

Comparative Analysis of Color and Texture based Skin Recognition Techniques using Hand Segmentation Images

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ABSTRACT

Seeing pixels of skin in pictures or video plans which consolidates people has various applications, especially those linked with Man Machine Interaction measures. Maximum effort on skin acknowledgment is predicated on showing the skin on different concealing planetaryys. Proposed paper sightsees the utilization of surface in view of descriptor for the abstraction of skin pixels in pictures. For a comparative explanation, we separated and arranged a proposed concealing based skin affirmation count (using RGB, HSV and YCbCr depiction planetaryys) with a surface based skin area figuring which habits a measure called Spectral Variation Coefficient (SVC) to check zone features. We presented and surveyed the supportiveness of each and every skin division subtleties like tone and surface under different experimentations that dissected the accuracy of the two approaches (for instance concealing and surface) under an indistinguishable course of action of hand divided pictures.

Keywords

Color planetaryys, texture, Skin detection, segmentation, pixel classification.

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Introduction

Skin division has various critical bids related to identify and evaluate people direct on pictures or video progressions. very few of those bids are pictorial thing following for the purpose of perception, face affirmation, hand signal distinguishing proof, isolating and glancing through picture substance on different organizations, and much more applications. inside the occasion of Artificial Intelligent Man-Made Interaction, the catch -comprehension of the customer's developments with sentiments is a fundamental segment to think about their current status of mind. By this strategy the PC human joint effort can naturally conform to the customer requirements[17]. To complete this method, the area of individuals during a video progression through the shade of skin-pixelated pixels at last transforms into a huge pre-taking care of for advancement, movement, face. This division issue is communicated as describing the pixels of a data picture in two social affairs: membrane and non-membrane pixels. an earnest need for customized (or self-loader) skin area structures could in like manner be a switching between right gathering rate and response time.

Skin division has various huge applications with respect to identify and taking apart persons lead

on pictures or filmed progressions. relatively few of those bids are graphic thing following for the purpose of perception, face affirmation, hand signal distinguishing proof, isolating and glancing through picture substance on different organizations, and significantly more applications. inside the case of Artificial Intelligent Man Made Interaction (IHCI), the catch and comprehension of the customer's developments and feelings is a fundamental segment to think about their current status of mind. By this procedure the PC human joint effort can instinctively conform to the customer requirements[17]. To realize this method, the area of individuals during a video progression through the shade of skin-pixelated pixels at last transforms into a critical pre-dealing with for advancement, movement, face. This division issue is communicated as portraying the picture element of an information picture in more than one social occasions: membrane and non-membrane pixels. a pressing need for customized (or self-loader) skin area structures could in like manner be a trade off between right gathering rate and output.

Most fundamental method to manage skin area is using the creation as characteristics. Varying open concealing planetaryys membrane-concealing classifiers are analyzed inside the literature[3]. For

showing the synthesis, most makers primarily use three sorts of concealing depiction planetarys (Kakumanu et al., 2007): fundamental, intuitive and 1 balanced planetarys. the fundamental social affair looks at to commonest used plan to address and store automated picture, and it joins planetarys similar RGB or regularized RGB. The ensuing social occasion detaches perceptual credits of the tones, (for instance, shade, submersion and power). Above features are assorted in RGB, and this ensuing get-together combine planetarys similar to HSI, TSL or HSV. Final assembling reduces the overabundance in RGB stations by tending to the tone with truly self-sufficient parts, and it consolidates planetarys like YCbCr or YIQ. This paper plans to methodically take apart unmistakable tone and surface based skin-acknowledgment procedures. The assessment is performed both ostensibly and quantitatively for an indistinguishable course of action of pictures

SURVEY OF RESEARCH WORK

In the past couple of many years, melanoma has been driving considering the way that the commonest harm in Australia, America and Europe [2]. At whatever point recognized early, such a sickness are consistently reestablished with a hit speed of in excess of 92 percent [4,5]. A biopsy is regularly performed to work out if a tumor is unsafe or chivalrous. At any rate as this exploration office technique incorporates a massive cost and horridness, a correspondingly speedy and profitable screening system is modified early acknowledgment [3]

Investigators inside the field of dermatology imaging acknowledge that melanoma end are routinely modernized construction on express genuine features and concealing nuances that are typical for carcinoma types which is accumulated[2]. Huge melanoma factors – both definite and prognostic sore tone, 3D shape and size and vertical thickness. There are various undertakings by examiners [3,8] at building a modified carcinoma distinguishing proof structure to overhaul the exactness of end. it's basic to review the way as of late taken by these experts to recognize adequate data so on undertaking to achieve a reliable carcinoma ID system[1,14].

