Image Segmentation for the Extraction of Face using Haar like Feature

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Abstract: *The segmentation of an image for the extraction of face is complex task. This paper presents a method for segmenting image for the extraction of human faces. The method is based on Haar Like Features (HLF) and it starts with skin colour detection in an input image. Then skin region is further processed by finding connected components and holes. Each connected component is tested to extract eye like holes by finding circularity and area. Each eye like holes is tested by comparingc correlation coefficient to confirm as eyes. If eye like features exist in the connected component then the rectangular box is drawn to enclose each eyes, nose and mouth like region based on the distance parameter between two eye like holes. Then HLF is detected by finding integral image. Based on the comparison of haar difference and test rules, the final verification of each connected component as face is done. The detected face is enclosed in rectangle box using distance parameter of the line between two eyes. The proposed method is tested on Bao face database and experimental results shows that the method is effective and achieves better accuracy of face detection and has low error rate as compared to Viola-Jones [19] and combining Haar feature and skin colour based classifiers [2].*

Keywords: *Skin color, connected component, holes, HLF, haar, integral image.*

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1. Introduction

Image segmentation is the partitioning of digital image into multiple segments based on intensity, color, texture, depth, motion etc. The segmentation of image for the extraction of human face is complex task. Detecting faces is a prerequisite for face recognition and facial expression analysis. The methods for face recognition analyze the position, size, and shape of the eyes, nose, cheekbones, and jaw. These features are then used to find other images with matching features for face recognition.

Human eye is one of the salient features of the human face and plays an important role in face recognition and facial expression analysis. Eyes can be considered prominent and relatively constant feature on the face in comparison with other facial features. Therefore, to detect facial features, it is advantageous to detect eyes before the detection of other facial features. The position of other facial features can be estimated using the eye position.

Haar like features is based on the concept of Haar wavelets. Haar features are used for visual recognition task. These features are determined by subtracting the average dark-region pixel value from the average light-region pixel value. The feature is said to be present if the difference is above a threshold. An integral image is used to find haar feature. Integral image at location (x, y) is the sum of all pixel values in an input image that lies above (x, y) and to the left of (x, y).

In this paper, we propose an image segmentation method for the extraction of face using haar like features. The paper is organised as follows. In section 2, related methods are reviewed. Section 3 gives the detailed description of our method, which includes the description of skin color detection, connected component region, eye like hole detection and haar like feature detection to extract face. Section 4 presents the experimental results and section 5 compares our method with existing methods. The conclusions are drawn in section 6.

2. Related Works

Face detection based on a new color space Luminance; Chroma: Green; Chroma: Red (YCgCr) [1] detects face by color segmentation. Face detection and facial feature extraction using color snake [14] detects face by estimating face region and template matching method. And then extract facial feature using color snake model. Face detection using rectangle features and Support Vector Machine (SVM) [21] finds integral image and rectangle features. Face is finally detected by face candidate selection and verification.

Domain specific view for face perception [9] performs a skin color analysis of the image. Then, random measurements are generated to populate the entrant face region according to the face anthropometrics using the eye location determined from the YCbCr color space. The detection using geometrical facial feature gives 96% accuracy for detecting frontal faces in color images.

Fast head tilt detection for human-computer interaction [20] is based on foreground and background segmentation. It is composed of four steps. Firstly, the method performs the analysis of the motion of the occluding boundary of the face to get head tilt estimate. Then, analysis of the motion of the center of the face is done to compute angle estimate. Finally, analysis of the confidence factor that determines the weighting of the two estimates in computing the final head tilt estimate.

A simple and efficient eye detection method in color images [17] finds skin color and then detects eyes by finding ellipse major axis, minor axis and its orientation. Eye detection algorithm on facial color images [10] developed method to detect eyes by constructing eye map and performs geometrical test like eyes-centre distance test, eye-pair distance test, eye angle test, eye shape test.

