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# FACE DETECTION USING COLOR BASED ALGORITHM AND FEATURE BASED ALGORITHM

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***Abstract***

*As human Face is Dynamic Object having a high degree of variability in its appearance. So, it is very difficult to detect or find out the location of human face area. In many Application Face Detection is a Important Topic. But Some Problems like Illumination and Pose variation, existence of occlusion, orientation, facial expression and presence and absent of structural components decrease the Performance. Out of these, some problems are solved. But the detection of occluded face is very difficult like masking. However there are number of methods to localize human face. Face detection is used in many application like face recognition, expression recognition, Biometric, Facial feature detection etc. In this paper we will see the proposed method to detect the human face with masking.*

***Keywords-*** *Face Detection, Feature Detection, Skin color segmentation, CIE Lab color space, Canny edge detection algorithm, Eye detection, Mouth detection, Flexible geometric model.*

## I. INTRODUCTION

Human face is an important clue for identifying people. Human face detection is related with finding the location and size of every human face in an image. Face detection plays a very effective role in human computer interaction field. Face detection has attracted many researchers because it has a wide area of applications. Face Detection is the first step of any face processing system like face recognition system, surveillance system, Biometric, low enforcement system, security system, identifying criminals. The aim of face detection is to identify the location of the face from image. Detecting faces from an image is very challenging task because of there are number of speed breakers like variation in scale, location angle, orientation and pose. Facial expression, occlusion like masking, wearing sun glasses, wearing or growing moustache and beard, the illumination, complex background. These types of speed breakers degrade the performance of face detection.

There are number of systems used for face detection. Detection rate and the number of false positives and number of false negatives are important factors in evaluating face detection systems. Detection rate is the ratio of number of faces correctly detected by the system and the actual number of faces in the image. False positive means number of objects detected which are not human faces. And false negative means numbers of human faces are not detected.

## II. DETECTING FACES IN SINGLE IMAGE

The techniques of face detection are classified into following four categories:

Knowledge based method [5, 11]

This method is related to the knowledge of common rules about human facial features. For example two eyes are symmetric with each other, a nose, a mouth and relationships between them in terms of distance, position. This method is best generally for frontal face detection. But the problem is there to translate the human knowledge into common rules and to detect faces in different poses.

Template based method [7, 11]

A standard face pattern is predefined by a function and predefined standard face pattern is used to match with the segments in the image to determine whether they are faces or not. To find the face is present in any image or not, correlation values with the standard face patterns are found out. But this method is fail with the variation in scale, shape, facial expression.

Feature based method [1, 2, 3, 4, 8, 9, 10, 11, 12]

This method is depends on the extraction of the facial features which are independent of pose and other factors. Features like skin color, shape, texture, edges, and facial features like mouth, eye, nose etc... Skin color is also important feature. Textures of human faces have a special texture that can be used to separate them from different objects. Facial features method depends on detecting features of the face. Some users use the edges to detect the features of the face and then grouping the

edges. Multiple features methods use several combined facial features to locate or detect faces. First find the face by using features like skin color, size and shape and then verifying these candidates using detailed features such as eye, nose etc...Every person has different skin color but for skin color detection appropriate color space is selected by research. Using facial features face detection is done. In these methods are fail with illumination, occlusion and noise.

Appearance based method [6, 11]
This is known as Machine learning method, which is learned from the set of training images which show the representative variability of facial appearance. It uses training algorithms to classify regions into face or non-face classes .These techniques depends on multi-resolution window scanning to detect faces, so these techniques have high detection rates but slower than the feature based techniques.

## III. PROPOSED METHOD

### 3.1 General Diagram

The general diagram of proposed method is shown below.

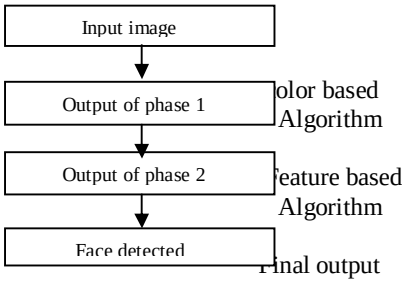



Fig. 3.1 General diagram of proposed method

From fig. 3.1 first take input images. In first phase system apply the color based algorithm to identify skin and non-skin pixel and in second phase system apply feature based algorithm for extracting the number of facial features like mouth, eye etc..For identify occluded face as well as the number of persons in the image.

