Colour feature selection for an unconstrained iris recognition system

Ana F. Sequeira, Samaneh Khoshrou, Jaime S. Cardoso
ana.filipa.sequeira@fe.up.pt, {skhoshrou,jaime.cardoso}@inescporto.pt
INESC TEC (formerly INESC Porto) and Faculdade de Engenharia, Universidade do Porto

***Abstract*—We consider the problem of fusing colour information to enhance the performance of an iris authentication system. The discriminatory information potential of a vast range of colour channels is investigated. The verification process is based on open-source implementation made by Libor Masek. A sequential search approach was used which is similar to the "plus L and take away R" algorithm that is applied in order to find an optimum subset of the colour spaces. The colour based classifiers are combined using the SVM classifier to find optimum colour features. We show that by fusing colour information using the proposed method, the resulting decision making scheme considerably outperforms the intensity based verification system.**

I. Introduction

Reliable automatic recognition of persons has long been an attractive goal. As in all pattern recognition problems, the key issue is the relation between inter-class and intraclass variability: objects can be reliably classified only if the variability among different instances of a given class is less than the variability between different classes. Although small and sometimes problematic to image, the iris has the great mathematical advantage that its pattern variability among different persons is enormous [1]. The iris recognition system implemented by Masek [2] was tested with near infrared images. However, this type of imaging imposes a distance related constraint to the system which is not coherent with the goals and situation of an unconstrained iris recognition system. Colour images allow recognition from further distances (than when near infrared illumination is used) which seems more appropriate for these conditions. Radu et al. [3] introduce a score level fusion of colour spaces in an iris recognition system in an unconstrained context. They obtained the discrimination ability of different colour spaces, then try to fuse more discriminate colour features. The main contribution of this work is to apply fusion techniques in order to find the optimal subset of colour channels in an iris recognition system. The paper is organized as follows. In sections II and III, repsectively, an iris recognition system and the concept of colour fusion are briefly presented, respectively. The proposed method is detailed in section IV. Section V will present the dataset of images that were used and the results of the experiments. Conclusions are given in section VI.

The first author would like to thank Fundação para a Ciência e Tecnologia (FCT) - Portugal for the financial support for the PhD grant with reference SFRH/BD/74263/2010.

II. Iris Recognition System

The system used in this project was implemented by Masek [2] (available in open source[1]) is to be composed of a number of sub-systems, which correspond to each stage of iris recognition. These stages are segmentation of the iris region in an eye image, normalisation and feature encoding. The input to the system will be an eye image, and the output will be an iris template, which will provide a mathematical representation of the iris region. In the refered work, the Hamming distance was employed for classification of iris templates, and two templates were found to match if a test of statistical independence failed [1]. For an overview of the system see Fig. 1.

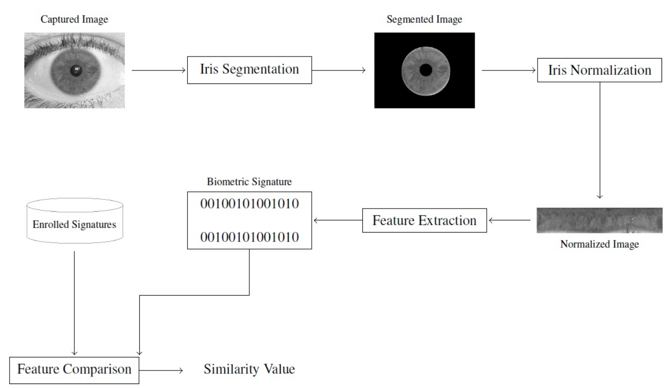

Fig. 1. Irirs recognition scheme, from [4]

III. Fusion Methods

Multiple expert fusion aims to make use of many different classifiers to improve the classification performance. Different colour channels show different performance in various applications. So, it is expected that better performance could be obtained by fusing classifiers based on different colour channels. An adopted version of the sequencial search approach [5], "Plus L and take away R" works based on finding the best "L" features in the beginning and then, try to find "R" worse features from our latest optimum subset. This method finds the best set leading to the best result generally. For all the cases we consider the same features [6].

IV. Method

We convert the images from RGB to other colour spaces. It is common to describe colour as a set of three primary colours

[1]http://www.csse.uwa.edu.au/p̃k/studentprojects/libor/sourcecode.html

TABLE I

RESULTS (%) USING SVM FOR DIFFERENT COLOUR SPACES CONSIDERING EER

	R	G	B	Intensity	H	S	V	RG	RB	GB
FARE	24	22.5	30.2	19.9	45.8	31.9	23.8	34.5	26.2	36.5
FRRE	24	22.7	30.6	19.9	44.9	31.6	23.6	33.9	26.3	36.8
TERE	48	45.2	60.8	39.8	90.7	63.5	47.4	68.4	52.5	73.3
FART	17.8	20.3	27.5	17.3	45.1	33.1	16.9	30.8	23.4	36.3
FRRT	22.7	19.7	27.4	18.2	39.7	22.6	24	35.8	28.6	33.7
TERT	40.5	40	54.9	**35.5**	84.8	55.7	40.9	66.6	52	70

(Red, Green and Blue) but there are different colour spaces that can be used. Wwe are going to use opponent colour channels given by $RG = R-G, RB = R-B, GB = G-B$), *Intensity* and also HSV(for more details see [7]).