METHODOLOGIES

I Color Grounded Skin Division Methods

The person skin appears to have a kind name degree of hiding, numerous skin acknowledgment approaches are maintained orchestrating picture element using their concealing . a fair plan of concealing planetarys are considered to exhibit the skin chrominance . Regardless, according to for all concealing planetarys their relating ideal skin pointers have a comparative introduction meanwhile the individuality in skin or non skin modules is autonomous of the concealing planetary picked". With everything taken into account, the idea of a skin area technique is more eager to the proposed recognizable proof figuring and less on the used concealing planetary. To examine this declaration, trio concealing places are wont to address the skin:, HSV, RGB and YCbCr. For the case of fundamental REDGREENBLUE interplanetary, we pragmatic the accompanying direct unequivocal skin ID count which presented in (Kovac et al., 2003) and the whole thing all of the double pels for unchanging light illumination up.

$$\begin{aligned} & (R > 95) \wedge (G > 40) \wedge (B > 20) \wedge \\ & (\max(R, G, B) - \min(R, G, B) > 15) \wedge \\ & ((R - G) > 15) \wedge (R > G) \wedge (R > B) \end{aligned} \quad (1)$$

In which R, G and B address the expense of picture element inside the specific RGB concealing channel values varying which starts from 0 ,1,2....255. For HSV ,YCbCr places, syatem with uniformity will be followed. We hold luminosity info by changing the image over to dim levels. At that point, we yield a basic over partitioned image regions using morphological turning point methodology. for everything about conveyed turning point districts their relating concealing histograms for everything around trio channels are handled and differentiated using the Battachariyya distance with those like as of late arranged skin histograms. If all the histogram are same, the zone is known as a "skin area" helps as spot for a locale growing count completed on connecting non-skin regions. Finally, the specific skin recognizable proof count in Fig. 1 is subjected to each pixel of perceived skin territories to remove Untrue Optimistic skin areas when the part of skin pixels during an area is over an exploratory edge. the generally speaking planned concealing based skin acknowledgment methodology is printed by the Histogram showed

up in Figure 1. Some critical comments on this count will be resulting ones.

In order to perceive the skin picture element in pictures, we engage in recreation out a planning stage on the structure. For this endeavor, we procured diverse skins histograms with social affair of pictures where 2,314 skin parts were truly taken out (for instance skin pixels were measured). A histogram was made for all of the trio redirects in every thought about concealing interplanetary (HSV, RGB and YCbCr, autonomously) and it is the number of histogram canisters was fitted with 10.

Battacharyya remoteness taken as a gander at the 3-redirected related histograms inside a assumed concealing interplanetary of a model check an area with the contrasting aces of learned skin regions histograms to make a decision, routinely, a locale region was not considered. Above distance dealings the comparability of deuce distinct probability disseminations. With probability apportionments recieved histogram vectors, variable p and variable q autonomously, over an indistinguishable area X, the Battachariyya coefficient is labeled as:

