Information Sciences Letters

Volume 7
Issue 1 *Jan. 2018*

Article 3

2018

An Elliptical Boundary Skin Model For Hand Detection Based on HSV Color Space

Usama Sayed
Department of Electrical Engineering, Faculty of Engineering, Assiut University, P.O. Box 71516 Assiut, Egypt, zenab_elzohry@yahoo.com

Mahmoud A. Mofaddel
Department of Mathematics and Computer Science, Faculty of Science, Sohag University, P.O. Box 82524 Sohag, Egypt, zenab_elzohry@yahoo.com

Samy Bakheet
Department of Mathematics and Computer Science, Faculty of Science, Sohag University, P.O. Box 82524 Sohag, Egypt, zenab_elzohry@yahoo.com

Zenab El-Zohry
Department of Mathematics and Computer Science, Faculty of Science, Sohag University, P.O. Box 82524 Sohag, Egypt, zenab_elzohry@yahoo.com

Follow this and additional works at: https://digitalcommons.aaru.edu.jo/isl

Recommended Citation

Sayed, Usama; A. Mofaddel, Mahmoud; Bakheet, Samy; and El-Zohry, Zenab (2018) "An Elliptical Boundary Skin Model For Hand Detection Based on HSV Color Space," *Information Sciences Letters*: Vol. 7 : Iss. 1 , Article 3.
Available at: https://digitalcommons.aaru.edu.jo/isl/vol7/iss1/3

This Article is brought to you for free and open access by Arab Journals Platform. It has been accepted for inclusion in Information Sciences Letters by an authorized editor. The journal is hosted on Digital Commons, an Elsevier platform. For more information, please contact rakan@aaru.edu.jo, marah@aaru.edu.jo, dr_ahmad@aaru.edu.jo.

Sayed et al.: An Elliptical Boundary Skin Model For Hand Detection Based on HSV

Information Sciences Letters
An International Journal

http://dx.doi.org/10.18576/isl/070103

An Elliptical Boundary Skin Model For Hand Detection Based on HSV Color Space

Usama Sayed[1], *Mahmoud A. Mofaddel*[2], *Samy Bakheet*[2] *and Zenab El-Zohry*[2,*]

[1] Department of Electrical Engineering, Faculty of Engineering, Assiut University, P.O. Box 71516 Assiut, Egypt
[2] Department of Mathematics and Computer Science, Faculty of Science, Sohag University, P.O. Box 82524 Sohag, Egypt

Received: 09 Oct. 2017, Revised: 15 Dec. 2017, Accepted: 25 Dec. 2017
Published online: 01 Jan. 2018

Abstract: Detection and tracking of human face and hands are curial for gesture recognition. In this paper, a skin segmentation framework is presented, where a robust elliptical model in HSV color space is developed, which promises not only to better model the skin color, but also to significantly lower the complexity of the hand detection process. In our approach, hand regions are identified and detected in Hue Saturation Value (HSV) color space that is proven to correspond closer to human perception of hand color than the traditional RGB color space. The obtained results show the potential of the method proposed and it yields good performance and has robustness with respect to illumination as well as with respect to image noise.

Keywords: Skin color; Hand-detection; HSV color space; elliptical boundary

1 Introduction

Skin detection consists in discovering human skin pixels from an image. The system output is a binary image defined on the same pixel grid as the input image. Skin detection plays a serious part in various applications like face detection, checking and filtering image content on the web. Research has been performed for the detection of human skin pixels in color images by use of various statistical color models. Some researchers have utilized skin color models such as Gaussian. In most experiments, skin pixels are obtained from a limited number of people under a fixed range of lighting conditions. Unfortunately, the illumination conditions are oftentimes unknown in an arbitrary image, so the variation in skin colors is much less constrained in practice. A good skin classifier should estimate distinguish among skin and non-skin pixels for a wide range of people with different skin kinds [1], such as white, brown, yellow and dark and be able to perform well under different illumination conditions such as outdoor, indoor and with white and non-white illumination sources. An important step in the image classification process is color segmentation of the image into similar skin-color regions and non-skin color regions in color space that is relatively invariant to minor illumination changes. Various color space models along with threshold, helps to remove non-skin like pixels from an image. This work describes an implementation for skin detection for image/video. The implementations for image construct on the H channel to characterize the skin colors range. The program initially converts RGB images to HSV one. The H channel is used to characterize the colors range for skin detection. The implementation for video is also convert frames of that video from RGB images to HSV. The paper is organized as follows: section 2 covers some related works on skin detection, section 3 presents the proposed method, and section 4 describes the experimental results. Finally, in section 5, we summarize the paper.

