Volume 3, Issue 6, June 2013 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Face Detection in Digital Images Using Color Spaces and Edge Detection Techniques

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Abstract - In this paper we propose a method to detect human faces in color images , that uses a combination of color spaces and edge detection for segmentation. Algorithm ingeniously combines different color space models, specifically, HSI and YCbCr along with Canny and Prewitt edge detection techniques.Experimental results indicate improved false acceptance rates. The overall performance of the face detection system is evaluated with a successful rate of 84%.

Keywords: Face detection, Skin segmentation, Skin-Color model, Skin likelihood, Morphological operation, Region Labeling, Euler Test, Canny Edge, Prewitt Edge, Template matching.

I. Introduction

Face detection is a necessary first step in face recognition systems with the purpose of localizing and extracting the face region from the background. Face detection techniques can be roughly classified into four categories [4], namely, skin color model-based approaches, template matching-based approaches, feature-based approaches, and statistical model-based approaches. Usually, face detection techniques integrate some or all of the four approaches to achieve high face detection accuracy and a low false detection rate. Detection rate and the number of false positives are important factors in evaluating face detection systems[1]. Detection rate is the ratio between the number of faces correctly detected by the system and the actual number of faces in the image.

Skin color model-based approaches build a skin color model using Gaussian normal distribution since color is one of the most widely used visual features in face detection. Specifically, said models convert the color image into an appropriate color space, such as HSI, YCbCr, or YIQ, to find skin color. These color spaces are more robust to the lighting conditions than the RGB color space and therefore are suitable for face detection under different illuminations. The mean and covariance matrix of the skin color are then computed from the skin colors. Finally, the results of this computation are used to find the likelihood that each pixel in the input image is, indeed, a skin color[3].

Feature-based approaches first process the input image to identify and extract (and measure) distinctive facial features such as the eyes, mouth, nose, etc., as well as other fiducial marks, and then compute the geometric relationships among those facial points, thus reducing the input facial image to a vector of geometric features. Standard statistical pattern recognition techniques are then employed to match faces using these measurements. Human skin color is a powerful feature that is used to detect faces, but different people have different skin color, several studies have shown that the basic difference based on its intensity chrominance instead[10].

In **Image based approach**, there is a face pattern standard predefined is used to match the segment in the image to determine whether they are faces or not. It uses training algorithms to classify regions face or non-face classes. Image-based techniques depends window multi-resolution scanning detect faces, so that these techniques have high detection rates but slower than the techniques of feature-based. Eigen-faces and neural networks are examples of techniques based on images. This approach has the advantage of being simple to implement, but it can not deal effectively with the variation in scale, pose and shape[7].

Template based approach used several templates to find out the face class and extract facial features. The template-matching compares the face candidate image with the face template, measures the level of similarity and concludes whether it is human face or a non-face. The color space chosen for the template matching is gray because the best results have been experimentally obtained. The face template is an image made by averaging all faces on the training images. A few human faces are not detected if only one face template is used[8].

Edge detection approach is a very important area in the field of Computer Vision. Edges define the boundaries between regions in an image, which helps with segmentation and object recognition. They can show where shadows fall in an image or any other distinct change in the intensity of an image.

The quality of edge detection is highly dependent on lighting conditions, the presence of objects of similar intensities, density of edges in the scene, and noise. While each of these problems can be handled by adjusting certain values in the edge detector and changing the threshold value for what is considered an edge, no good method has been determined for automatically setting these values, so they must be manually changed by an operator each time the detector is run with a different set of data[12]. This paper is organized as follows: Section II discusses face detection using Skin Likelihood, Skin Segmentation, Canny edge detection, Prewitt edge detection, Morphological operation, Region labeling, Euler's test, Template matching. Section III discussing the Results of the proposed method and Section IV concludes the paper.

II. Propsed Method

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. Canny and Prewitt edge detection using with a combination of color spaces to identify the skin pixels for good segmentation is proposed. As all the skin segmented regions are not face regions, each segmented region is passed through an algorithm to check whether the segmented region is face or not. So to implement these Combination of methods first we perform **Skin likelihood model.**

A. *Skin Likelihood Model*

A reliable skin color model that is adaptable to people of different skin colors and different lighting conditions is necessary if we want to segment skin regions from non-skin regions .The input image is skin segmented using YCbCr color model and also By HSI color Model. After performing that we got two Likelyhood images. One from YCbCr color model and second from HSI color model[11].