Facial feature detection using Haar classifiers [22] uses adjacent rectangular groups of pixel values based on contrast values to detect faces. Face tracking based on HLF and Eigen faces [8] is based on haar like features and Eigen images and Principal Component Analysis (PCA) are used in the recognition stage of the system. Multi-pose face detection with asymmetric Haar features [13] builds classifiers more accurate than other features. It uses skin color segmentation and genetic algorithm to generate feature set.

Combining Haar feature and skin color based classifiers for face detection [2] presents a hybrid method for face detection in color images based on Haar feature-based face detector developed by Viola and Jones [19, 18] and a skin-colour filter. The image is first passed through a Haar-feature based face detector and then using the skin color post-filtering method many of false detections can be eliminated easily.

3. Method

The proposed method segments the image by extracting human faces by finding the facial features.

3.1. Skin Color and Connected Component Region

Image is segmented by separating human skin regions from non-skin regions based on colour. A reliable skin colour [5, 6, 9, 16] and Gaussian model [15] that is adaptable to people of different skin colors and to different lighting conditions is used. The connected components may be face or other skin area of human like hand, neck etc. We find number of holes [12] in each connected component to detect whether the connected component contains face or not.

3.2. Each Accepted Region is Tested for Facial Feature (Testing Each Component for Face)

3.2.1. Phase 1 (For Detecting Eye Like Holes Having Similar Features)

Find all holes in a connected component perform circularity test [5] on each of these holes and also find the area and sum of pixels in each hole of that component. Find XY-coordinate value of all holes. The compactness of continuous geometric figure [9] is given by:

$$(Perimeter\text{^}2/Area)>=4\pi \tag{1}$$

More compact a region is more is area enclosed for the given perimeter. Based on this, circularity test is performed.

$$Circularity=Perimeter\text{^}2/4 * \pi *Area \tag{2}$$

Threshold value for both eyes circularity value is decided by performing sample testing on 50 images. The complete comparison of circularity and XY value is shown in Table 2 [5]. Find those holes whose circularity test value lies within the threshold value and also having same Y-value. If the face is straight then we get two such holes, and these holes are confirmed as eyes or eyebrows with same Y-value. The eye or eyebrow like holes have almost equal sum, area, black pixel count and Y- value as shown in Table 3 [5]. By these testing’s, we can conclude that these holes may be eyes and considered for phase 2 to confirm as eyes.

3.2.2. Phase 2 (to Confirm Detected Holes as Eyes)

3.2.2.1. Finding Correlation Coefficient

The two holes detected in each connected component in phase 1 is further tested to confirm as eyes. This is done by comparing correlation coefficient between two holes. The holes in the color input image are found using the coordinate values of two eye like holes detected in previous phase. Find the correlation coefficient between two holes in the color image. Correlation coefficient is a measure that determines the degree to which two variable’s movements are associated. Color image contains RGB values. Correlation coefficient is obtained by considering three colors separately. If this coefficient is greater than 0.7 for red, green and blue color separately then we can conclude that the detected holes are eyes.

$$r=\frac{\sum\sum(A_{mn}-A')(B_{mn}-B')}{\sqrt{\left[\sum_{m}\sum_{n}(A_{mn}-A')^2\sum_{m}\sum_{n}(B_{mn}-B')^2\right]}} \tag{3}$$

Where A_{mn} and B_{mn} are the matrices of m rows and n columns; A' and B' are the mean of the values in A_{mn} and B_{mn} respectively. The A_{mn} and B_{mn} are the matrices of two eyes like holes in the color image detected in previous phase.

Due to lighting and other background parameters, the holes which are actually eyes may not be highly correlated. The reason behind taking the value of correlation coefficient exactly greater than 0.7 is to accept all those connected component in which two holes are likely to be eyes.

If we take high value of correlation coefficient (such as >0.9), there is possibility of rejecting connected components containing holes which are actually eyes. This increases the false rejection and therefore such high values of correlation coefficient are not taken. The correlation coefficient below 0.7 will not only consider all connected component in which eye like holes are present but also those connected component in which eye like holes are not present. Therefore, all such non face connected components which does not contains eye like holes are also unnecessarily considered for further testing using HLF. This will increase the search space and the search time and therefore the value of correlation coefficient below 0.7 is not taken.