2 Related Works

Human skin color has been used to identify and differentiate the skin. This has been proven as useful methods applicable in face recognition, identification of nude and pornographic images [2] and also such image processing tasks have been used extensively by intelligence agencies [3]. A number of image processing models have been applied for skin detection [4]. The major paradigms included heuristic and recognizing patterns which were used to obtain accurate results.

* Corresponding author e-mail: zenab_elzohry@yahoo.com

© 2018 NSP
Natural Sciences Publishing Cor.

Among various types of skin detection methods, the ones that make use of the skin color as a tool for the detection of skin is considered to be the most effective [5]. Human skins have a characteristic color and it was a commonly accepted idea driven by logic to design a method based on skin color identification. The problem arose with the provision of different varieties of human skin found in different parts of the world. A number of published researches included various skin models and detection techniques [6,7], however, none came up with complete accuracy. There have been many problematic issues in the domain of skin detection. The choice of color space, the model of precise skin color distribution, and the way of mechanizing color segmentation research for the detection of human skin. Most researches have been focused on pixel based skin recognition, classifying each pixel either as skin or non-skin. Each pixel is considered to be an individual unit [8]. Pixel-base skin recognition is considered to be one of the finest models that under normal conditions give high level of accuracy of the detection phase of the process. Due to its high applicability and efficiency, some color models are used extensively in the arena of skin detection. These models make use of pixel based skin recognition using a model such as RGB [9]. In this method the researchers considered the spatial method of skin pixels, and took them into account during the detection phase with the target of maximizing efficiency. As a contradiction to the fact that different people have different types of skin colors, it is found that the major difference does not lie in their chrominance; rather it is determined by intensity to a large extent. The simplest color models useful for intensity invariant skin detection are HSV. The HSV model is an effective mechanism to determine human skin based on hue and saturation.

Fig. 1: Samples for human skin

```
Read the image header, BMP head
For i = 1 to BMP head height
For j = 1 to BMP head width
Read pixel Color
Mx = Max (Color × R, Color ×G, Color × B)
Mn = Min (Color × R, Color ×G, Color × B)
¶ =Mx - Mn
If (Mx = Color × R) then
H = (Color ×G -Color × B) d
Else If (Mx = Color ×G) then
H = 2 + (Color × B - Color × R) d
Else
H = 4 + (Color × R - Color ×G) d
End if
H = H× 60
If (H<0) then
H = H + 360
End if
If (T1 £ H £T2 ) then
Detect pixel as skin
End if
End
End
```

Fig. 2: An algorithm for skin modelling

3 The Proposed Method

In this section, the proposed segmentation method for hand detection is presented. First, the HSV color model is applied for a given image, then we use the tested value H in elliptical boundary for the video. The details of our approach are given in the following subsections.

3.1 HSV Model

First, the image in RGB was converted to HSV color space, because it is more related to human color perception. The skin in channel H is characterized by values between 2 and 45. In this work, we used images from different Caucasian people, from different places of the world.

Figure 1 shows some of samples for human skin. Hue-saturation based color spaces were introduced when there was a need for the user to specify color properties numerically. Hue defines the dominant color (such as red, green, purple and yellow) of an area; saturation measures the color fullness of an area in proportion to its brightness. The ”intensity”, ”lightness” or ”value” is related to the color luminance [10]. It can be used as a decision parameter to detect human skin. In Figure 2, a high-level description of the algorithm for the skin model in HSV space is shown.

Figure 3 presents the segmentation results for a sample test video sequence. As depicted in the figure, it is evident that the proposed method delivers quite good segmentation results for skin detection applications, however it has developed with the primary aim to be employed in gesture recognition applications [12,13].