Fig 1: Input Image

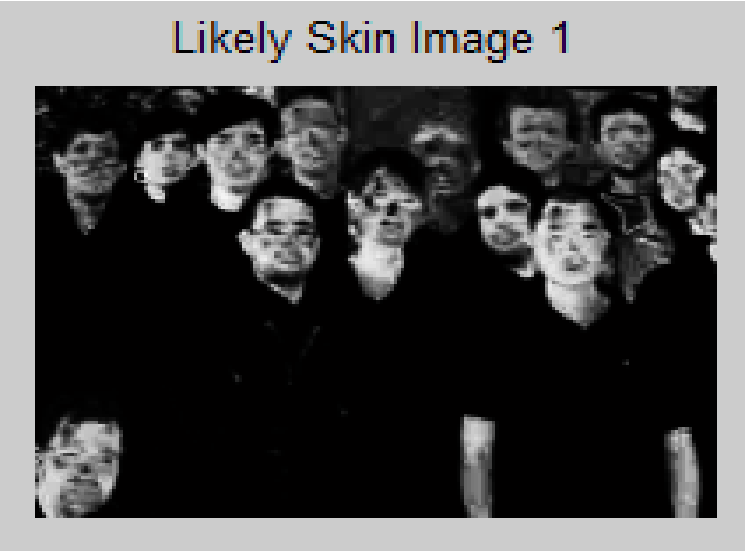

Fig 2(a):Skin Likelihood(YCbCr)

Fig 2(b): Skin Likelihood(HSI)

B. *Skin segmented image*

After calculating the likely skin images we calculate the segmented images from both color models. skin regions are brighter than the other parts of the image, the skin regions can be segmented from the rest of the image through a process called thresholding[2].

Fig 3(a):Segmented Image(YCbCr)

Fig 3(b):Segmented Image(HSI)

C. *Gray Scale image*

Segmented images obtained are combined into single segmented image called Gray scale image. The result of the enhancement is subjected to skin segmentation, which contains the possible face candidate, followed by the skin tone percentage index method for region adjustment and noise removal. In contrast, the gray component of the enhanced image is subjected to edge detection[6].

D. *Canny Edge Detection*

We used the Canny algorithm for edge detection. We can vary the lower and upper threshold to control the edge density in an image in this method. The image boundaries generated by the Canny method are thinner, so we applied the morphological dilation operation.

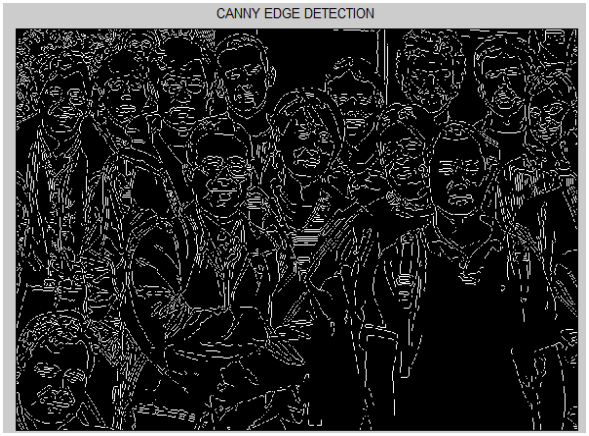

Fig 4:Canny Edge Detection Image

One issue with the Canny edge detection algorithm is that we need to specify a high threshold and a low threshold. We use a simple threshold selection scheme using the mean of the gray scale image pixel values[13].

E. *Prewitt Edge Detection*

Prewitt Edge detection refers to the process of identifying and locating sharp discontinuities in an image. The discontinuities are abrupt changes in pixel intensity which characterize boundaries of objects in a scene. The concept of edge is highly useful in dealing with regions and boundaries as an edge point is transition in gray level associated with a point with respect to its background. Prewitt is used for detecting vertical and horizontal edges in images. It returns edges at those points where the gradient of image is maximum[12].