3.3. Draw Rectangle Box

Once straight face is obtained, calculate the distance w from the minimum x-value of left eye to maximum x-value of right eye. Draw the rectangle box enclosing two eyes of length w and width w/3 from the centre of eyes and draw vertical rectangle box enclosing nose and mouth as shown in the Figure 1. If the nose and mouth is not visible in the image, then also draw the vertical rectangle of length w and width w/3.

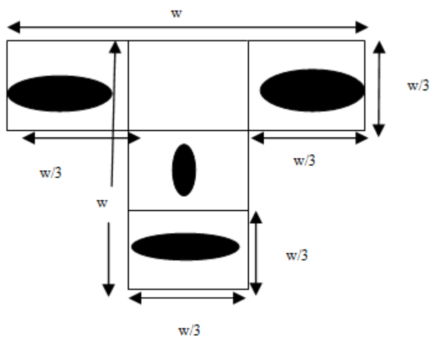


Figure 1. Rectangle box enclosing holes.

3.4. Confirmation of the Connected Component Containing Eyes Detected in Previous Phase as Face

Find integral image to detect Haar like features of that connected component in color image which contains eyes. Haar like features contains rectangle combinations for the recognition tasks. The presence of a Haar feature is determined by subtracting the average dark-region pixel value from the average light-region pixel value. If the difference is above a threshold, that feature is said to be present. To determine the presence or absence of hundreds of Viola and Jones technique called an integral image is used to detect Haar like features [18, 19]. The integral value for each pixel is the sum of all the pixels above it and to its left. Starting at the top left and traversing to the right and down, the entire image can be integrated with a few integer operations per pixel. The two rectangle combinations for Haar difference is shown in Figure 2.

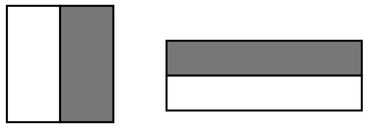


Figure 2. Two rectangle combinations for Haar difference.

3.4.1. Integral Image

Every pixel is the summation of the pixels before it. Integral image at location (x, y) is given by:

$$ii(x, y)=\sum p(x', y') \text{ for all } x'\leq x \text{ and } y'\leq y$$

AI, BI, CI and DI are the integral sum of the pixel values as shown in Figure 3.

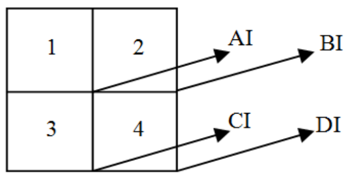


Figure 3. Integral sum.

- AI=sum of pixel in box 1.
- BI=Sum of pixel in box 1 and 2.
- CI=Sum of pixel in box 1 and 3.
- DI = sum of pixel in box 1, 2, 3 and 4.
- Sum of the pixel in box 1=AI.
- Sum of the pixel in box 2= BI-AI.
- Sum of the pixel in box 3=CI-AI.
- Sum of the pixel in box 4=DI-BI-CI+AI.

3.4.2. Finding Haar Difference

The sum of pixels of the each rectangle box is in R_1, R_2, R_3, …, R_9 respectively as shown in Figure 4 using integral image.

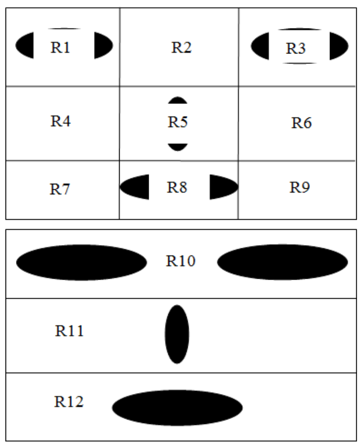


Figure 4. Rectangle box R1 to R9 and horizontal rectangle box R10 to R12.