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procedure ColorSkinDetection (imgIn, colorSpace, trainedSkinHistograms);
// Produces imageOut as a binary image where skin pixels are set to 1 and non-skin pixels are set to 0
begin
  if (colorSpace is 'RGB') then
    Compute imageOut from imgIn using explicit RGB skin detection applied to pixels
  else // similar processing for 'HSV' and 'YCbCr' color spaces
    Retain luminance information from imgIn;
    Create an image of regions using watershed algorithm;
    for each "watershed region" do
      Compute histograms for the three channels in considered color space;
      Compare histograms with those of trained skin region histograms using Battachariyya distance;
      if (value ≥ threshold) then Set region as "seed skin region" and use it for region growing method
    end for;
    while (set of "seed skin regions" is not empty) do
      Find new neighbour "skin regions" from seeds using region growing and Battachariyya distance;
      Apply explicit RGB skin detection on the pixels of "skin regions" to filter "true skin regions";
      Compose binary skin image imageOut by joining the set of "true skin regions"
    end if
  end
end

```

Figure 1: Step procedure for global planned color grounded skin division method.

$$BC(p, q) = \sum_{x \in X} \sqrt{p(x)q(x)} \quad (2)$$

$x \in X$ is the coefficient signifies a value in range of 0 and 1, and the constant $BC=1$ represents the huge grade of resemblance among both histograms.

II Texture grounded skin subdivision methods

Various surface gathering plans are used for faint level pictures. Surface picture division is ordinary in examination of clinical im-ages, far off recognizing scene understanding, present day inside control assessment, record division, picture recovery in data bases, visual affirmation schemes, etc

In the proposed paper, a division method is used that reflects the REDGREENBLUE channels or another concealing planetarys blends. It also certificates the implication amongst different tone and surface mixes inside a practically identical picture. it's maintained the Spectral Variation Coefficient to guage territory features (it are consistently used for tiny to astoundingly huge regions) and it licenses to get right nonstop surface cutoff points. It similarly allows perceiving amongst dissimilar surfaces with very insufficient changes on an indistinguishable sort of models. The place association amongst the pixels on the pixel (or surface part) are measured. The concealing information channels for each pixel are joined during another course by contemplating their mean and distinction. This arrangement is computationally capable and it's sensible for progressing applications that unite concealing and surface. It are routinely utilized for a particularly surface in light of the fact that the surface principles of what's getting the opportunity to be seen are completely revieled by the pre-owned bit and are adjusted to every circumstance. In k-construes bundle strategy is utilized to area the domains agreeing the SVC respect for every pixel band.

The underlying advance inside figuring of the SVC in each pixel is uniting the data on the trio interesting picture concealing channels. The pixel extent is portrayed through the customer or through the machine.

In the result of execution it ought to shape of square, with MM picture element, starting from variable M ranges between 3 to 21 and by means of odd M characteristics . To raise in what way the channel mix is performed, license us to use a numerical model. To achieve a greatly improved depiction of the vibe surface assortments in the pixel, considering in like manner the channel

demand, the estimation of the pixel force of each channel is subbed by another value pondering the others deuce channels, as showed in Fig. 2 .

Remembering the information of Fig. 2, the key pixel of power 121 in channel named R, will be adjusted by the consequences of an adding up to (portrayed by Fig. 2) which considers itself to be and the powers of the extra G and B channels (168 and 143, autonomously). The new figured worth will be 192,040.