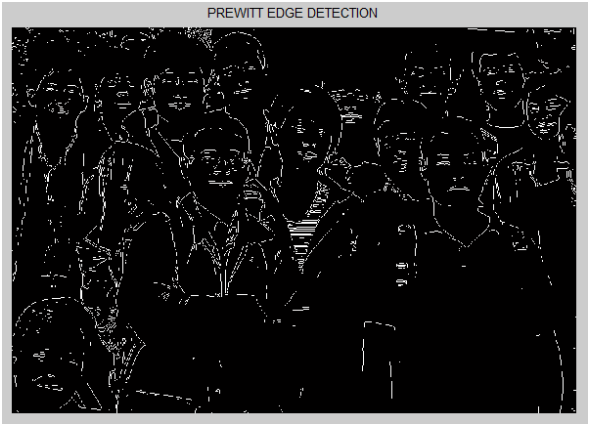

Fig 5:Prewitt Edge Detection Image

F. *Canny and Prewitt Edge Detection*

After calculating the Canny Edge detection and Prewitt Edge detection We obtained the Edge-images obtained by both the methods are combined and complemented to obtain region boundaries. Different edge detectors work better under different conditions. Then we apply Morphological Operations on it.

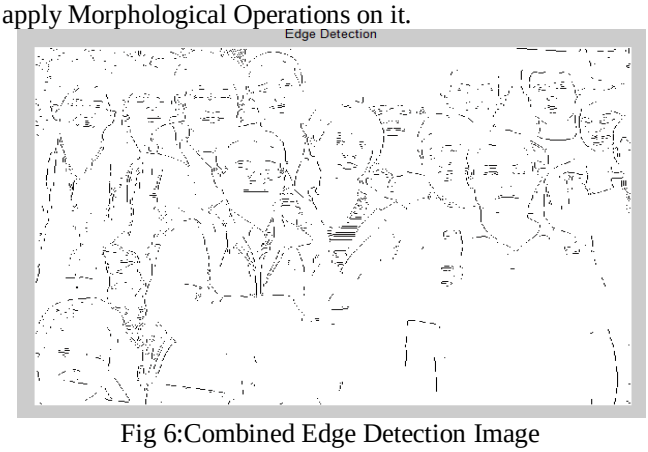

Fig 6:Combined Edge Detection Image

G. *Morphological Operations*

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[10].

Fig 7 (a): Edge Detection After Erosion Image

Fig 7(b): Edge Detection After Dilation Image

H. *Region Labeling*

The resulting image, which is a combination of the skin tone image and edge image, is now searched for connected components Using the result from the previous section, we proceed to determine which regions can possibly determine a frontal human face. To do so, we need to determine the number of skin regions in the image[11].

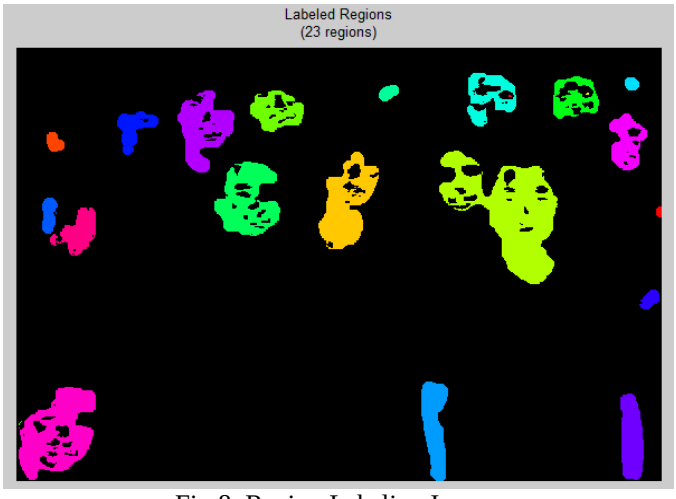

Fig 8: Region Labeling Image

I. *Euler Test*

The segmented regions containing holes due to the presence of eyes and mouth are assumed to be probable segmented face regions and eliminate other segmented regions[10].

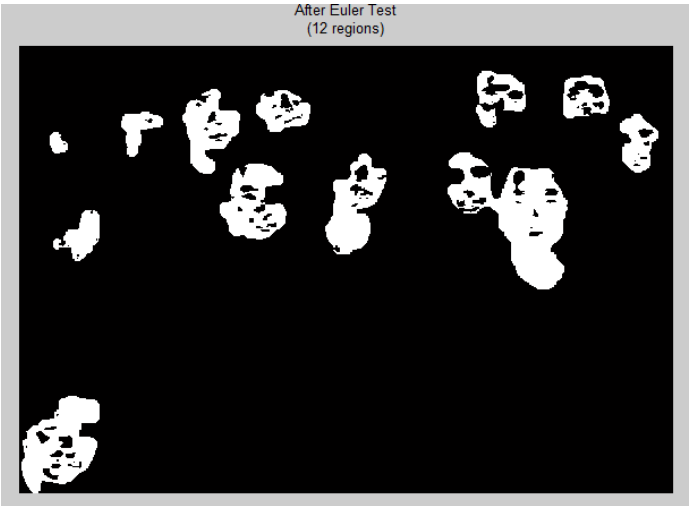

Fig 9: Euler Test Image

J. *Template Matching*

A few human faces are not detected if only one face template is used. The reason for the undetected faces is due to the very different color of skin or face profiles found across several subjects. Additional face templates are used to detect the missing faces[9].