The three horizontal rectangles are drawn enclosing both eye like holes, nose and mouth as shown in Figure 3. The value R_{10}, R_{11} and R_{12} is:

$$R_{10}=R_1+R_2+R_3 \quad (4)$$

$$R_{11}=R_4+R_5+R_6 \quad (5)$$

$$R_{12}=R_7+R_8+R_9 \quad (6)$$

The Haar difference H_1 to H_{11} and rules from C_1 to C_{17} is defined in Table 1.

Table 1. Haar difference and rules.

Haar Difference	Test Rules
$Hd_1 = R_1-R_4$	C_1:$Hd_1<0$
$Hd_2 = R_1-R_2$	C_2:$Hd_2<0$
$Hd_3 = R_3-R_6$	C_3:$Hd_3<0$
$Hd_4 = R_3-R_2$	C_4:$Hd_4<0$
$Hd_5 = R_4-R_5$	C_5:$Hd_5\geq0$
$Hd_6 = R_6-R_5$	C_6:$Hd_5=Hd_6$ by T_1 (threshold value)
$Hd_7 = R_7-R_8$	C_7:$Hd_6\geq0$
$Hd_8 = R_9-R_8$	C_8:$Hd_7\geq0$
$Hd_9 = R_{10}-R_{11}$	C_9:$Hd_8\geq0$
$Hd_{10} = R_{10}-R_{12}$	C_{10}:$Hd_7=Hd_8$ by T_2 (threshold value)
$Hd_{11} = R_{11}-R_{12}$	C_{11}:$Hd_9<0$
	C_{12}:$Hd_{10}<0$
	C_{13}:$Hd_{11}\leq0$

Test all rules from C_1 to C_{13}. Based on the Haar difference, threshold value is decided. If we get positive result at least eleven conditions of the condition verification table shown in Table 6, then the given connected component of the input image can be concluded as face.

3.5. Enclosing the Face by Rectangle

Once the component is concluded as face, then we enclose the face by drawing rectangle box. The distance between two eyes is w. The rectangle box enclosing eyes, nose and mouth shown in Figure 5 does not cover the complete face. The left portion of face is included by reducing the left most coordinate of rectangle box R1 by w/3 as shown in Figure 5 and the right portion of face is included by increasing the rightmost coordinate of rectangle box R3 by w/3 as shown in Figure 5. The forehead portion of the face is included by reducing the top coordinate value by w/3 and the portion below mouth is included by increasing the bottom coordinate value by w/3 as shown in Figure 5.

$$Left=left-w/3 \quad (7)$$

$$Right=right+w/3 \quad (8)$$

$$Top=top-w/3 \quad (9)$$

$$Bottom=bottom+w/3 \quad (10)$$

Where (w is distance value between two eyes).

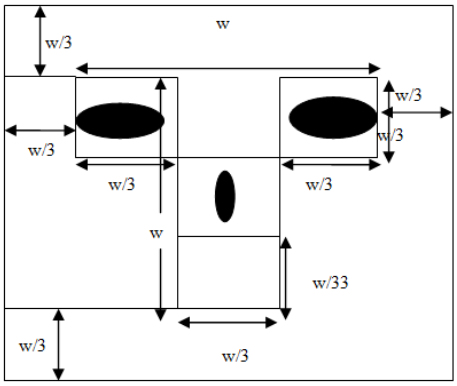


Figure 5. Face enclosed by rectangle.

4. Experimental Results

Experiments are performed on 50 images [3, 4, 6] of which 10 images contain multiple faces. We have implemented the method on an Intel Core 2 Duo/1.66 GHz processor with Microsoft Windows XP operation system and Matlab. The method is tested on Bao face database [3]. We performed training by repeated testing on 50 images and concluded the conditions of condition verification table. This method gives very good result for detecting faces on image. This method has failed in some cases where there is problem in detecting exact eye location of two eyes. Due to which false detections still exists. The comparison of circularity and XY-value is shown in Table 2 and feature value is shown in Table 3. The true set 1 shown by pink color and true set 2 shown by blue colour are two sets of holes having nearly same circularity test value: Condition a and nearly same Y-value: Condition b as shown in Table 2. These two sets are further tested by finding feature values for confirmation of eyes.