3.2 HSV Color Model

By examining skin and non-skin distributions in several color spaces, Lee and Yoo [11] have concluded that skin color cluster, being approximately elliptic in shape is not well enough approximated by the single Gaussian model.

© 2018 NSP
Natural Sciences Publishing Cor.

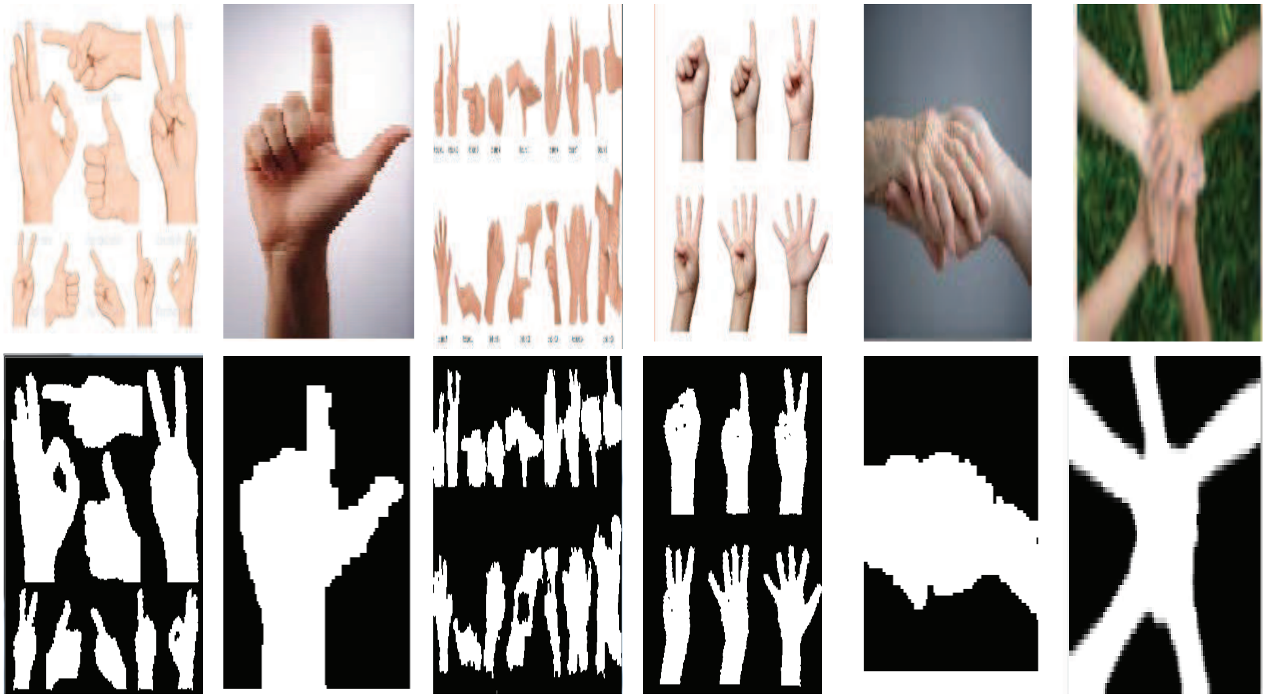

Fig. 3: Segmentation results for sample test images.

