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A Novel Approach to Face Detection and Feature Extraction using Image Processing

Sunny Shah[1], Ms. Bhavna Pancholi[2]
[1]PG Student, [2]Asst. Professor, Dept of EE,
The Faculty of Technology And Engineering Maharaja Sayajirao University of Baroda, India

Abstract: ***This paper describes a human face detection and feature extraction based on skin color segmentation and geometry of face. The system consists of several stages. First, the system searches for the regions where face might exist by using skin color segmentation. After performing some morphological operation on the skin, it utilizes the aspect ratio of a face to find out possible face block, and then other feature extraction carried out within face block. Features are extracted using the size and the relative position. If system fails to find any of single feature in possible face block, it rejects face block.***
Keywords: ***Face Detection, Feature Extraction, Color Segmentation, Eye Detection, Nose Detection, Lips Detection.***

I. INTRODUCTION

Face detection has received much attention and has been an extensive research topic in recent years. It is the important first step of many applications such as face recognition [1] etc. Recently, techniques achieved in the researches for face detection can be broadly classify as: (i) Template matching methods (ii) Feature based methods (iii) Knowledge based methods (iv) Machine learning. In Template matching [2], final decision comes from similarity between pre register image with input image. In Feature based [3], input image is compared with all of pre registered image and classified as face or non face based on result. In Knowledge based [4], isosceles triangle detected to judging face or non face. In Machine learning [5], trained samples are used to judging face or non face.
Feature extraction [6] are the most important and critical step within image processing. The concept of feature extraction is to look for significant information in image. Eye, Nose, lips component extraction carried out in within face block. The extraction determines distance between components.
In this paper, we propose a novel approach combining feature based and knowledge based for detecting human faces. Firstly skin color segmentation [7] is performed to find skin regions. Secondly, possible face blocks are located based by using restrictions on the regions. Thirdly, features are extracted from detected face block.
The rest of this paper is organised as follows: In section 2, we describe skin color segmentation. In section 3, we describe how to locate face block. In section 4, we describe how to extract features from face block.

II. SKIN COLOR SEGMENTATION

Color is useful piece of information for skin detection. Skin color detection may avoid exhaustive search for faces in image. Here we have combined RGB, Normalized RGB, and HSV color spaces to detect ski pixels. In Normalized RGB, color values (r, g) are defined in equation,

$$r = \frac{R}{(R+G+B)}$$
$$g = \frac{G}{(R+G+B)} \quad \text{where } r+g+b = 1$$

The HSV color space can be represented by the given equation, where hue (H) varies from 0 to 360° , saturation (S) and value (V) varies between 0 to 1.

$$HI = \cos^{-1}\left\{\frac{0.5[(R-G)+(R-B)]}{\sqrt[2]{(R-G)^2+(R-B)(G-B)}}\right\}$$
$$H = HI \quad \text{if } B \leq G$$
$$H = 360^\circ - HI \quad \text{if } B > G$$
$$S = \frac{MAX(R,G,B) - MIN(R,G,B)}{MAX(R,G,B)}$$

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$$V = \frac{MAX(R, G, B)}{255}$$

A pixel is labelled as a skin pixel if its color values satisfy the below equations,

$$R > G, |R - G| \geq 1$$

$$0.33 \leq r \leq 0.6, 0.25 \leq g \leq 0.37$$

$$340 \leq H \leq 359, 0 \leq H \leq 50$$

$$0.12 \leq S \leq 0.7, 0.3 \leq V \leq 1$$

As a result, we can generate a binary map where the white point represent skin pixel and black point represent non skin pixels.

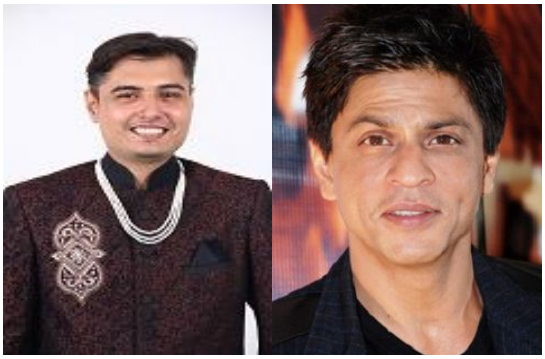

Fig. 1 Original images

Fig. 1 Skin color segmented images

III. LOCATING FACE BLOCK

Firstly we apply median filter for noise removing and morphological opening with size of 3x3 to eliminate small blocks from skin color segmented image. Afterward, utilizing all connected skin regions, each region is labeled by a bounding box.

To locate a face, we use three parameters: Aspect Ratio, Occupancy and Area Size. A bounding box that satisfies all three parameters is regard as face block; otherwise, a non face block.

The first constraint is that the ratio of height to the width of bounding box, denoted by Aspect Ratio, is between 0.8 to 2.6.

The second constraint is that the ratio of the amount of skin pixel to the number of pixels in bounding box, denoted by Occupancy, is greater than or equal to 40%.