Table 2. Comparison of circularity and XY value.

Hole Number	Minimum X-Value	Maximum X-Value	Minimum Y-Value	Maximum Y-Value	Circularity Test Value Condition 1	Same Y-Value Condition 2	Decision Value Based on Condition 1 and 2
1	1	406	1	264	1.7200	False	
2	173	190	97	101	1.3259	Hole number 2 and 5	True set 1
3	180	189	107	112	1.3258	Hole number 3 and 6	True set 2
4	200	205	145	147	1.3254	False	
5	211	231	98	102	1.3260	Hole number 2 and 5	True set 1
6	213	224	106	112	1.3259	Hole number 3 and 6	True set 2
7	248	250	129	131	1.3252	False	

The hole number 2 shown in second row and hole number 5 shown in fifth row of the Table 2 is identified as true set 1. The minimum Y-value of hole number 2 is 97 and that of hole number 5 is 98. The maximum Y-value of hole number 2 is 101 and that of hole number 5 is 102. The circularity value of hole number 2 is 1.3259 and that of hole number 5 is 1.3260.

The minimum Y-value, maximum Y-value and circularity value of hole number 2 and 5 are nearly same and hence these holes are identified as true set 1. Similarly true set 2 is found. The True set 1 is shown by pink colour and true set 2 shown by blue color in Table 2 are two sets of holes satisfying the circularity and XY-value condition. These two sets are further tested by finding feature values for confirmation of eyes.

The two sets of similar holes are identified as true sets 1 and 2 from Table 2. The eye like hole is either the hole pair shown by true sets 1 or 2. The hole pair is confirmed as eye pair by comparing the feature value of hole pair of true sets 1 and 2. The feature value of hole pair is computed by finding black pixel count, sum of pixel values, area of hole as shown in Table 3 to confirm the holes as eyes.

Table 3. Comparison of feature value.

Feature Value	Left Eye Brow	Right Eye Brow	Left Eye	Right Eye
Circularity value	1.3259	1.3260	1.3258	1.3259
Black pixel	56	60	47	44
Sum	90	90	90	90
Area	107128	107116	107133	107123
XY-value	Same Y-value and different X-value.			

4.1. Single Frontal Face Extraction

The input image is shown in Figure 6 contains single frontal face. The sum of pixels in each rectangle box of face like component of input image are computed using integral image matrix of input image and shown in Table 4. The value of R1 is 178, R_2 is 225, R_3 is 164, R_4 is 225, R_5 is 225, R_6 is 225, R_7 is 225, R_8 is 210, R_9 is 225, R_{10} is 567, R_{11} is 675 and R_{12} is 660 for input image. The Haar difference Hd_1 for input image is computed as -47 by subtracting R_4 from R_1 and similarly Hd_2 to Hd_{11} are found and shown in Table 5.

Figure 6. Experimental result on input image.

Table 4. Sum of pixel in each rectangle box using integral image.

No.	Input	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R1	R1
1	Figure 6	178	225	164	225	225	225	225	210	225	567	675	660

Table 5. Haar difference table.

No.	Input Image	Hd_1	Hd_2	Hd_3	Hd_4	Hd_5	Hd_6	Hd_7	Hd_8	Hd_9	Hd_{10}	Hd_{11}
1	Figure 6	-47	-47	-61	-61	0	0	15	15	-108	-93	15

The value of thirteen conditions is found using the Haar difference. The Haar difference Hd_1 for connected component of input image is computed as-47 which is less than 0, implies that the condition C_1 is true and shown as T for true value in the condition verification Table 6.

Table 6. Condition verification table.

No.	Input Image/Connected Component	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	Output Face/Non Face
1	Image (Figure 6)	T	T	T	T	T	T	T	T	T	T	T	T	F	Face.