K. *Final Face Detection*

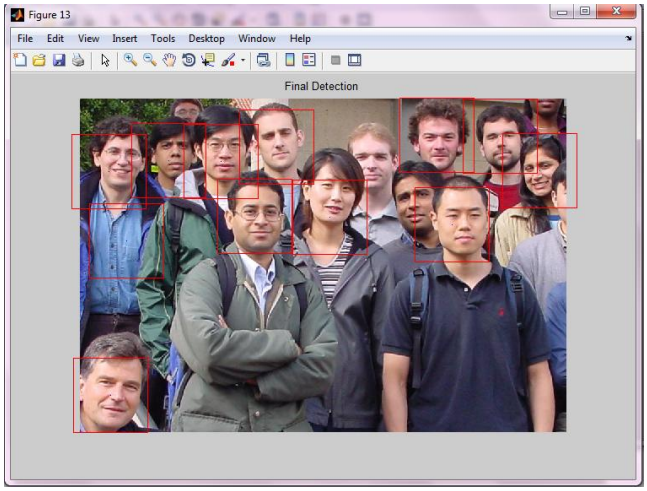

Fig 10: Final face Detection Image

NEW PROPOSED ALGORITHM – PRECAN ALGORITHM

Canny and Prewitt edge detection using with a combination of colour spaces to identify the skin pixels for good segmentation is proposed. As all the skin segmented regions are not face regions, each segmented region is passed through a algorithm to check whether the segmented region is face or not.

Step-1: The input image is skin segmented using YCbCr colour model. Apply various morphological operations such as erosion and dilation on this skin segmented regions.

Step-2: The input image is also skin segmented using HSI colour model. On this skin segmented regions various morphological operations such as erosion and dilation.

Step-3 : The input image is converted into gray scale image.“Canny” and “Prewitt” edge detection of gray-scale is obtained. Then Edge-images obtained by both the methods are combined and complemented to obtain region boundaries.

Step-4: Segmented images obtained in Step-1 and Step-2 is combined into single segmented image. On this image connected component analysis is carried out to obtain a Combined-Segmented image.

Step-5: Region boundaries obtained in step-3 is multiplied with the Combined-Segmented image obtained in Step-4. After performing relevant morphological operations such as erosion and dilations as in Step-3 we get the final segmented image.

The segmented regions containing holes are assumed to be probable segmented face regions and eliminate other segmented regions.

III. Perfomance Analysis And Discussion

The following parameters were chosen to evaluate the performance of the proposed face detection method:
TP: True Positive (number of correctly detected faces)
TN: True Negative (number of lost faces)
FP: False Positive (number of non-face items detected)
TF: Total Faces (TP+TN)
CDR: Correct Detection Rate (TP/TF)
FPR: False Detection Rate (FP/TF)
LR: Labled Region
ET: Euler Test

Face detection performance by using combination of different color space and edge detection.

Table 1 : Performance Analysis By using combination of different color space and edge detection

1	Total Faces	13
2	True Positive	11
3	True Negative	2
4	False Positive	1
5	Correct Detection Rate (%)	84.61%
6	False Detection Rate (%)	7.69%
7	Labled Region	23
8	Euler Test	12

From Table 1 we can see that out of 13 faces from the digital image, 11 were correctly detected by the skin color based segmentation. The detection rate was 84.61% and false detection rate was 7.69%, here we calculated labled region 23 , euler number 12 , number of correctly detected faces was 11 and number of lost faces was 2 , but here 1 false positive was also detected.

IV Conclusion And Future Work

The experimental result shows that the proposed method gives more accurate and efficient results as compare to previous skin color based segmentation method. The efficiency of this proposed method is 84%.

In the future work, we will improve this algorithm combined with more edge detection algorithm to achieve better performance and further reduce the false missing hit. we can see in our current algorithm, when we get more accuracy in our implementation then one misshit is detected, it is came due to the shrinkness of the shirt so it is calculated as a hole in the region and the method treated this area as a face so, to recover this problem we can apply more edge detection approaches on it.

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