As a color based algorithm there are number of color space to separate skin pixels and non-skin pixels. The color spaces are RGB, YCbCr, HSV , normalized RGB ,CIElab etc. But among them RGB color space is illumination dependent. HSV color space is not good for detecting skin pixels for multiple face in single image. So YCbCr and CIElab color space is efficient for skin detection.

There are number of algorithms used for extraction of any facial features like eye, mouth, nose, eyebrow etc… Among some algorithms are shown below.

A. Geometry based algorithm [3]

The eye searching is started from geometry central point in the binary face image, when reaching a connected area the size and location of this area are judged, it will be preserved if suitable for the eye characters or else discarded. The nose is detected at the line which is vertical to the connective line between the two eye central points. The central points of mouth and nose are in same line, and the mouth is below the nose, the mouth is founded and located according to a fixed length range and the position of central point of nose.

B. Color based algorithm [1]

Every facial feature has specific color information. In color based algorithm, the color ranges are defined for each and every facial features, like eye is related to the black and white color , lips are related to pink color, nose are related to skin color, eye brows are related to black color etc..

C. Intensity based algorithm

Features such as eyes and mouths are extracted based on the observation that they are darker than the rest of the face.

D. Edge based algorithm [12]

Features are extracted using edge detection of each and every feature. There are number of edge algorithms like Robert, Sobel, Prewitt, Canny etc..

E. Template based algorithm [11]

For each and every facial feature one standard pattern is fixed which is known as sub-template. The correlation values with the standard patterns are computed for each and every facial feature.

### 3.2 Workflow

The workflow of proposed method is shown below.

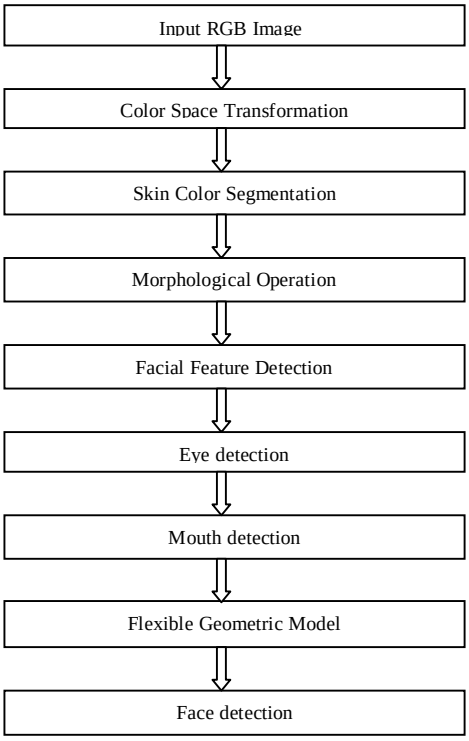



Fig. 3.2 Workflow of proposed method

A. Input RGB image
At first the RGB image is applied, which is color image. Input image is combination of primary color, which are red, green and blue.

B. Color Space Transformation
The input image is RGB image but in this image R, G, B components are dependent on illumination condition, so when the illumination is changed then output is also changed. And different human face has different brightness so using only RGB color space detection rate is decreased and performance is also decreased. So color space transformation is required. There are number of color spaces like HSV,YCbCr, normalized RGB, CIELab etc. Here CIELab color space is used for skin detection.

CIELab color space has main advantage that it is device independent. CIE represents international commition on illumination. It is uniform color space which how to colors differs to see when human observe that two colors. So in this color space all the colors are arranged by the perceptual difference of the color. In this color space L , a and b is obtained using non-linear mapping of XYZ coordinates. Three components of lab color space is l represents luminance (1 for white and 0 for black) and a,b represent the chroma information its position between red/magenta and green (***a****, negative values indicate green while positive values indicate magenta) and its position between yellow and blue (***b****, negative values indicate blue and positive values indicate yellow) respectively.