The value of Haar difference Hd_2, Hd_3, Hd_4, Hd_9 and Hd_{10} are less than 0 implies that the condition C_2, C_3, C_4, C_{11} and C_{12} are true and shown as T in the Table 6. The value of Haar difference Hd_5 and Hd_6 is 0 implies true value for condition C_5, C_6 and C_7. The value of Haar difference Hd_7 and Hd_8 is greater than 0 implies true value for condition C_8 and C_9. The Haar difference Hd_7 is equal to Hd_8 implies true value for condition C_{10}. The Haar difference Hd_{11} is greater than 0 implies false value (F) for condition C_{13}. The value of twelve conditions C_1 to C_{12} are true (T) and the value of only one condition C_{13} is false (F) for connected component of input image1 in condition verification Table 6. The true value for more than eleven conditions of condition verification table. concludes the tested region as face.

4.2. Multiple Face and Side Face Extraction

The input image containing multiple faces is shown in Figure 7. Each connected region of the input image is tested. The sum of pixels in each rectangle (R_1 to R_{12}) of each connected component of input image using integral image matrix is found and R_1 to R_{12} of one component is shown in Table 7. The computed Haar differences (Hd_1 to Hd_{11}) for one connected component is shown in Table 8 and conditions are checked. The value of eleven conditions of condition verification table are found true and that of two conditions are found false for that component and shown in Table 9. The resulting true value for eleven conditions implies that the tested region is face. The connected component concluded as face is marked by rectangle. These steps are repeated for each connected component to find remaining faces of the input image.

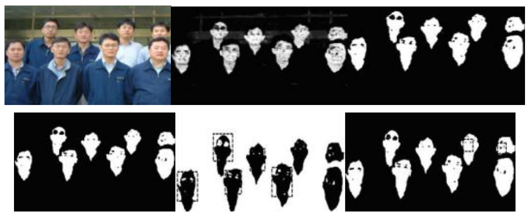


Figure 7. Experimental result on input image.

Table 7. Sum of pixel in each rectangle box using integral image.

No.	Input Image	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12
1	Multiple Face Image (Figure 7)	250	350	247	361	361	361	350	361	361	961	1072	969
2	Side Face Image (Figure 8)	115	121	115	121	121	121	121	121	121	357	363	357

Table 8. Haar difference.

No.	Input Image	Hd_1	Hd_2	Hd_3	Hd_4	Hd_5	Hd_6	Hd_7	Hd_8	Hd_9	Hd_{10}	Hd_{11}
1	Multiple Face Image (Figure 7)	-111	-100	3	-103	0	0	-11	0	-111	-103	-8
2	Side Face Image (Figure 8)	-6	-6	0	-6	-6	0	0	0	0	-6	-6

Table 9. Condition verification table.

No.	Input Image/ Connected Component	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	Output Face/ Non Face
1	Multiple Face Image (Figure 7)	T	T	F	T	T	T	F	T	T	T	T	T	F	Region concluded as face.
2	Side Face Image (Figure 8)	T	T	F	T	F	T	T	T	T	T	T	T	T	Face.

Similarly, input image containing side face shown in Figure 8 is processed. The sum of pixels in each rectangle box of connected component are found and shown in Table 7. The Haar difference are computed and shown in Table 8. The conditions of condition verification table are checked and shown in Table 10. The eleven conditions are found true and hence the tested component is concluded as face and enclosed by rectangle. The results of multiple faces are shown in Figure 7 and that of side face is shown in Figure 8.

Figure 8. Experimental result on input image.

Table 10. Comparison of HLF based method with existing method.

Method	Number of Cascade/Phases	Number of Haar Features in All the Cascade
Viola-Jones [19]	38	6060
Combining	Combines Viola-Jones and	
HLF Based	3 Phases.	12 rectangle

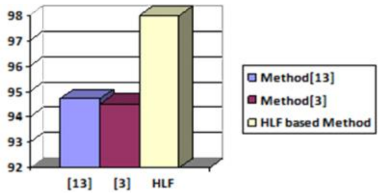
5. Comparison of HLF based Method with Existing Methods

The method Viola-Jones [19], combining Haar feature and skin colour based classifiers [2] and our method uses integral image, haar like features and training phase for face detection. The method [2] compares 6060 features in 38 cascade stages and achieves an accuracy of 94.7%. The method [2] combines the method [19] and skin color classifiers to detect face and achieves an accuracy of 94.5% and gets false positive less than [19].

