An Automatic Face Detection and Gender Classification

Piotr Milczarski
Faculty of Physics and Applied Informatics
University of Lodz
Pomorska str. 149/153, Lodz, Poland
piotr.milczarski@uni.lodz.pl

Zofia Stawska
Faculty of Physics and Applied Informatics
University of Lodz
Pomorska str. 149/153, Lodz, Poland
zofia.stawska@uni.lodz.pl

***Abstract*— Face detection is one of the most important issues in the identification and authentication systems that use biometric features. In this paper we present algorithms for detecting skin color. The selection and implementation of an algorithm for automated authentication system and face detection can significantly improve the effectiveness of such a system. The second groups of algorithms are the ones responsible for the gender classification. Because of their complexity they are not suitable for nowadays mobile devices but can be used in systems working on more demanding machines. The selection and implementation of algorithms have accuracy about 80-90%. We show the advantages and disadvantages of that methods and future challenges to the researches.**

Keywords—face identification, authentication, biometrics, skin color, gender classification.

I. Introduction

In the soft biometrics face recognition and authentication is still very important problem. Some of the examined features are gender and skin color.

There are many gender classifications approaches and methods. They can be divided in feature-based and appearance-based methods [1]. They use different approaches but they usually are trimmed on the same database. When they are compared on the same FERRET database they show around 90% accuracy or even 99%. When the database is different than the one used by the authors of the gender classification method, then the methods' accuracy drops to 60-70%.

Authentication and identification systems are increasingly. Nowadays, more and more popular become NFC transactions and mobile payments. We want to protect our resources against unauthorized access. The commonly used authentication method using login and password appear to be insufficient and too easy. They are also exposed to a high risk of attack. There is therefore a need to develop alternative methods, which seem most promising biometric methods using individual human characteristics. Biometric methods can use a variety of physical characteristics such as fingerprints, hand geometry, ear and facial geometry, iris of the eye [3][7]. Among these features face as our individual identifier seems to be the most interesting and gives new features research [4][5][6].

Face area is now one of the most interesting elements of the image to the research on its location in the image, the appointment of facial symmetry, finding the significant points [7], searching for similarities between several images and compared the skin color detection. Locating faces in the image using its search algorithms need to be able to work on the details and provides a basis for further research in the diagnosis of skin color [3].

The paper is organized as follows. In Sec. II effectiveness of the skin color recognition and classification methods are presented. In the next Section we analyze gender classification methods. Finally, Sec. IV concludes the paper.

II. Skin color recognition methods

The skin color recognition methods are divided into several different groups. Several approaches propose to use color space transformation [8]. Explicit threshold-based skin cluster classifiers are the simplest and often applied methods to classify skin and non-skin pixels. These methods explicitly define the boundaries of the skin cluster in certain color spaces [9].

TABLE I. Effectiveness of recognition methods of skin and non-skin colours [11]

Method / classifier	CDR (%)	FDR (%)	CR (%)
Traditional RGB method	81.27	23.71	77.04
Distance Map (DM)	***89.97***	***9.27***	***90.61***
Bayesian classifier [12][13]	83.92	10.92	88.30
Multilayer perceptron classifier [14]	83.33	11.54	87.69
Color consisty with implementing neural networks[15]	85.60	10.68	88.76
Segment- and edge-based refinements of Bayesian classifier [16]	82.62	10.44	88.44
Principal feature analysis, PFA and Markov random field, MRF based methods [17]	83.93	10.87	88.35

Analyzing the effectiveness of the method one of the methods has almost 90% accuracy in finding correct skin region. In TABLE I. there are shown: (a) correct detection rate (CDR)—percentage of skin pixels correctly classified, (b) false detection rate (FDR)—percentage of non-skin pixels

incorrectly classified as skin pixels, and (c) overall classification rate (CR)—percentage of pixels correctly classified [7][11]11]. In assessing effectiveness used, there was used Compaq database of the skin and non-skin images [12][13]. It includes an appropriate number of images of containing the skin regions (4000) and non-skin images (5500). All the data obtained in TABLE I. are the average values based on simulation 500 test images. As it was mentioned above the best method is method using distance map (DM). As we show in the case of gender recognition methods it can connected with the database properties.

III. Gender Classification Methods

In the TABLE II. There are shown the results of different gender recognition methods based on FERET database and a database having pictures from Web in similar format as first one. Both consist of images with and without hair. The results of correct classification CR varies from 57% to 92% with advantage of FERET database.

TABLE II. Gender Classification Methods Classification Rate With Hair (CRH+) and Without Hair (CRH-) [1]

Method	FERET images		Web images	
	CRH+ (%)	CRH- (%)	CRH- (%)	CRH+ (%)
Neural network	92.22	90	65.95	61.29
SVM	88.89	82	66.48	57.41
Threshold Adaboost	86.67	90	66.29	66.75
LUT Adaboost	88.89	93.33	66.19	64.81
Mean Adaboost	88.33	90	66.14	67.02
LBP + SVM	80.56	92	67.25	66.54

Apart from the results shown above the best results were reported by Zheng et al. For FERET database they obtained 99,1% and for CAS-PEAL database even better result – 99,8%, but the authors were selected only frontal face images from the datasets. For the images taken in uncontrolled environment the results are a little worst The best result in this case was 94,8% obtained by Shan et al. using LFW dataset.