The third constraint is the size of bounding box, denoted by Area Size, is greater than 30x30.

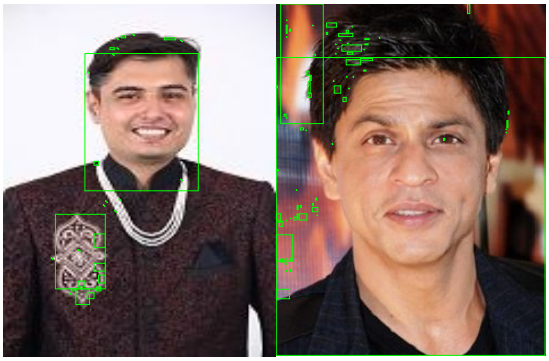

Fig. 3 All skin regions labeled by bounding box

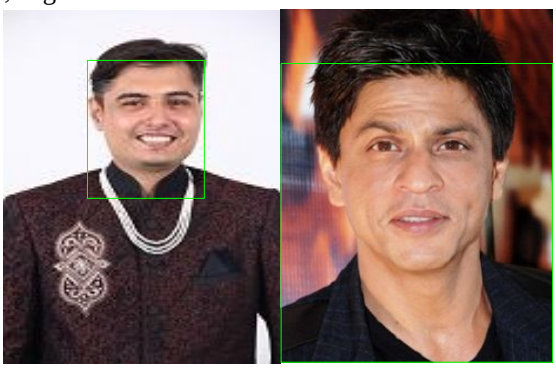

Fig. 4 Face located based on upper criteria

IV. FEATURE EXTRACTION

The face region is further processed to obtain the face component. This is conducted by extracting eyes, nose and mouth components.

A. Locating Eye Block

Firstly connected component perform on negative of skin color segmented image to find all eye like block. Each eye like block is labeled by bounding box. To locate eye, we use three conditions:

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The first condition is that the Aspect Ratio of eye like block must be between 0.2 to 1.67.
The second condition is that the Occupancy must be greater than or equal to 30%.
The third condition is that ratio of width of eye like block to the width of possible face block is between 0.028 to 0.4.

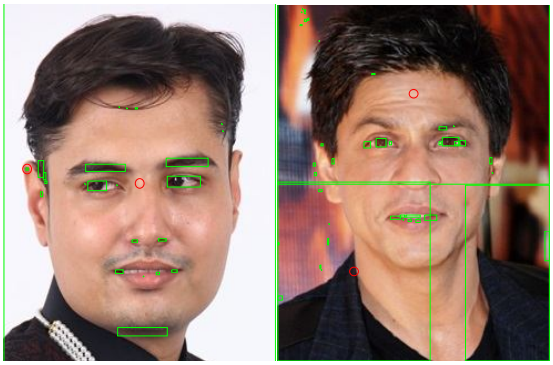

Fig. 5 All eye like labeled by bounding box

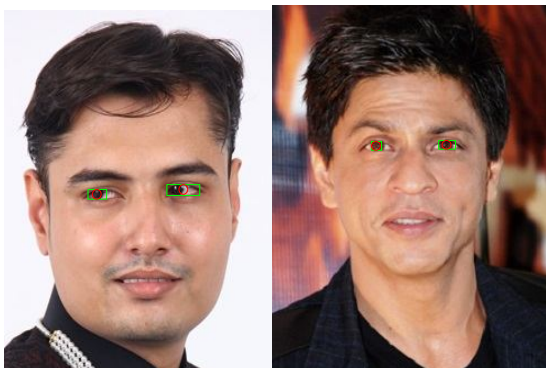

Fig. 6 Eye located based on upper criteria

B. Locating Nose And Mouth Block

Firstly we locate centroid of each of two eyes and calculate horizontal distance between centroid. Based on former researches, nose height and width is determine as shown in equations:

Nose Height = 0.75*V
Nose Width = 0.65*V
Where V = Distance between centroid of two eyes

1) Based on former researches, mouth height and width is determine as shown in equations

Mouth Height = 0.5*V
Mouth Width = V
Where V = Distance between centroid of two eyes