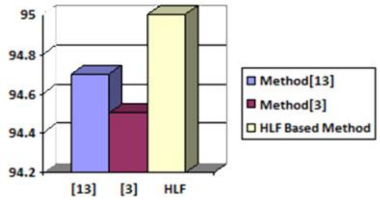
The HLF based method removes non-face like object by detecting skin color and eye features and applies integral image and haar comparison on only face like region. Due to which 11 haar differences and 12 rectangle features are calculated and 13 conditions are compared, which is very less in comparison with [19] and [2]. It achieves greater accuracy of 98% for single face, 95% for multiple face, and 90% for tilted face with less number of comparison. The comparison of face extraction using HLF with [19] and [2] is shown in Tables 10 and 11. And the accuracy graph for single and multiple faces is shown in Figures 9-a and 9-b respectively.

Table 11. Performance comparison of HLF based method with existing methods.

<table>
<tr><th rowspan="3">S.No.</th><th rowspan="3">Algorithm</th><th colspan="4">Accuracy</th></tr>
<tr><th colspan="3">Detection Rate</th><th rowspan="2">Overall Error Rate (Includes False Positive and False Negative)</th></tr>
<tr><th>Single Face</th><th>Multiple Face</th><th>Tilted Face/ Side Face</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Viola-Jones [19]</td><td>94.7%</td><td>94.7%</td><td>Not Reported.</td><td>16.5%</td></tr>
<tr><td colspan="3">Tested on Bao face database[3].</td><td></td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Combining Haar Feature and Skin Color Based Classifiers [2]</td><td>94.5%</td><td>94.5%</td><td>Not Reported.</td><td rowspan="2">5.00%</td></tr>
<tr><td colspan="3">Tested on Bao face database[3].</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">HLF Based Method</td><td>98%</td><td>95%</td><td>90%</td><td rowspan="2">3.5%</td></tr>
<tr><td colspan="3">Tested on Bao face database[3].</td></tr>
</table>



a) Methods for single face.



b) Methods for multiple faces.

Figure 9. Comparison graph.

6. Conclusions

The proposed method is working on the concept of HLF. The method segments the image based on skin color, extracts the face from the images containing single face, tilted face and multiple faces. It is tested on 50 images and found to be giving 98% accuracy for images containing single face and 95% accuracy for images containing multiple faces and 90% for images of tilted face and side face containing both eyes. The proposed is compared with Viola-Jones approach [19] and combining Haar and skin classifiers [2]. In our technique only face like component is tested by eliminating other non face like components which reduces the number of comparisons.

The phases 1 and 2 of this method are based on eye like hole detection. If the component which is not face, is accepted in the phases 1 and 2, it will be rejected by haar like features extraction phase. This increases the detection rate by detecting face component and rejecting non-face component. There may be very few facial images in which eyes are not visible, partially visible etc., due to complex background. Our method rejects the components in which eyes are not detected. Such face component will be rejected in the phases 1 and 2 testing itself. Then, such connected component is not further considered for any other testing. This increases the false rejection error rate by rejecting the face component. The technique can be further improved in future by considering other facial features before rejecting any connected component for images with more complex background.

References

[1] Dios J. and García N., "Face Detection Based on a New Color Space YCgCr," *in Proceeding of International Conference on Image Processing*, Spain, pp. 909-912, 2003.

[2] Erdem C., Ulukaya S., Karaali A., and Erdem T, "Combining Haar Feature and Skin Color Based Classifiers for Face Detection," *in Proceeding of IEEE 36th International Conference on Acoustics, Speech and Signal Processing*, Prague, pp.1497-1500, 2011.