An histogram equalization was applied for photometric normalization of images. The segmentation of the iris region was done manually due to the difficulty of applying the segmentation part of the method of Masek [2] to the noisy images of the database chosen (UBIRIS.v2 [8]). The manual segmentation consisted of selecting three points: the center of pupil and iris, one point in the border of pupil and one point in the border of iris. In this process two "major" assumptions were made: the coincidence of the centers of pupil and iris and the circular shape of both regions. Also the noise mask that should be obtained with the information of the occluded regions was considered to be empty, so the iris image used in the posterior process had some noise that was considered as iris regions. After the manual segmentation we used Masek's code for normalization of the iris image, for the extraction of features and matching. Once the raw scores in different colour spaces were extracted then we could start the fusion part of the method.

We worked on the prediction using a support vector machine (SVM) and tried to apply sequential search method on this new set of features. The sequential search algorithm, "Plus 2 and Take away 1" ($+2-1$), was applied for selecting an optimum subset of the colour channels. The system uses the prediction of SVM, which is trained based on hamming distances of client and impostor classes, as input. The selection procedure keeps adding or taking away features (colour channels in our case) until the best evaluation performance is achieved. The optimum set found is applied to evaluate the performance of the system in the test step. Two different approaches (averaging and product) are also employed to give a critical view on differences between various fusion methods.

V. EXPERIMENTAL SETUP

A. Dataset

We used 10 images of each of the 40 different subjects selected from the UBIRIS.v2 database [8]. The major purpose of the UBIRIS.v2 database is to constitute a new tool to evaluate the feasibility of visible wavelength iris recognition under far from ideal imaging conditions.

B. Experimental Results and Discussion

In the following tables, for each different colour spaces, the results are shown using: FARE, FRRE and TERE (False Acceptance, False Rejection and Total Error, respectively, Rate for Evaluation); FART, FRRT and TERT (False Acceptance, False Rejection and Total Error, respectively, Rate for Test). The results of Table I were obtained using a SVM in individual colour channels shown in the table. For Table I the boundary surface for SVM was displaced for minimizing the difference between the FAR and FRR for training (Equal Error Rate, EER). The best performance is obtained in intensity colour space. The results of Table II were obtained using SVM considering EER in three different fusion methods.

TABLE II

RESULTS (%) FOR FUSION METHODS USING SVM CONSIDERING EER

	+2-1	Averaging	Product
FARE	16.7	19.4	19.8
FRRE	16.9	19.4	19.8
TERE	33.6	38.8	39.6
FART	14.6	15.7	16.3
FRRT	16.2	18.1	18.1
TERT	**30.8**	33.8	34.4

In this experiments, the results obtained by adapted "Plus 2 and take away 1" algorithm outperforms "Averaging" and "Product". The best result in individual subspaces was 35.5% for intensity space (see Table I) and for this experiment we had obtained a result of 30.8% for $+2-1$ method. So, as expected the results improved considerably.

VI. CONCLUSIONS

We addressed the problem of using colour information in an iris recognition system. We concluded that, fusing the colour information improves our system. Even using a more inteligent method, sequential search plus SVM method outperforms the blind fusion agorithms such as produtct and averaging.

REFERENCES

[1] J. Daugman, "How iris recognition works," in *Image Processing. 2002. Proceedings. 2002 International Conference on*, vol. 1, 2002, pp. I–33 – I–36 vol.1.

[2] L. Masek, "Recognition of human iris patterns for biometric identification," *Measurement*, vol. 32, no. 8, pp. 1502–16, 2003.

[3] P. Radu, K. Sirlantzis, W. Howells, S. Hoque, and F.Deravi, "Information fusion for unconstrained iris recognition," *International Journal of Hybrid Information Technology*, vol. 4, no. 4, pp. 1–12, 2011.

[4] H. Proenca, "Towards non-cooperative biometric iris recognition," 2006.

[5] P. Pudil, J. Novovičová, and J. Kittler, "Floating search methods in feature selection," *Pattern Recogn. Lett.*, vol. 15, pp. 1119–1125, November 1994.

[6] M. Sadeghi, S. Khoshrou, and J. Kittler, "Svm-based selection of colour space experts for face authentication." in *ICB'07*, 2007, pp. 907–916.

[7] J. D. Foley, A. Van Dam, S. K. Feiner, and J. F. Hughes, *Computer Graphics: Principles and Practice*. Addison-Wesley, 1990, vol. 2nd, no. Book, Whole.

[8] H. Proenca, S. Filipe, R. Santos, J. Oliveira, and L. Alexandre, "The ubiris.v2: A database of visible wavelength iris images captured on-the-move and at-a-distance," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 32, no. 8, pp. 1529 –1535, 2010.