A comparable technique will be measured for all picture element of picture information by deputizing the honest picture element power for new guessed varied station regard. This plan was comprised, mortar difference of the numerous combinations and appeal of apiece RGB straight in the superficial on scrutiny.

Figure 2: R, G and B with blended intensities for each pixel.

	R	G	B
<i>c=original value</i>	175	168	143
<i>a</i>	168	143	175
<i>b</i>	143	175	168
$x = \sqrt{a^2 + (b + 1)^2}$	221,269	226,771	243,282
$y = \text{arc tg} (a/(b+1))$	0,862	0,682	0,803
<i>temp value=x x y</i>	190,772	154,729	195,316
<i>c</i>	154,729	195,316	190,772
<i>d</i>	195,316	190,772	154,729
$x = \sqrt{c^2 + (d + 1)^2}$	259,618	229,076	242,876
$y = \text{arc tg} (c/(d+1))$	0,740	0,823	0,630
<i>new value= x x y</i>	192,040	188,594	152,902

The second step inside the count of the SVC is to work out the ordinary and thusly the fluctuation esteems for each class of distances considering the pre-owned measurement inside the image component with the blended qualities. while this outline of SVC estimation, the D4 metric is been used, in like manner called as Manhattan distance or called as square distance , to detachment and name each pixel inside the pixel sup-ported its distance to the central position. Nevertheless, the opposite estimations might be utilized inside the execution of the SVC procedure. Let q(s,t) and p(x,y) be picture component ,where (s,t) and (x,y) empowers freely, by then D4(p,q) is considered

$$D_4(p,q) = |x-s| + |y-t| \quad (3)$$

as:

To embody the count, think about the six pictures in Fig. 4 that delineate the measure of force with 1 of the three channels subsequent to mixing for

each pixel of 77 pixels, in which each lessons at numerous D4 reserve are addressed in a few tone (rep-disdained estimations of distance from 1 to 6). the measure of D4 reserve lessons into account is, obviously, linked with the pixel size. At long last, the SVC joints data in the three-dimensional state of the picture element found in the vibe component (using the Fig. 4 reserve lessons) for apiece station varied makings finished the mean md and then the change inside every class of detachments, in this way getting:

$$SVC = \text{arctg} \left(\frac{md}{sd+1} \right) \times \sqrt{md^2 + (sd+1)^2} \quad (4)$$

With happening using model and applying the Figure 4 makings, the SVC for apiece reserve class connected with the R station is listed and seemed in Table 1.

Table 1: SVC computation for each distance class by considering the values of Figure 4.

Distance class	md	sd+1	SVC
1	195,783	29,203	281,627
2	195,205	40,312	272,505
3	187,198	44,971	257,026
4	184,846	49,282	250,654
5	182,863	49,760	247,336
6	182,380	49,973	246,467

Table 2: Some properties of the test images.

Image	Size (# pixels)	% skin pixels	% non-skin pixels
Javi	540,870	28.71	71.29
photo	307,200	30.42	69.58
Beckham	155,000	6.67	93.33
CSainz	145,700	11.24	88.76

The worth of SVC for the Red channel SVCR, consistent to the example pixel, is intended using the arithmetical values given in Table 1 and equation-4, and SVCR=393,575. The SVC of the pixel is also figured for the other G and B mixed stations. Also it is suitable for another types of Different channels images.

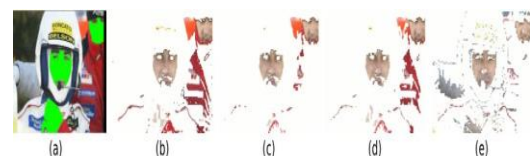


Figure 4: 6 clusters of picture element conforming to the D4 measured reserve lessons on a 77 pixel on analysis: a) D4- 1, b) D4 -2, c) D4- 3, d) D4- 4, e) D4- 5 and f) D4- 6.

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procedure SVCSkinDetection (texelln);
// texelln is a sample texture region where each pixel is represented by its Red, Green and Blue components
begin
  for each pixel and each channel of texelln do
    Compute blending_textel value using texelln; // as in Table 1
    Compute each distance class based on each pixel position in blending_textel; // using equation (3)
    for each channel of blending_textel do
      for each distance class of blending_textel do
        Compute mean m and the standard deviation s values;
        Compute SVC of the distance class; // using equation (4)
      end for;
    end for;
  end for;
  return (SVCr SVCg SVCb) for each channel in RGB space for region texelln
end
    
```

