Face Clip Detection System Using HSV Color Model

Dhia A. Alzubaydi*
Al-Mustansiriyah University
College of Science
Department of Computer Science
Iraq, Baghdad

Samar A. Yousif
Al-Mustansiriyah University
College of Science
Department of Computer Science
Iraq, Baghdad

Abstract*: Human face detection is concerned with localize human face in given image. Face detection plays an important role in computer vision field. It represents the first step in any automatic face recognition, facial features detection, and expression recognition. The face detection system presented in this paper depends on using features based approach and pixel based, consists of two separate stages, in first stage, after read color face image, extracts boundary rules through using a number of images that contain skin area and the second stage detects and extracts face clip area which consists of five steps after read color face image, first step is converting to HSV color space, in second step, the extracted boundary rule is apply to obtain skin color area, noise removal using median filter is the third step, in fourth step localize the position of skin area in image and finally remove unnecessary parts and extract face clip. The proposed system tested on dataset consists of 300 images for 30 persons for each person 10 images in different cases (front view, rotate to left, rotate to right , more than one expression and pose), the background not the same in all images. Also, the proposed system tested on different image randomly selected form internet. In experiments our system has achieved high detection rates (94.66%) to localize and extract a human face clip.

Keywords— Face Detection, HSV Color Space, Features based approach

I. INTRODUCTION

Detection of the human face is an first and important step in many application of computer vision and biometric applications, many of research are being carried out. The most important step in any of these systems is the accurate detection of the presence and position of the human face in an image. Detection rate is the ratio between the number of faces correctly detected by the system and the numbers of false detect [1]. This is the most awaited technology, which can be applied to many aspects of daily life. The main challenge in face detection is to cope with a wide variety of variations in the human face such as face pose and scale, face orientation, facial expression, ethnicity 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 [2], [8]. In this paper, we present face detection system used feature based approach based on skin color and pixel based model for detect skin area in face image.

II. FACE DETECTION APPROACHES

This section, reviews existing techniques to detect faces from a single intensity or a color image. The single image detection methods can be classified into four categories [3].

A. *Knowledge-based Methods:* These rule-based approach encode human knowledge of what represent a typical face. Usually, the rules capture the relationships between facial features. These methods are designed mainly for determine face position in image.

B. *Feature based Approaches:* This approach aim to determine structural features that exist even when there are vary in pose, orientation, or lighting conditions, and then use these to locate faces. These methods are also designed mainly for face localization [9].

C. *Template Matching Methods:* Many standard patterns of a face are stored to illustrate the face as a whole, or describe the facial features separately. The correlations between an input image and the stored patterns are computed for detection. These methods have been used for both face localization and detection.

D. *Appearance-based Methods:* In conversely to template matching, the models (or templates) are learned from a set of training samples images, which should acquirement the representative variability of facial appearance. These learned models are, then, used for detection. These methods are designed mainly for face detection.

III. HSV COLOR MODEL FOR SKIN COLOR CLASSIFIACTION

The researches on human skin color classification have gained expanding consideration in recent years due to the dynamic research in content-based image representation. Case in point, the capacity to locate image object as a face can be exploited for image coding, editing, indexing or other user interactivity purposes. Hence, skin color classification has become an important task. Many of the researches in features based (skin color) based face localization and detection is based on using normalize RGB, YCbCr and HSV color spaces. HSV color model based presented when there was a need to detail color properties numerically; they describe color with intuitive values, based on concept of tint, saturation and tone. Hue defines the dominant color (such as red, green, and blue) of region; saturation measures the colorfulness of an area in proportion to its brightness. The intensity, lightness or value is related to the color luminance as explain in Fig. 1.