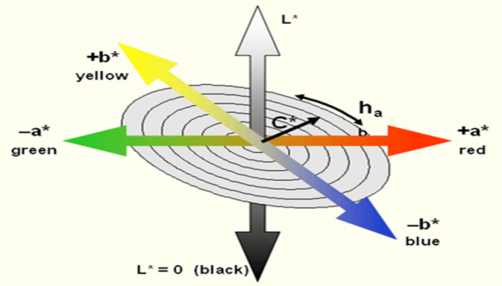



Fig. 3.3 CIE Lab Colors Space.

C. Skin Color Segmentation
After transformation in CIELab color space the components are concatenate with each other and again transform the image into RGB color space. After finding R, G and B component then applying the skin region range skin is detected. The range used which is given below.
(R, G ,B) is classified as skin if:
R>92 and G>40 and B>20 and
max(R, G, B)-min(R, G, B)>15 and
|R-G|>15 and R>G and R>B

D. Morphological operation
In this section noise removal process is done using convert the grayscale image into binary, filling the holes, and removes from a binary image all connected components that have less than 1890 pixels.

E. Facial Features detection
Now the facial features like eye and mouth are detected. Eye is detected using canny edge detection algorithm and using geometric relation mouth is detected.

F. Eye detection
To detect the eye, feature based algorithm is used. As a feature, edges are detected using edge detection algorithm. There are number of edge detection algorithm, here canny edge detection algorithm is used because it provide good and reliable detection.
There are five steps to detect the edge using canny edge detection algorithm.

1. Apply Gaussian filters to smooth the image in order to remove the noise.
All edge detection results are suffering with noise so it is necessary to remove the noise means image smoothing. For that the Gaussian filter is used. The equation for a Gaussian filter kernel with the size of 2k+1*2k+1 is shown as following:

$$H_{ij} = \frac{1}{2\pi\sigma^2} * e^{\left(-\frac{(i-k-1)^2+(j-k-1)^2}{2\sigma^2}\right)} \quad 3.1$$

For this method the Gaussian kernel size is 5 and standard deviation of Gaussian filter is 3.

2. Find the intensity gradients of the image.
An edge in an image may point in a variety of directions, so the Canny edge detection algorithm uses four filters to detect horizontal, vertical and diagonal edges in the blurred image. From this the edge magnitude and direction is determined from the following equations.

$$G = \sqrt{Gx^2 + Gy^2} \quad (3.2)$$

$$\Theta = \text{atan2}(Gy,Gx) \quad (3.3)$$

For this method maximum and minimum value of magnitude is 40 and 4 respectively.

3. Apply non-maximum suppression to get rid of spurious response to edge detection.
This is used to thin the image means for image thinning. Edge extracted from gradient value is still blurred. So, non maximum suppression technique is used to suppress all the gradient value to zero except the local maximal, which indicates location with the minimum change of intensity value. The algorithm for each pixel in the gradient image is:

a. Compare the edge strength (magnitude) of the current pixel with the edge strength of the pixel in the positive and negative gradient directions.

b. If the edge strength of the current pixel is the largest compared to the other pixels in the mask with the same direction (i.e, the pixel that is pointing in the x direction, it will be compared to the pixel right and left it in the horizontal axis), the value will be store. Otherwise, the value will be suppressed.

4. Apply double threshold to determine potential edges.
The result of non-maximum suppression, the edge pixels are quite accurate to present the real edge. But, there are still some edge pixels caused by noise and color variation. So, it is essential to filter out the edge pixel with the weak gradient value and store the edge with the high gradient value. Thus two threshold values are set to clarify the different types of edge pixels, one is called high threshold value and the other is called the low threshold value. If the edge pixel's gradient value is higher than the high threshold value, they are marked as strong edge pixels. If the edge pixel's gradient value is smaller than the high threshold value and larger than the low threshold value, they are marked as weak edge pixels. If the pixel value is smaller than the low threshold value, they will be suppressed.
For this method the threshold value is 0.37.

5. Track edge by hysteresis: Finalize the detection of edges by suppressing all the other edges that are weak and not connected to strong edges. To track the edge connection, Binary Large Object-analysis is applied by looking at a weak edge pixel and its 8-connected neighborhood pixels. There is one strong edge pixel is involved in the BLOB, that weak edge point can be identified as one that should be preserved.