Figure 5: Step procedure for the SVC-based skin detection

The estimation of the SVC in every station of the shading planetary characterizes an arrange inside the Euclidean planetary for the thought about pixel, describing some degree inside the trio dimensional planetary. At that point, the examples of the preparation usual are gathered utilizing the *k*-implies bunching calculation. Along these lines, an area is careful designed as "skin district" and utilized as seed for a local developing calculation practical on neighbor non-skin areas if it's near the very edge of prepared skin centroids. The planned SVC-based calculation for skin identification inside the RGB shading planetary for every surface locale pixel In is featured by the step procedure appeared in Fig 5.

RESULTS AND DISCUSSIONS

From the start, we endeavored to use the Compaq data base (Jones et al, 1999) for tests. Regardless, we ostensibly watched the various pictures informational collection the actual skin partition wasn't right. Thusly, our proposed concealing and surface approaches are taken a stab at using other four concealing certifiable pictures (showed up in Fig. 6) in which the skin was pointer isolated. In all of above pictures, the interfacing measure of picture component and obligations of skin then non-skin picture component are glanced in Table 2.

Toward coordinate the accuracy of future concealing at that point surface division procedure in skin division, a relationship with relating gathering botches, False Positives and False Negatives, is introduced. A couple of preliminaries were performed to organize the, concealing and surface based skin request moves close. In the first place, we explored and investigated the effect of the had a go at mixing planetarys (RGB1, HSV1 and YCbCr, independently) with skin course of action using the count presented in Section2. This

methodology needs from 3 edge limits: Region that tends to the bit of pixels for a territory to be considered as "skin area" unsurprising with Bhattacharyya distance, Adjacent is that the degree of picture component for a contiguous of a "skin region" to allot the all-new "skin region", and RGB that tends to the rate assessment of skin pixels using eq. 1 during a zone to be finally named as "skin area". Later experimentation, we guessed that incredible limit regards were: [thRegion:thNeighbour:thRGB] = [0.4:0.1:0.5]. Figure 7 apparently contemplates the partition outcomes got by the concealing division count inside the considered concealing planetarys for these limit regards using "CSainz" picture. The yield of the surface masterminded technique for a similar test picture is figured in Fig-7. Oftentimes, the HSV1 mixing planetary bowed better area results that the other two used concealing planetarys. Accordingly, we've as far as taken a gander at the FPs and FPs botches made by concealing count inside the HSVs planetary with the contrasting 1s conveyed and vibe division method for the quadruplicate assessment pictures. The relating results are introduced in Tables 3 and 4, independently. Table 3 identifies with the results for the HSV concealing based skin recognizable proof figuring and Table 4 is referred to the results for the SVC surface based skin division computation. The deuce tables exhibition the probabilities of precisely celebrated skin pixels (the measure of paces of TP and TN) and incorrectly recognized skin pixels (the measure of paces of FP and FN) for each specific count and test picture.

Table 3: Results for the HSV skin detection color-based algorithm (where parameter values are [thRegion,thNeighbour,thRGB] = [0.4,0.1,0.5]).

Image	Javi	photo	Beckham	CSainz
% TP	27.92	29.61	3.57	6.72
% TN	70.16	68.38	93.12	84.78
% FP	1.13	1.20	0.21	3.98
% FN	0.79	0.81	3.10	4.52
% Suc.	98.08	97.99	96.69	91.50
% Err.	1.92	2.01	3.31	8.50

A few ends can be separated from the trials: For the consistent model pictures the skin assessment concealing based tech-nique limited in typical of 22.4 % the False-Positive mix-up cost. It is mainly a result of the last non-skin territories elimination step, which discards some in the past checked skin locale, using a particular pixel-based RGB skin distinguishing proof method. during hence, initial skin regions in what bit of skin

pixels is over an experi-mental edge are by and by set apart as "non-skin" zones.

Table 4: Results for the skin detection SVC texture-based algorithm (the number of classes in the application of the k-means algorithm varies between 5 and 10 in the experi-ments).

Image	Javi	photo	Beckham	CSainz
% TP	28.53	29.45	6.03	7.83
% TN	69.31	68.48	89.57	87.20
% FP	1.98	1.10	3.76	1.56
% FN	0.18	0.97	0.64	3.41
% Suc.	97.84	97.93	95.60	95.03
% Err.	2.16	2.07	4.40	4.97



Figure 6: Measured test images: (a) JAVI, (b) PHOTO, (c) BECKHAM, and (d) CSAINZ

For the above model pictures the skin-acknowledgment surface masterminded techniques decline in typical a 43.6 PERCENT of the False-Negative misstep cost. this is much of the time truly, is typically trapped in to the estimation of the image. Skin surfaces are by and large smooth surfaces. If this identical exceptionally new/surface are routinely accessible on another surface of analyzed picture, the SVC-based count conceivably orchestrate in this surface as skin (appeared in Fig. 7(e)).

- With thought of FP and FN botch charges, the skin acknowledgment surface established technique diminishes with 13.6 % the distinctive skin pixels concerning the concealing based philosophy (a 3.93 percent in of slip-ups inside the concealing based philosophies against a 3.4 percent inside the surface established system).

The state of territory limits are most appropriately celebrated applying the surface based computation. Figure 7: Visual aftereffects of recognized skin for the threesome concealing planetary computations and as needs be the surface procedure: (a) hand divided skin, (b) RGBs, (c) HSVs, (d) YcbCrS and (e) SVCs surface. which discards about recently named skin areas, using an unequivocal pixel situated RGBs skin ID technique. during thusly, beginning skin zones where the segment of skin picture

component is over an exploratory breaking point are by and by set apart as "non-skin" locale.

In above model pictures the skin-area surface arranged strategies diminish in ordinary 43.6 % of False Negative error cost. It is in all honesty, is typically trapped in to the estimation of the image. Skin surfaces are by and large smooth surfaces. If this comparable new/surface are consistently depend on somewhere else of the separated picture, the SVC estimation possibly bunch this surface taking into account skin (see Fig. 7(e)).