The intuitiveness of the color space components and explicit discrimination between luminance and chrominance properties made these color spaces popular in the works on skin color segmentation. The equations (1), (2), and (3) represent transformation rules to obtain the (H, S, V) values from RGB color space [4], [5],[7].

$$H=\begin{cases}\left(\frac{G-B}{Max-Min}\right)/\ 6 & if\ R=Max\\ \left(2+\frac{B-R}{Max-Min}\right)/\ 6 & if\ G=Max\\ \left(4+\frac{B-R}{\quad}\right)/\ 6 & if\ R=Max\end{cases} \quad \ldots (1)$$

$$S=\left(\frac{Max-Min}{Max}\right) \quad \ldots (2)$$

V= Max … (3)

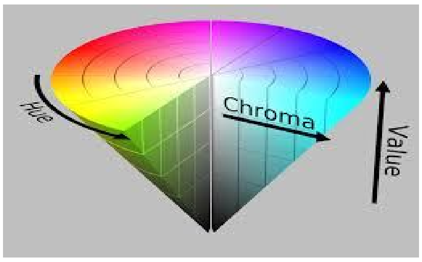


Fig. 1 HSV color space

IV. PROPOSED SYSTEM

Using skin color as a main feature for localize face area has several advantages. In particular, processing color is much faster than processing other kind of facial features. Also color information is invariant to face orientations, variant pose, expression and occlusion. This paper presents a model to detect human face in color image by using HSV color space. This work, after read the color face image as bmp file format is divided into two independent stages. First stage extracts rules through using a number of images that contain skin area and the second stage detects and extracts face clip area. In first stage a number of color images are using. These images are converted into HSV color space. After that compute the color values of skin area, by drawing a histogram for each color of HSV color space, through it, to determine the numbers that will help us to extract the rules which would be used to classify all image pixels into skin or non-skin color. As illustrated in Fig. 2.

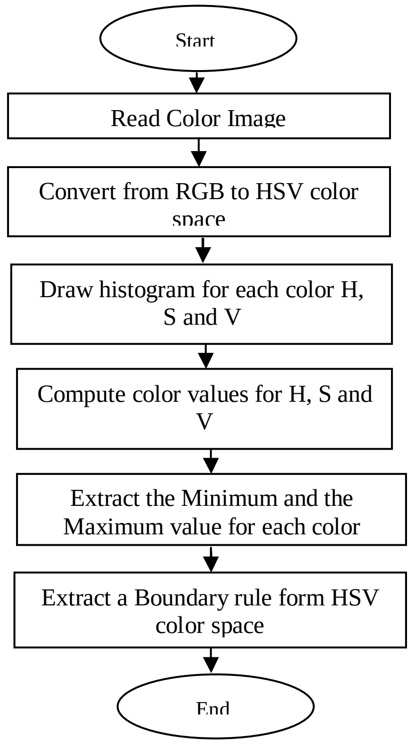


Fig. 2 First Stage explain Rule Determination

Second stage includes entering color image then convert it into HSV image, after that, the extracted rules from first stage are used to classify the pixels of the image into skin or non-skin color. Then remove the pixels that represent noise from image by applying medium filter. After that the segmented skin pixels area is localizing by determine main four points. Finally unnecessary parts can be removed to extract the face clip. Fig. 3 illustrates the steps.

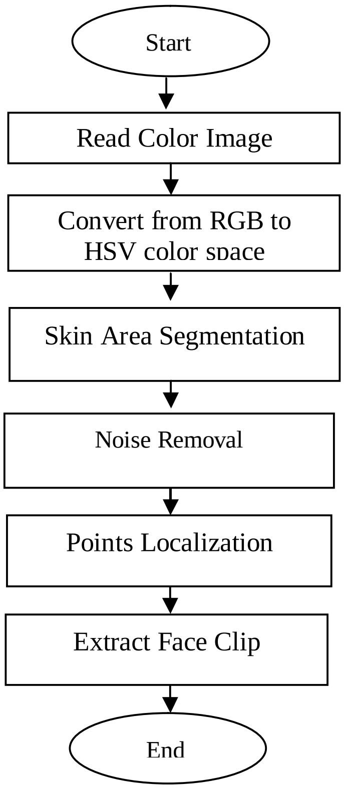


Fig. 3 Second Stage Extract Face Clip

A. Convert from RGB to HSV Color Model

In RGB color space too great change in color values might not be detected by a human observer as shown in Fig. 4. Therefore, this color space is not suitable for skin detection, for this reason, HSV color space which is suitable for representing human skin color have been applied in the proposed system as shown in Fig. 5. This step aim to determine skin area in face image by first convert RGB to HSV color space and second extract certain boundary rules to determine the skin area.