After getting the edge divide the image in two equal parts and called cell 1 and cell 2 for each eye. Then for smoothing the image find out the gradient of cell 1 and cell 2. Now eye shape is curvature so find out curvedness.

$$Curvedness=sqrt(FXX^2+2FXY^2+FYY^2) \quad (3.4)$$

Where, FXX is magnitude of FX which is magnitude of cell 1.

FXY is direction of FX which is direction of cell 1.

FYY is direction of FY which is direction of cell1.

Similarly find out for cell 2.
Then find the short distance for each eye which is called displacement vector. Then find maximum isocenter. eye labeling is done.
For eye labeling , first take the center point for left eye is (x1,y1) and for right eye is (x2,y2). Now find out the length between this point.

$$Len\_XY= sqrt ((x1-x2)^2 + (y1-y2)^2) \quad (3.5)$$

$$th= 0 \text{ to } 3.6 \text{ to } 360 \quad (3.6)$$

$$Xunit1 = 30 * cos(th) +x1 \quad (3.7)$$
$$Yunit1 = 30 * sin(th) +y1 \quad (3.8)$$
$$Xunit2 = 30 * cos(th) +x2 \quad (3.9)$$
$$Yunit1 = 30 * sin(th) +y2 \quad (3.10)$$

G. Mouth detection
Due to (x1,y1) and (x2,y2) using the length between this two point, the point related mouth is detected which is (x3,y3).

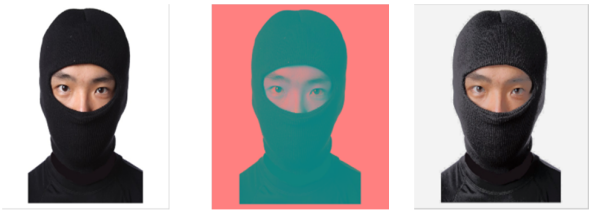
$$x3 = x1 + Len\_XY * cos (a+160) \quad (3.11)$$
$$y3 = y1 + Len\_XY * sin (a-60) \quad (3.12)$$

H. Flexible geometric model
Then making the flexible geometric model which is connecting three points (x1,y1), (x2,y2) and (x3,y3). This is a triangle shape.

I. Face labeling
Now finding the mean of x1, x2 , x3 and y1,y2,y3, which is called the centroid of x and y respectively.
After that using rectangle function face labeling is done.
Using this proposed method the occluded face is detected which is occluded by masking.

## IV. SIMULATION RESULTS

From proposed algorithm we have seen there are two phases one is color based segmentation and another is feature based algorithm. From fig.3.2 first step is input RGB image and second step is color based segmentation to identify the skin pixels. Then using canny edge detection algorithm eye is detected. After that using sine and cosine function mouth is detected. After finding the centre of detected eye portion and the point at detected mouth portion flexible geometrical model is developed. And using that face is detected.



(a) Input image (b) CIE Lab image (c) RGB image

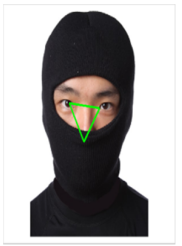

(d) Skin color segmentation


(e) Cropped image


(f) Edge detection


(g) Eye detection


(h) Mouth detection

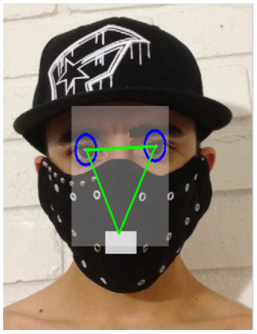

(i) Flexible geometrical model


(h) Face detection

The total step by step implementation of proposed method is shown in Fig. (a) to (h) steps. In step (a) there is a input image which is device dependent so to make device independent first convert the input image in CIELab color space and after that convert in RGB image ,which is shown in step (b) and (c). After that using some specific range skin color is detected, which is shown in step (d). Now the image is cropped for simplicity, shown in step (e). Using Canny edge detection algorithm eye portion is detected and using sine and cosine function mouth portion is detected, which is shown in step (f),(g) and (h). Now using geometrical relation between eye portion and mouth portion flexible geometrical model is developed, it is in step (i). Finally using geometrical relation Face is detected.

Some other images are shown in Fig, which are shown below.