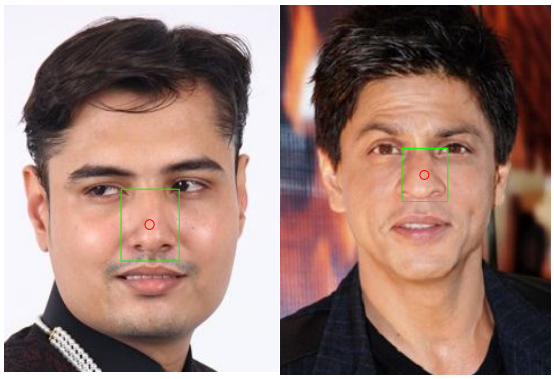

Fig. 7 Nose located based on upper criteria

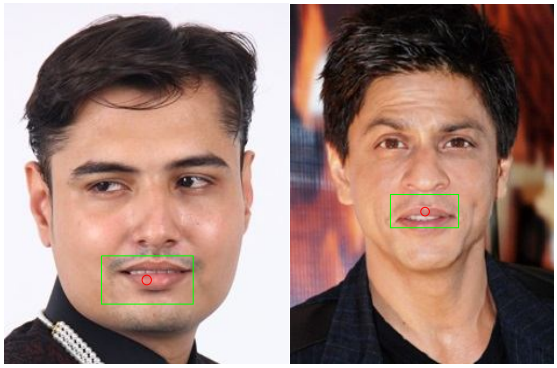

Fig. 8 Mouth located based on upper criteria

V. CONCLUSIONS

This paper proposes human face detection and feature extraction based on skin color segmentation. Proposed system perform better in face detection. Although it still has some problems as stated in the following:

A. Since skin color is use for face detection, if the illumination is too bright or too dark the system would fail in skin color segmentation.

B. Since we determine face component according to location of eyes, when eyes are not successfully detected, the system would fail in detection.

C. In our future work, we would like to solve these problems. For the first problem, we will try to find robust skin detection algorithm. For the second problem, we might try to relax rules of detecting eye pairs.

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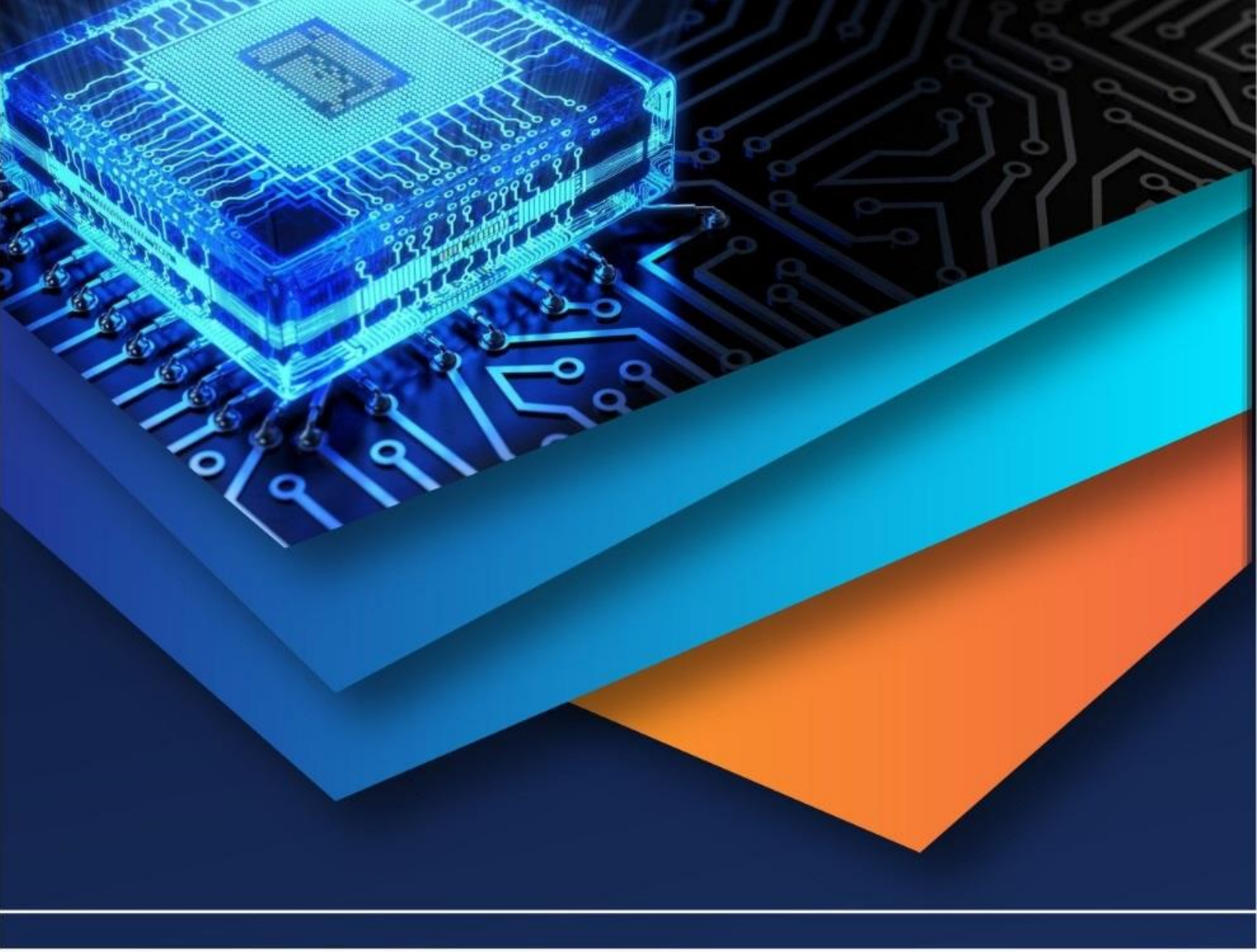

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