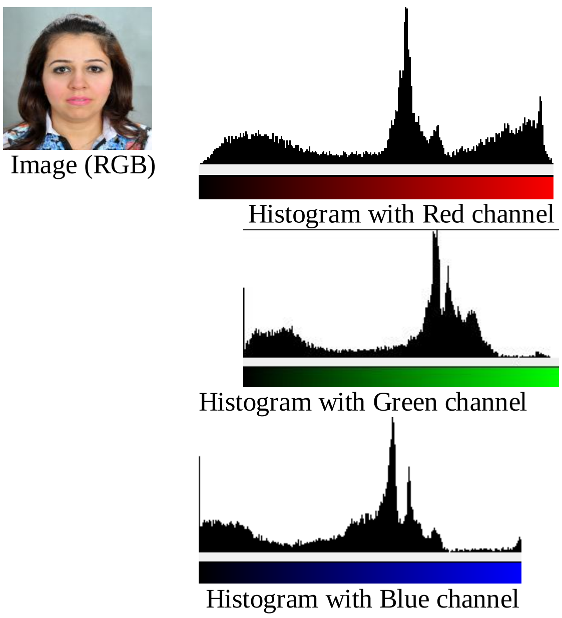


Fig.4 Histogram Distribution of color Face Image

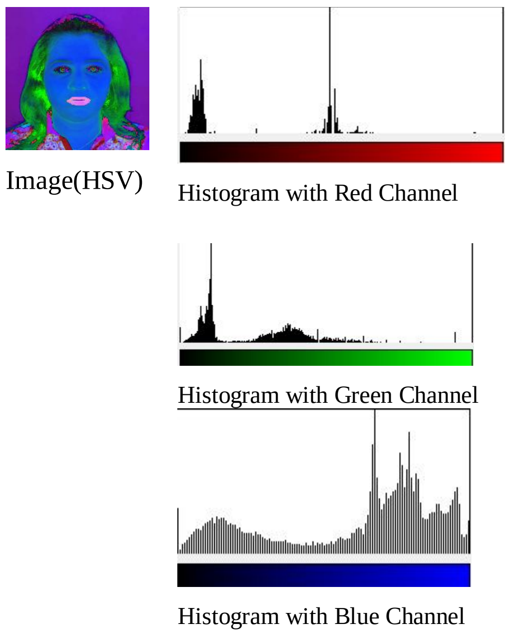


Fig. 5 Histogram Distribution of Face Image in HSV color space (Red= H, Green= S, Blue= v)

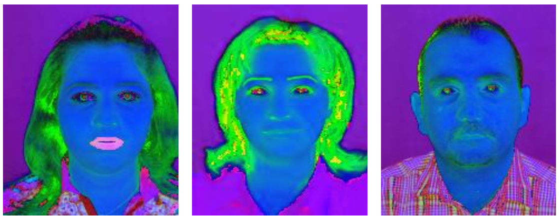
B. Skin Color Area Segmentation

From the skin color subspace analysis, a set of bounding rules is derived from the HSV color space, based on our training observations. All rules are derived for intensity values between 0 and 255, based on the observation that the HSV subspace is a strong discriminates of skin color; the hue values exhibit the most noticeable separation between skin and non-skin areas. We estimated three cutoff levels as the H, S and V subspace skin boundaries, 3 bounding rules that enclosed the HSV skin color region are formulated as below:

$$\begin{array}{l} (H > 0) \text{ and } (H < 40) \text{ and} \\ (S > 30) \text{ and } (S < 160) \text{ and} \\ (V > 150) \text{ and } (V < 255) \end{array} \quad \ldots (4)$$

Therefore, each pixel that achieves equation (4) is classified as a skin color pixel; Fig. 6 shows examples of face skin color detection.