(a) Input image


(b) Face detection


(a) Input image


(b) Face detection

### 4.1 Performance Table

From above implementation on images it can be find out the detection rate. Detection rate is defined by the ratio of successfully detected faces to total number of faces. In mathematical term it is,

$$DR = \frac{\textbf{Successfully detected faces}}{\textbf{Total number of faces}} \quad (4.1)$$

Table 4.1 Performance table

| | |
|---|---|
| Total number of faces | **30** |
| successfully detected faces | **28** |
| Detection rate | **93.33%** |

## V. CONCLUSION & FUTURE WORK

An approach for face detection method based on color based segmentation and feature based algorithm which is explained in proposed method. From literature review, there are various methods for face detection. But masking face is not detected easily. In color based algorithm, there are number of color space for skin detection. Here CIELab color space is used because of it is device independent. For eye detection canny edge detection algorithm is used. In this method initially eye is detected and using eye's location, mouth is detected than face is detected. So if eyes are occluded then it has not proper results.

In proposed method detection rate is somewhat low so in future, it should be try to increase it and also try to detect faces in multi-face images.

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## REFERENCES

[1] Md.Mahendi Hasan,Md.Foisal Hossain, " Facial Features Detection in color images on skin color Segmentations" , *IEEE ,3rd International conference on Informatics Electronics & Vision* ,978-1-4799-5180-2, ISSN 4799-5180, 2014.

[2] Mrs.Sunita Roy, Prof. Samir K. Bandhyopadhyay ,"Face detection using hybrid approach that combines HSV and RGB", *International Journal of Computer Science and Mobile Computing* ,vol.2, Issue 3, ISSN 2320-088X ,March 2013, pp.127-136.

[3] Rong Wang, XiaoGang Yang, "A face detection method based on color and geometry information" , *IEEE* ,978-1-4577-2074-1, ISSN 4577-2074 ,2012, pp.1960-1963.

[4] Yogesh Tyal, Ruchika Lamba Subhransu Padhee, "Automatic Face Detection Using Color Based Segmentation", *International Journal of Scientific and Research Publication,*Vol-2, Issue 6, ISSN 2250-3153, June 2012, pp.1-7.

[5] Varsa Power, Aditi Jahagirdar, "Reliable face Detection in Varying Illumination and Complex Background", *IEEE and International conference on Communication, Information & Computing Technology*, ISSN 4577-2078, oct. 19-20, 2012.

[6] Marijeta Slavkovic, Dubravka Jevtic, "Face Recognition Using Eigenface Approach", *SarbianJournalofElectricalEngineering,*vol.9,No.1, DOI:10.2298/SJEE 1201121S, February 2012, pp.121-130.

[7] Hlaing Htake Khaung Tin, "Robust Algorithm for Face Detection in Color Images", *I.J.Modern Education and Computer Science*, vol.2, DOI:10.5815/ijmecs.2012.02.05, 2012, pp.31-37.

[8] Wu-Chih Hu,Ching-Yu Yang, Deng-Yuan Huang and Chun-Hsiang Huang, "Feature based Face Detection Against Skin color Like Backgrounds with Varying Illumination", *Journal of Information Hiding and Multimedia Signal Processing*, vol.2, no.2, ISSN 2073-4212, April 2011,pp.123-132.

[9] Yao-Jiunn Chen,Yen-Chun Lin, "Simple Face-Detection Algorithm Based on Minimum Facial Features", *33rd Annual Conference of the IEEE Industrial Electronics Society,* ISSN 4244-0783 , 5–8 Nov 2007, pp. 455-460.

[10] Mohamed A. Berbar, Hamdy M.Kelash and Amnay A. Kandeel, "Faces and Facial Features Detection in color Images", *IEEE proceeding of the Geometric Modelling and Imaging,* ISSN 7695-2604, 2006.

[11] M.H.Yang, D.J.Kriegman, and N. Ahuja, "Detecting faces in images: a Survey", *IEEE Transaction on pattern Analysis and Machine Intelligence*, vol.24, no.1, ISSN 0162-8828, 2002, pp.34-58.

[12] Renan Contreras, Oleg Starostenko, Leticia Flores Pulido, "An Improved Method for Facial Features Extraction in Images", *IEEE* , 978-0-7695-3320-9, ISSN 7695-3320, 2008, pp.261-266.

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