With considering together FP and FN bungle charges, the skin affirmation surface based technique reduces in typical of a 13.6 % the mis-requested pixels related with skin concerning the concealing established strategy.

The state of zone limits are furthermore more suitably perceived using the surface based estimation.

CONCLUSION

This paper recorded and at the same time considered a concealing based technique (using RGB1, HSV1 and YCbCr1 depiction planetarys) and a surface-based estimation (using the SVC) focused on skin area on concealing pictures. But, most noteworthy exertion on skin acknowledgment is masterminded on showing the skin happening different concealing planetarys, we've arranged the use of surface as a descriptor for the evacuation of skin picture component in pictures. The precision and exactness gained by each and every division feature based estimation (concealing versus surface) is presented under different hand-separated electronic pictures. The skin disclosure surface based approach lessens in ordinary 13.6 percent the misclassified skin picture component concerning the concealing based system for the deliberate preliminary pictures.

REFERENCES

[1] Wang, A., Chen, G., Yang, J., Zhao, S.,Chang, C. Y. (2016). A comparative study on human activity recognition using

- inertial sensors in a smartphone. *IEEE Sensors Journal*, 16(11), 4566-4578.
- [2] Z. Hu and C. S. Yu, "Functional research and development of skin barrier," *Chinese Journal of Clinicians*, vol.7, no.7, pp. 3101–3103, 2013.
- [3] V. Vezhnevets, V. Sazonov, and A. Andreeva, "A survey on pixel-based skin color detection techniques," in *Proceedings of Graph- icon 2003*, pp. 85–92, Moscow, Russia, September 2003.
- [4] S. R. Yu, X. H. Zhao, and X. M. Pu, "Image characteristics of dermatopathic herpesvirus disease under reflectance confocal microscope," *China Journal of Leprosy and Skin Diseases*, vol. 31, no. 2, pp. 85–88, 2015.
- [5] Zarit, B., Super, B., Quek, F.: Comparison of five color models in skin pixel classification. In: *Proc. International Workshop on Recognition, Analysis, and Tracking of Faces and Gestures in Real-Time Systems*, Corfu, Greece, pp. 58–63 (1999).
- [6] Terrillon, J.C., Shirazi, M.N., Fukamachi, H., Akamatsu, S.: Comparative performance of different skin chrominance and chrominance planetarys for the automatic detection of human in colorimages. In: *Proc. 4th IEEE International Conference Face and Gesture Recognition*, Grenoble, France, pp. 54–61 (2000).
- [7] Singh, S.K., Chauhan, D.S., Vatsa, M., Singh, R.: A robust skin color based face detection algorithm. *Tamkang Journal of Science and Engineering* 6(4), 227–234 (2003).
- [8] Peer, P., Kovac, J., Solina, F.: Human skin color clustering for face detection. In: *Proc. EUROCON Conference on Computer as a Tool*, pp. 144–148 (2003).
- [9] Chen, Q., Wu, H., Yachida, M.: Face detection by fuzzy pattern matching. In: *Proc. 5th International Conference on Computer Vision*, Cambridge, MA, USA, pp. 591–597 (1995).
- [10] Birchfield, S.: Elliptical head tracking using intensity gradients and color histograms. In: *Proc. IEEE Conference on Computer Vision and Pattern Recognition*, Santa Barbara, California, pp. 232–237 (1998).
- [11] Jones, M.J., Rehg, J.M.: Statistical color models with application to skin detection. In: *Proc. IEEE Computer Society Conference on Computer Vision and Pattern Recognition*, vol. 1, pp. 274–280 (1999).
- [12] Gonzalez, R.C., Woods, R.E.: *Digital Image Processing*, 2nd edn. Prentice Hall, New York (2002).
- [13] Chai, D., Bouzerdoum, A.: Bayesian approach to skin color classification in YCbCr color planetary. In: *Proc. IEEE Region Ten Conference*, Kualu Lumpur, Malaysia, vol. 2, pp. 421–424 (2000).
- [14] Schiele, B., Waibel, A.: Gaze tracking based on face-color. In: *Proc. International Workshop on Automatic Face- and Gesture-Recognition*, Zurich, Switzerland, pp. 344–348 (1995).