(a)



(b)

Fig. 6 Face Skin Area Segmentation: (a) After convert face image to HVS color space (b)After apply bounding detection rule

C. De-Noise

Medium filter used to reduce the noise pixels that may appear after classifying the pixels that are not skin and to enhance the image. The median is just the middle value after ascending all the values of the pixels in the neighbourhood; the median has half the values in the neighbourhood larger and half smaller [6]. Fig. 7 shows samples of the input noisy images and the produced smooth images. The size of applied median filter is (3x3), and is applied three times to obtain an acceptable result.

(a)

(b)

Fig. 7 Face Image De-nosing:(a) The input noisy faces images (b) The faces images after De-Noising

D. Face Localization

The aim of this stage is determine the position of face clip in the face image. This is done by determine four main points. Determine the position of skin area in order to localize interest clip in test face image, which based on checking the skin area coordinates arrays in order to find the minimum and maximum points.

In this scanning, the minimum and maximum values of x and y-coordinates (the margins of the skin area) are registering, the minimum and maximum x values represent the left and right margin, while minimum and maximum y values represents the top and bottom margins, respectively, Fig. 8 presents a sample explain the localization of face skin area. Algorithm (1) explain the implemented steps

ALGORITHM 1: POINT LOCALIZATION

```
INPUT: IMAGEPIXELS(4 ,0 TO WID-1, 0 TO HGT-1).SKINHSV // SKIN COLOR AFTER DE_NOISE
OUTPUT: MAXLEFTX ,MINRIGTHX , MAXTOPY, MINBOTTOMY // POINT LOCALIZATION
Step 1: find location MaxLeftX ,MinRigthX
        Set MaxLeftX ← 0
        Set MinRigthX ← Hgt
  For all X, Y Do {where 0 to Wid-1, 0 to Hgt-1}
         If ImagePixels(4, X, Y).SkinHSV = 255 Then
             If X >= MaxLeftX Then
               Set MaxLeftX← X
                 Set MaxLefty ← Y
              For all K do { where Wid - 1 to 0 Step -1}
                 If ImagePixels(4, K, Y).SkinHSV = 255 Then
                    If k <= MinRigthX then
                    Set MinRigthX ← K
                       Set MinRigthy ← Y
               End If
            End For
         End If
    End For
Step 2: find location MaxTopy , MinBottomy
      Set MaxTopy← 0
      Set MinBottomy← Wid
         For all Y, X Do {where 0 to Hgt-1, 0 to Wid-1}
          If ImagePixels(4, X, Y).SkinHSV = 255 Then
            If Y >= MaxTopy then
             Set MaxTopy← Y
             Set MaxTopx ← X

           For all K Do { where Hgt-1 to 0 Step -1}
               If ImagePixels(4, X, K).SkinHSV = 255 Then
                If K <= MinBottomy then
                Set MinBottomy← K
                Set MinBottomx← X
             End If
           End For
         End If
    End For
End.
```

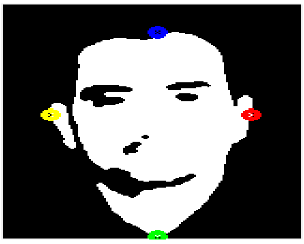


Fig. 8 Point Localization

- Point (MinTopX, MinTopY)
- Point (MaxBottomX, MaxBottomY)
- Point (MinRigthX, MinRigthY)
- Point (MaxLeftX, MaxLeftY)

E. Clipping face

The clipping face represent the final step in the proposed system, the purpose of this step is obtain face clip, without unnecessary parts like right ear, left ear, neck and Palate as in Fig. 9 below.

The process of removing all unnecessary parts from the face depending on computing the percentage of white to black, the minimum ratio of white value to the black value for all pixels in the area. The minimum ratio from left to remove left ear and from right to remove right ear, also from bottom to remove neck and palate. Algorithm (2) explain the implemented steps