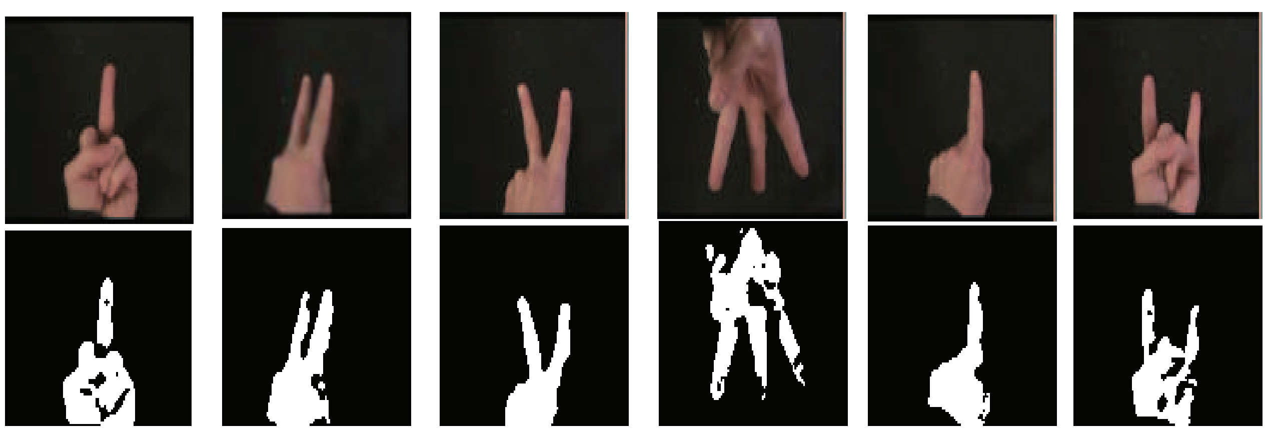

Fig. 4: Segmentation results for a sample test video.

Due to the asymmetry of the skin cluster with respect to its density peak, usage of the symmetric Gaussian model leads to high false positive rate. They propose an alternative they call an elliptical boundary model which is equally fast and simple in training and evaluation as the single Gaussian model and gives superior detection results on the Compaq database compared both to single and mixture of Gaussians.

In our work, firstly we generate Skin Probability Maps (SPM) as follows: the histograms for skin region and non-skin region are calculated, and then a decision for each pixel based on those histograms is made. For getting a decision an initial guess for skin pixels, I used a bootstrap. For bootstrapping we get the last HSV, and normalize RGB, take the pixels that are in the ranges in booth color spaces and combine them. After we get a bootstrap, we can start training the model to get a better segmentation. Basically, this means calculating two histograms, one for skin pixels and one for non-skin pixels. We normalize the histograms with the number of skin and non-skin pixels to create Probability Density Function (that sums to one).The SPM simply states you make a binary prediction (yes or no) for each pixel based

© 2018 NSP
Natural Sciences Publishing Cor.

on a θ value.

$$\frac{p(c|skin)}{p(c|non-skin)} > \theta \quad (1)$$

We iterate a number of times with train- predict operations, where every iteration we use the result of the prediction to train the model again. Then we tried EBM (Elliptical Boundary Model). The elliptical boundary model is defined as:

$$\varphi(c) = (c-\varphi)\Lambda^{-1}(c-\varphi) \quad (2)$$

Where c is the tested pixel color-value in r-g space, φ is the mean value of the distribution and Λ is calculated as follows,

$$\varphi = \frac{1}{N}\sum_{i=1}^{N} f_i(c_i-\mu)(c_i-\mu)^{\tau} \quad (3)$$

Where μ is a weighted mean of the colors in the histogram, f_i is the frequency of the color-value c_i both of which come from the histogram. Pixel with color c is classified as skin in case when $\varphi(c) < \theta$ where θ is a threshold value.

4 Experimental Results

In our approach, all the algorithms are implemented using OpenCV computer vision library and C/C++ programming language. Such an implementation is quite fast and therefore suitable for fast real time applications. For Skin Detection Number of skin patches of people from various ethnic groups are collected under different illumination conditions. Figure 3 shows segmentation results on sample test images yielded from the application of the HSV skin color based algorithm. These patches are in RGB color space. These are converted to HSV color space. From the results contained in figures, it is quite remarkable that in HSV space, the true skin detection rate steadily increases.

5 Conclusions

In this paper, an effective and robust segmentation method for hand detection based on Elliptical Boundary Modelling (EBM)in the HSV color space to model the skin distribution has been presented. The obtained results show the feasibility of the method and its high robustness to environmental influences or image distortions such as, noise and illumination changes.

Acknowledgement

The authors are very grateful to the anonymous reviewers for their careful and meticulous reading of the paper and for their constructive and insightful comments and suggestions that greatly improved the quality of our work.