Conclusions

It can be concluded that: (1) that the most promising results can be obtained from the methods using the distance map, DM; (2) methods and programs are trimmed into FERET DB; (3) it is worth checking which set of method can make the CR the highest; (4) in case of authentication or identification systems the reliability of the result is so important that we should strive to use algorithms that give the highest accuracy, even at the expense of the significant increase in computational complexity.

References

[1] E. Mäkinen and R. Raisamo, "An experimental comparison of gender classification methods" Pattern Recognition Letters vol. 29, pp. 1544–1556, 2008.

[2] P.J. Phillips, Moon H., S.A. Rizvi, and P.J. Rauss, "The FERET evaluation methodology for face-recognition algorithms," Pattern Analysis and Machine Intelligence, IEEE Transactions on, vol. 22, no. 10, pp. 1090-1104, 2000.

[3] P. Milczarski, L. Kompancts, and D. Kurach, " An Approach to Brain Thinker Type Recognition Based on Facial Asymmetry," LNAI 6113, pp. 643-650, 2010.

[4] J. L. Crowley, J. Coutaz, "Vision for Man Machine Interaction, Robotics and Autonomous Systems", Vol. 19, pp. 347-358, 1997.

[5] D. Cahi, K. N. Ngan, "Face Segmentation Using Skin-Colour Map in Videophone pplications," IEEE Transaction on Circuit and Systems for Video Technology, Vol. 9, pp. 551-564, 1999.

[6] R. Kjeldsen and J. Kender, "Finding Skin in Colour Images," Proceedings of the Second International Conference on Automatic Face and Gesture Recognition, pp. 312-317, 1996.

[7] P. Milczarski, "A New Method for Face Identification and Determining Facial Asymmetry," In: Katarzyniak R., Chiu T.F., Hong C.F., Nguyen N.T. (Eds.), Studies in Computational Intelligence: Semantic Methods for Knowledge Management and Communication, Springer,Berlin, 2010.

[8] J. L. Crowley and F. Berard, "Multi-modal tracking of faces for video communications," in Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR '97), pp. 640–645, San Juan, Puerto Rico, USA, June 1997.

[9] J. Kovac, P. Peer, and F. Solina, "2D versus 3D colour space face detection," in Proceedings of the 4th EURASIP Conference on Video/Image Processing and Multimedia Communications, vol. 2, pp. 449–454, Zagreb, Croatia, July 2003.

[10] S. L. Phung, A. Bouzerdoum, and D. Chai, "Skin segmentation using color pixel classification: analysis and comparison," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 27, no. 1, pp. 148–154, 2005.

[11] M. Abdullah-Al-Wadud and O. Chae, "Region-of-interest selection for skin detection based applications," In Proceedings of the International Conference on Convergence Information Technology (ICCIT '07), pp. 1999–2004, Gyeongju, Korea, 2007.

[12] M. J. Jones and J. M. Rehg, "Statistical color models with application to skin detection," in Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR '99), vol. 1, pp. 274–280, Fort Collins, Colo, USA, June 1999.

[13] M. J. Jones and J. M. Rehg, "Statistical colormodels with application to skin detection," International Journal of Computer Vision, vol. 46, no. 1, pp. 81–96, 2002.

[14] S. L. Phung, D. Chai, and A. Bouzerdoum, "A universal and robust human skin color model using neural networks," in Proceedings of the International Joint Conference on Neural Networks (IJCNN'01), vol. 4, pp. 2844–2849, Washington, DC, USA, July 2001.

[15] N. Bourbakis, P. Kakumanu, S. Makrogiannis, R. Bryll, and S. Panchanathan, "Neural network approach for image chromatic adaptation for skin color detection," International Journal of Neural Systems, vol. 17, no. 1, pp. 1–12, 2007.

[16] S. L. Phung, A. Bouzerdoum, and D. Chai, "Skin segmentation using color and edge information," in Proceedings of the 7th International Symposium on Signal Processing and Its Applications (ISSPA '03), vol. 1, pp. 525–528, Paris, France, July 2003.

[17] K. Chenaoua and A. Bouridane, "Skin detection using a Markov random field and a new color space," in Proceedings of the IEEE International Conference on Image Processing, pp. 2673–2676, Atlanta, Ga, USA, October 2006.

[18] J. Zheng, Lu B.-liang, "A support vector machine classifier with automatic confidence and its application to gender classification," Neurocomputing, vol. 74, no. 11, pp. 1926-1935, 2011.

[19] [28] Shan C., "Learning local binary patterns for gender classification on real-world face images," Pattern Recognition Letters, vol. 33, no. 4, pp. 431-437, 2012.