ALGORITHM 2: DETERMINE FACE CLIP

```
Input: ImagePixels(4 ,0 to Wid-1, 0 to Hgt-1).SkinHSV // Skin Color
       MaxTopy, MinBottomy,  MaxLeftX,  MinRightX, Wid, Hgt
Output: C_F_ Hgt, C_F_ Wid // Height and width of  Face Clip
Step 1: eliminate unnecessary part from the left
       Set xPerMax←100
       For all Y Do {where MinBottomy to MaxTopy}
        Set CDistanc ← Int((MaxLeftX - MinRigthX) / 2) + MinRigthX
         For all X Do {where MaxLeftX to CDistanc }
              Set countx ← 0
           For all K Do {where MinBottomy to MaxTopy}
             If ImagePixels(4, X, k).SkinHSV = 255 Then
               Set countx ← countx +1
           End For
              Set per ← Int((countx / (MaxTopy - MinBottomy)) * 100)
           If per <= xPerMin Then
                 Set xPerMax ←per
                 Set MinLocx ← X
           End If
         End For
       End For
        Set MaxLeftX← MinLocx
Step 2: eliminate unnecessary part from the right
     Set xPerMax←100
     For all Y Do {where MinBottomy to MaxTopy}
        Set CDistanc← Int((MaxLeftX - MinRigthX) / 2) + MinRigthX
        For all X Do {where MaxLeftX to CDistanc }
          Set countx ←0
           For all K Do {where MinBottomy to MaxTopy}
             If ImagePixels(4, X, k).SkinHSV = 255 Then Set countx← countx + 1
        End For
        Set  per ← Int((countx / (MaxTopy - MinBottomy)) * 100)
        If per <= xPerMax Then
          Set xPerMax ← per
          Set MaxLocx ← X         End If
    End For
   End For
Set MinRigthX ← MaxLocx
Step 3: eliminate unnecessary part from the bottom
        For all J Do {where MaxTopy to Wid ,Step -2}
         Set mask(1) ← ImagePixels(4, CenterX, j).SkinHSV
         Set mask(2) ← ImagePixels(4, CenterX - 1, j - 1).SkinHSV
         Set mask(3) ← ImagePixels(4, CenterX - 1, j).SkinHSV
         Set mask(4) ← ImagePixels(4, CenterX - 1, j + 1).SkinHSV
         Set mask(5) ← ImagePixels(4, CenterX, j + 1).SkinHSV
         Set mask(6) ← ImagePixels(4, CenterX + 1, j + 1).SkinHSV
         Set mask(7) ← ImagePixels(4, CenterX + 1, j).SkinHSV
         Set mask(8) ← ImagePixels(4, CenterX + 1, j - 1).SkinHSV
         Set mask(9) ← ImagePixels(4, CenterX, j - 1).SkinHSV
         Set coutw ← 0
       For all m Do {where 1 to 9}
        If mask(m) = 255 Then
```

```
        Set coutw ← coutw + 1
      End for
      If coutw = 9 Then
     Set  MaxTopy ← j
       Exit For
      End If
      End for
Step 4: Cutouts face clip
   Set C_F_Wid←0
   For all i Do {where MinRigthX to MaxLeftX }
      Set  C_F_ Hgt←0
     For all j Do {where MinBottomy to MaxTopy }
     Set ImagePixels(0, C_F_Wid, C_F_ Hgt).ClipFace ← ImagePixels(0, i, j).Value
     Set ImagePixels(1, C_F_Wid, C_F_ Hgt).ClipFace ← ImagePixels(1, i, j).Value
     Set ImagePixels(2, C_F_Wid, C_F_ Hgt).ClipFace ← ImagePixels(2, i, j).Value
     SetImagePixels(4,C_F_Wid,C_F_Hgt).ClipSkinHSV←ImagePixels(4,i, j).SkinHSV
     Set C_F_ Hgt← C_F_ Hgt+1
    End for Set C_F_ Wid ← C_F_ Wid +1
     End for
   END.
```