References

[1] S. Bakheet, A. Al-Hamadi, A hybrid cascade approach for human skin segmentation, British Journal of Mathematics & Computer Science, **17**, 1-18 (2016).
[2] M. Fleck, Forsyth D. A., C. Bregler, Finding naked people, European Conference on Computer Vision (ECCV), **2**, 592-602 (1996).
[3] J. Ahlberg, A system for face localization and facial feature extraction, Tech. Rep. LiTH ISY-R-2172, Linkoping University, 1999.
[4] S. Sadek , M.A. Mofaddel, Multicolor skin modeling with application to skin detection, Journal of Computations & Modelling, **3**, 153-167 (2013).
[5] B. D. Zarit, B. J. Super and F. K. H. Quek, Comparison of five color models in skin pixel classification, International Conference on Computer Vision 99(ICCV99) Intl Workshop on recognition, analysis and tracking of faces and gestures in real-time systems, 58-63 (1999).
[6] J. C. Terrillon, M. N. Shirazi, H. Fukamachi, S. Akamatsu, Comparative performance of different skin chrominance models and chrominance spaces for the automatic detection of human faces in color images, Intl. Conf. on Automatic Face and Gesture Recognition, 54-61 (2000).
[7] S. Bakheet, An SVM framework for malignant melanoma detection based on optimized HOG features, Computation, **5**, 1-14 (2017).
[8] J. Brand, J. Mason, A comparative assessment of three approaches to pixel level human skindetection, Intl. Conf. on Pattern Recognition, **1**, 10561059 (2000).
[9] A. Albiol, L. Torres, E. J. Delp, Optimum color spaces for skin detection, Intl. Conf. on Image Processing, **1**, 122-124 (2001).
[10] V. Vezhnevets, V. Sazonov, A. Andreeva, A survey on pixel-based skin color detection techniques, 85-92 (2003).
[11] Y. J. Lee, S. I. Yoo, An elliptical boundary model for skin color detection, International Conference on Imaging Science, Systems, and Technology, 2002.
[12] S. Bakheet, A fuzzy framework for real-time gesture spotting and recognition, Journal of Russian Laser Research, **38**, 61-75 (2017).
[13] S. Bakheet, A. Al-Hamadi, Hand gesture recognition using optimized local gabor features, Journal of Computational and Theoretical Nanoscience, **14**, 1-10 (2017).

© 2018 NSP
Natural Sciences Publishing Cor.

Usama Sayed received his B.Sc. and M. Sc. degrees from Assiut University, in 1985 and 1993, respectively, and his Ph.D. degree from Czech Technical University in Prague, Czech Republic, in 2000. From November 2001 to April 2002, he was a post Doctoral Fellow with the Faculty of Engineering, Czech Technical University in Prague, Czech Republic. He authored and co-authored more than 100 scientific papers. His research interests include image coding, speech coding, telecommunication technology, statistical signal processing, blind signal separation, wireless communication network, video coding, and RFID.

Mahmoud A. Mofaddel received his B. Sc. and M. Sc. Degrees from Assiut University in 1985 and 1991 respectively, and his Ph. D. degree from Rostock University, Germany in 1999. Currently, he working as an associate professor at Mathematics and Computer Science Department, Faculty of Science, Sohag University, Egypt. He authored and co-authored more than 23 scientific papers. His research interests include high performance computing, and image processing.

Samy Bakheet received the Engineering doctoral degree (Dr.-Ing.) in Technical Computer Science from Otto-von-Guericke University Magdeburg, Germany in 2013. Since September 2013, he has become an Assistant Professor of Computer Science at Sohag University, Egypt. His research interests are geared towards high-level recognition problems in machine vision, such as human activity/event recognition, human pose estimation, object/scene recognition, etc. He also works on various multimedia related applications, such as visual surveillance, content-based image/video retrieval, video summarization, and semantic video annotation. Bakheet has authored/coauthored roughly 40 reviewed technical papers in well reputed international journals and conference/symposium proceedings in the fields of computer vision, machine learning, pattern recognition, medical imaging, and robotics.

Zenab El-Zohry received her BSc. and MSc. degrees from South Valley University and Sohag University in 2005 and 2012, respectively. From June 2012, she has served as a Lecturer at Faculty of Science, Sohag University, Egypt. Her primary research interests include network security, genetic algorithms, image processing and pattern recognition.

© 2018 NSP
Natural Sciences Publishing Cor.