[3] Frischholz R., http://www.facedetection.com, Last Visited 2014.

[4] FTarrés Rama, http://gpstsc.upc.es/gtav/researchareas/upcfacedatabase/gtavfacedatabase.html, Last Visited 2013.

[5] Hemlata A. and Motwani M., "Face Detection by Finding the Facial Features and the Angle of Inclination of Tilted Face," *International Journal of Computer Science Issues*, vol. 10, no. 2, pp.472-479, 2013.

[6] Huynh-Thu Q., Meguro M., and Kaneko M., "Skin-Color-Based Image Segmentation and Its Application in Face Detection," *in Proceeding of Workshop on Machine Vision Applications*, Japan, pp. 48-51, 2002.

[7] Images, http://www.eliteforsk.dk /arkiv/eliteforsk-2009/ prismod tagere009/ BlagoyBlagoevfoto.jpg., Last Visited 2014.

[8] Menezes P., Barreto J., and Dias J., "Face Tracking Based on Haar-Like Features and Eigenfaces," *IFAC/EURON Symposium on Intelligent Autonomous Vehicles*, vol. 500, 2005.

[9] Metilda M. and Santhanam T., "Domain Specific View for Face Perception," *Information Technology Journal*, vol. 7, no. 1, pp. 105-111, 2008.

[10] Nasiri J., Khanchi S., and Pourreza H., "Eye Detection Algorithm on Facial Color Images," *in Proceeding of Second Asia International Conference on Modelling and Simulation*, Malaysia, pp. 344-349, 2008.

[11] Rakhmadi A., Rahim M., Bade A., Haron H., and Amin I., "Loop Back Connected Component Labeling Algorithm and Its Implementation in Detecting Face," *Journal of World Academy of Science, Engineering and Technology*, vol. 64, no. 40, pp. 105-110, 2010.

[12] Ramirez G. and Fuentes O., "Multi-Pose Face Detection with Asymmetric Haar Features," *in proceeding of Workshop on Applications of Computer Vision*, Colorado, pp. 1-6 , 2008.

[13] Seo K., Kim W., Oh C., and Lee J., "Face Detection and Facial Feature Extraction Using Color Snake," *in Proceeding of IEEE International Symposium on Industrial Electronics*, pp. 457-462, 2002.

[14] Sharif M., Mohsin S., Javed M., and Ali M., "Single Image Face Recognition Using Laplacian of Gaussian and Discrete Cosine Transforms," *The International Arab Journal of Information Technology*, vol. 9, no. 6, pp. 562-570, 2012.

[15] Shemshaki M., "Face Detection Using Fuzzy Granulation and Classifier Fusion in Color Images," *The International Arab Journal of Information Technology*, vol. 11, no. 2, 2014.

[16] Sidibe D., Montesinos P., and Janaqi S., "A Simple and Efficient Eye Detection Method in Color Images," *in Proceeding of International Conference on Image and Vision Computing*, New Zealand, pp. 385-390, 2006.

[17] Viola P. and Jones M., "Rapid Object Detection Using A Boosted Cascade of Simple Features," *in Proceeding of IEEE Computer Society Conference on Computer Vision and Pattern Recognition*, Hawaii, pp. 511-518, 2001.

[18] Viola P. and Jones M., "Robust Real Time Face Detection," *International Journal of Computer Vision*, vol. 57, no. 2, pp. 137-154, 2004.

[19] Waber B., Magee J., and Betke M., "Fast Head Tilt Detection for Human-Computer Interaction," *in Proceeding of the International Conference on Computer Vision in Human-Computer Interaction*, Beijing, pp. 90-99, 2005.

[20] Wang Q., Yang J., and Yang W., "Face Detection using Rectangle Features and SVM," *International Journal of Intelligent Systems and Technologies*, vol. 1, no. 3, pp. 228-232, 2006.

[21] Wilson P. and Fernandez L., "Facial Feature Detection Using Haar Classifiers," *Journal of Computing Sciences in Colleges*, vol. 21, no. 4, pp. 127-133, 2006.

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