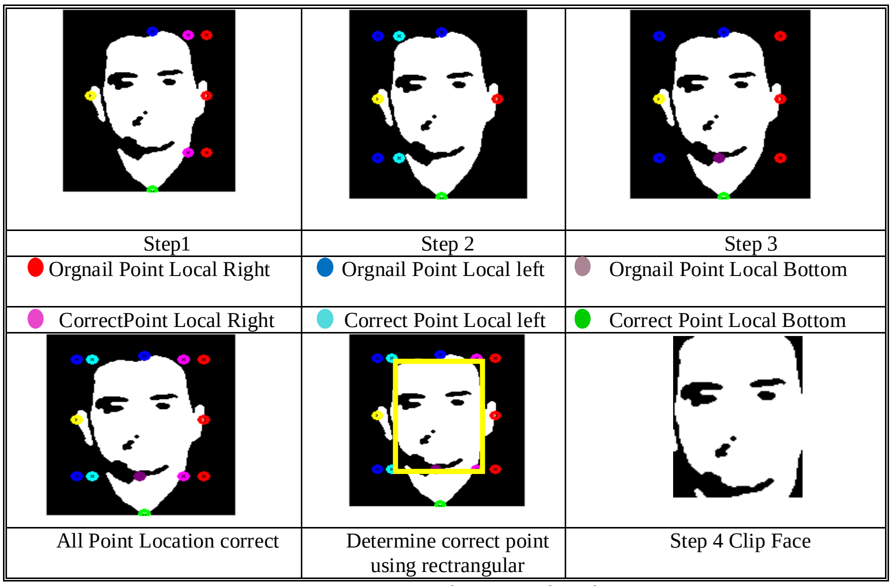


Fig. 9 Explain the steps of obtaining final face clip

V. EXPERIMENTAL RESULT

The proposed system applied on Dataset consists of 300 images for 30 persons for each person 10 images in different cases (front view, rotate to left, rotate to right, more than one expression and pose), the image is read as BMP 24 bit/pixel (bit depth), its size is 320×500 pixels. As shown in Fig. 10. In experiments our system has achieved high detection rates (94.66%) to localize and extract a human face clip. The face detection system was implemented using Windows-7 operating system, laptop computer (processor: Intel Pentium Dual CPU T230, 1.60 GHz, and (2GB) RAM.

To evaluate our experiments, we defined performance metric to gauge the success of our proposed system. Detection Success Count (DSC) is defined as the number of correctly detected faces over the actual number of faces in the image.

$$DSC = \frac{\text{no. of correctly detected faces}}{\text{Total number of faces}} \times 100\%$$

TABLE (I)
EXPLAIN DETECTION RATE OF FACE CLIP

Case	No. of Face Image	No. of False Detect	DSC %
Front view	60	0	100
Rotate to left	60	6	90
Rotate to Right	60	8	86.66
Different pose and expression	120	2	98.33
Total Image	300	16	94.66

VI. CONCLUSIONS

In this paper, we have introduce a model to detect and extract face in color image, by utilizing HSV color space which demonstrated clearer discrimination between skin and non-skin regions. Skin region segmentation was performed using a certain boundary rules derived from the HSV color space, based on our training observations, The experimental results, showed that our new approach in modeling skin color was able to achieve 94.66% rate of accuracy rate. It can be noticed that the model is able to separate the skin regions from the back grounds.

As shown in the test images in Fig. 10 the proposed system succeed in detecting face in different cases (frontal view, rotate to left, rotate to right, pose and expression). Also, Fig. 11 shows the test results of proposed system on images were randomly selected from the Internet.

