and column are removed.

Below are few matrices which depict the criteria. Let the threshold for 1's be 4.

$$\begin{bmatrix} 0&0&1&0&1&0&1&0&1&0 \\ 1&1&0&1&0&1&0&1&0&1 \\ 1&1&0&1&0&0&0&0&0&0 \\ 1&1&1&1&1&1&1&1&1&1 \\ 0&1&0&1&1&1&0&0&0&0 \\ 0&1&0&1&0&1&0&0&1&0 \end{bmatrix} \quad \begin{bmatrix} 1&0&1&1&1&1&1&0&0&0 \\ 1&0&1&1&1&1&0&1&0&1 \\ 1&0&1&1&0&0&1&0&1&0 \\ 0&1&1&1&0&1&0&1&0&1 \\ 1&0&1&1&0&1&0&1&1&0 \\ 1&0&0&0&0&0&1&0&1&0 \end{bmatrix} \quad \begin{bmatrix} 0&1&1&1&1&1&1&0&1&0 \\ 1&1&1&1&1&1&1&0&1&0 \\ 1&1&1&1&1&1&1&1&1&0 \\ 0&1&1&1&1&1&1&1&0&1 \\ 0&1&0&1&0&1&1&1&0&0 \\ 0&0&0&1&0&1&0&1&0&1 \end{bmatrix}$$

(i) (ii) (iii)

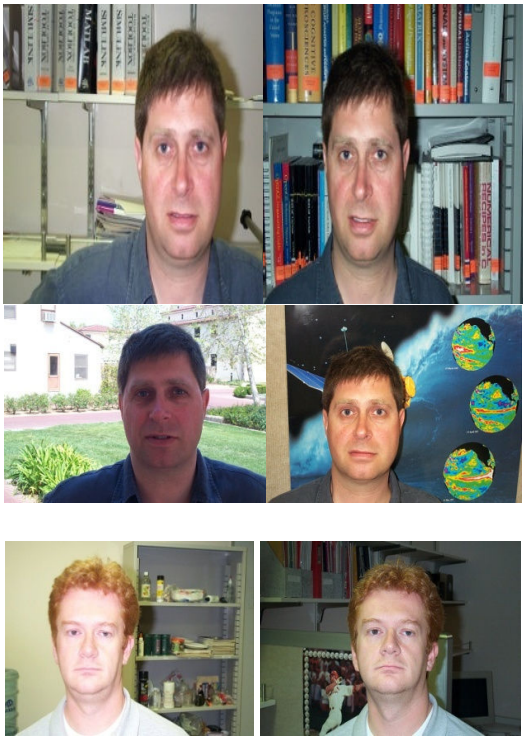
Consider the matrix (i), the column 1 has only three 1,s which is below threshold and thus the search is shifted to 2nd column. The columns 2 and 4 have continuous number of 1's and the count is greater than four. But these two columns are not adjacent and hence discontinuity is confirmed and those two columns are eliminated from the search. Now consider matrix (ii) columns 2 and 3 have continuous 1's but the 3rd column has no continuous 1's. Thus the square pattern is not obtained and therefore the search is shifted to next consecutive columns. In matrix (iii) the columns 2, 3, 4 and 5 have continuous 1's in a square fashion and satisfies the threshold value of 1's. This region is therefore swapped into a new matrix and is expected to contain the face region.

2.2 Implementation method

Step-1: The input image is first segmented using HSV and YCgCr color model.
Step-2: This partial segmented image is converted to binary image.
Step-3: A threshold value is set to remove discontinuous white pixels and thus obtain the face region.
Step-4: The resultant image is used as a mask to map the original color image.
Step-4: Bounding box is applied to the mapped image and the region containing only the face is cropped.

3. EXPERIMENTAL RESULTS

This study has been conducted using a set of Caltech database images with complex background, different facial expressions, lighting conditions and different orientations. Caltech database is a frontal face dataset collected by Markus Weber at California Institute of Technology. It contains 450 face images of size 896 x 592 pixels in JPEG format of 27 or so unique people under different lighting/expressions/backgrounds. Fig 1-7 speaks about the algorithm steps mentioned in the previous sub article.



Face segmentation was carried out first on the training set. The experimental results are as shown in figure. The best results were achieved applying the segmentation with the minimum Cg and the maximum Cr thresholds.

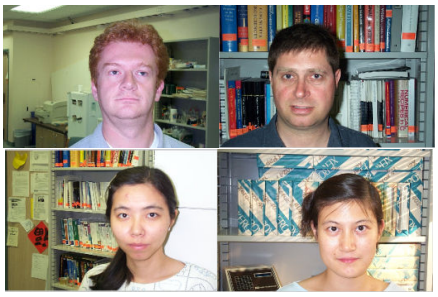


Fig 1: Original images of the database before applying segmentation.

Fig 2: Images after color segmentation

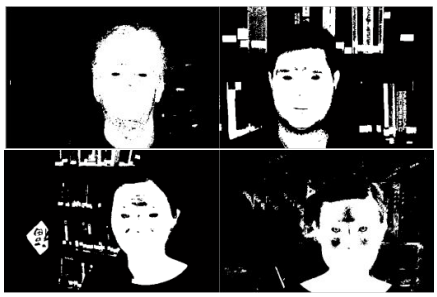


Fig 3: Binary conversion of images

Fig 4: After removal of discontinuous points

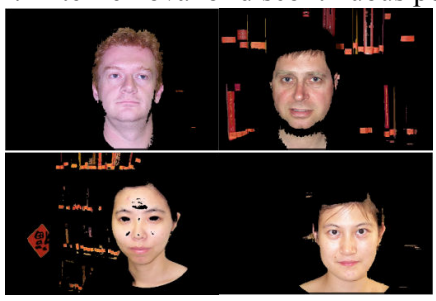


Fig 5: Color mapped segmented images

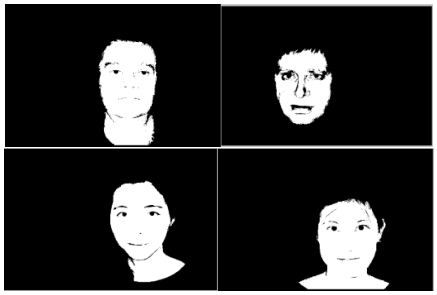


Fig 6: After applying bounding box

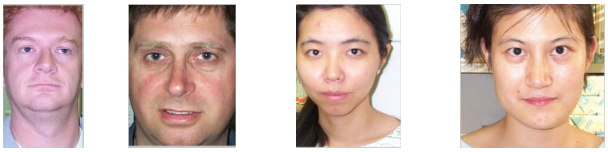


Fig 7: Final cropped image.

4. CONCLUSION AND FUTURE WORK

In this paper, an effective skin color segmentation algorithm for face detection is proposed. We have studied highlighting attributes of the dual color space and have developed a framework for extracting features that can be used for image segmentation. The experimental result shows that this algorithm yet simple, gives a very efficacious way of segregating face and non face in image with complex background.

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