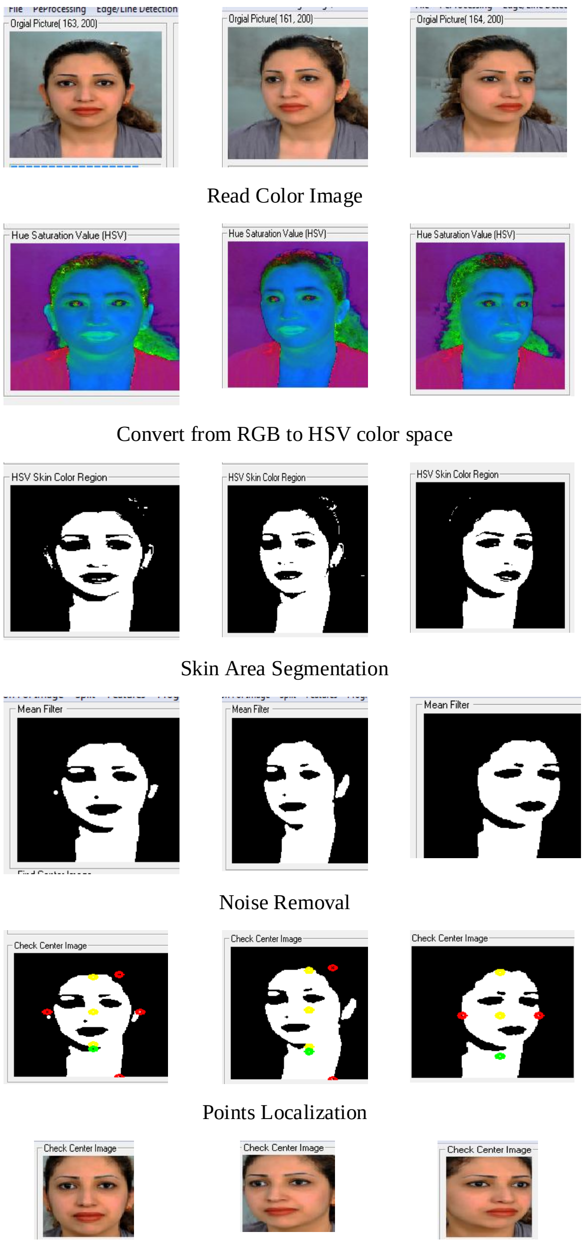


Fig. 10 Explain the steps of applying the proposed system on Dataset

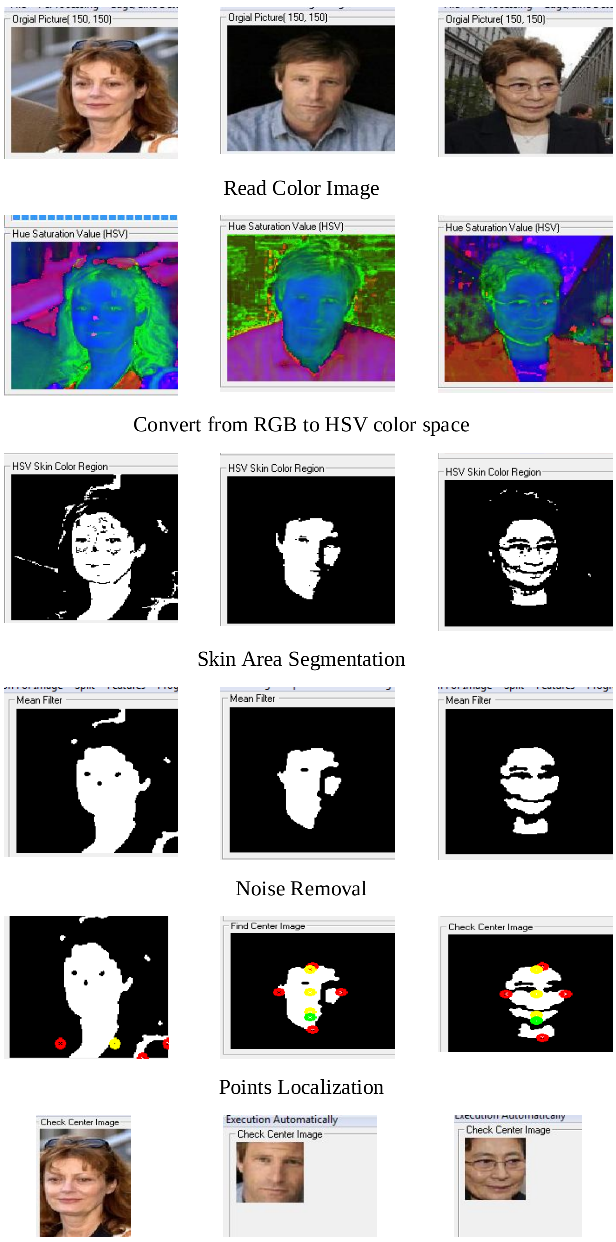


Fig. 11 Explain the steps of applying the proposed system on different samples

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