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Эффективный алгоритм распознавания лиц

(Рецензирована)

Аннотация. *Представлен алгоритм для верификации в большинстве случаев одинаково ориетированных на 2D изображениях лиц. Классификатор реализован в виде Евклидова расстояния, параметрами которого служат корреляционные коэффициеты Пирсона. Алгоритм протестирован на общедоступных базах Color FERET and Face94 Directory by Dr. Libor Spacek.*

Ключевые слова: *система контроля доступа, верификация лиц, коэффициенты корреляции Пирсона, ROC-кривые.*

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An efficient face verification algorithm

Abstract. *This paper presents an algorithm without training for an arbitrary database for verification of approximately identically posed faces. The classifier is Euclidean distance with Pearson's correlation coefficients as parameters. The performance of the algorithm is tested on publicly available databases Color FERET and Face94 Directory by Dr. Libor Spacek.*

Keywords: *access control, face verification, Pearson's correlation, ROC curves.*

1. Introduction

Physical access control biometrics includes everything that requires identity authentication by scanning a person's unique physical characteristics. It is used where high security is a necessity due to its superiority compared with conventional access control methods [1]. Face recognition, particularly in unconstrained images with low dimensional feature vector, attracts much research attention as one of the most popular application in access control systems [2]. In two dimensional (2D) recognition basic techniques are [3] eigenfaces, neural networks, dynamic link architecture, hidden Markov model, geometrical feature matching, and template matching. Template matching has two problems [3]: computational complexity and tradeoff between tolerant to certain discrepancies between the template and the test image and preservation the differences that make individual faces unique. We present an algorithm of template matching type with image representation size 1,24 kB that was developed on limited gray-scale image database and comes through these problems.

2. Algorithm

The face verification algorithm is developed for Smilart company access control systems. Their main components are face detection and face verification. The first algorithm passes coordinates of outer points of the left and right eyes to the second algorithm. The face dataset of Smilart company, that contains images of 44 persons, is used for building the algorithm. Gallery consists of 9 differently posed face images per person. Query includes approximately identically posed face images with respect to Gallery (fig. 1).

Fig. 1. Pair of approximately identically posed faces

Our algorithm is holistic matching method [4], i.e. without using any local features, and doesn't require any restrictions over environmental conditions such as scale, lighting, focus, resolution, facial expression, accessories, makeup, occlusions, background, and photographic quality. Frontalization [5] is not carried out since every person in Gallery is presented with a set of differently posed face images. Normalization makes use of coordinates of outer points of the eyes. The source 8-bit images have maximum size 400x400 pixels, after normalization 173x140 pixels. Pre-processing of grayscale images includes local, histogram transformations and reduction of the image to the size 40x31 pixels (fig. 2(b)).

a b

Fig. 2. Images (a) before and (b) after preprocessing (scaled up)

The classifier is Euclidean distance which has as parameters Pearson's correlation coefficients between corresponding rows and columns of two images of type (b) in figure 2. As it will be shown subsequently, the algorithm is applied on arbitrary database without training procedure for this particular one.

3. Experiments and results

Portions of the research in this paper use the FERET database of facial images collected under the FERET program, sponsored by the DOD Counterdrug Technology Development Program Office [6, 7] and the face image database Face94 Directory constructed by Dr. Libor Spacek [8].

3.1. Test fa-fb for FERET

Gallery consists of 994 images from 994 different subjects with neutral facial expressions of first session for all subjects. Query consists of 992 images from 992 subjects with alternate facial expression of first session for all subjects. The test result for $FPR \in [0; 0{,}11]$ is presented in figure 3. In the article [9] it is given the result: $FPR = 0{,}0674$, $TPR = 1$, obtained by SURF method with kd-tree search. At the same point our algorithm gives $TPR = 0{,}993$ and $TPR = 0{,}617$ at $FPR = 0$.

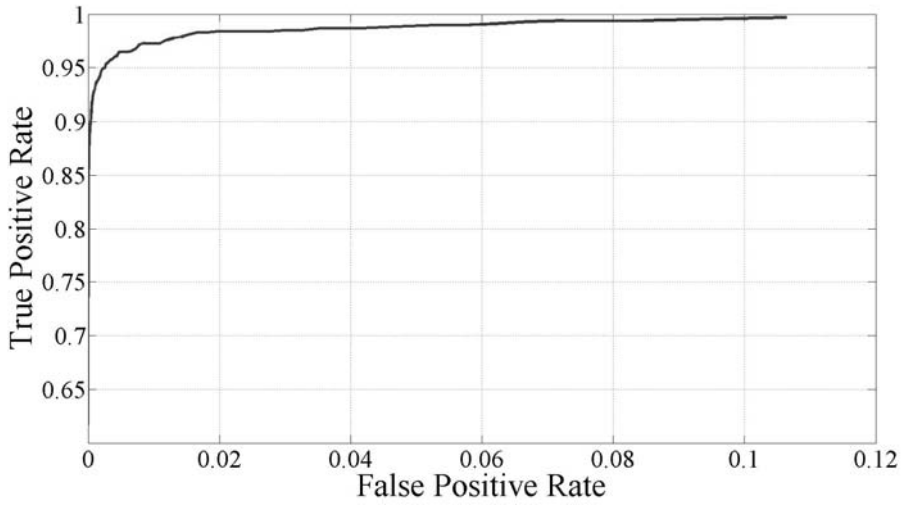

Fig. 3. ROC curve for FERET (fa-fb)

3.2. Test fa-fc for FERET

Gallery consists of 1196 images from 1196 different subjects with neutral facial expressions.

Query consists of 194 images from 194 subjects. Images were taken under different lighting conditions. The test result for $FPR \in [0; 0{,}002]$ is presented in figure 4. In the article [10] it is given the best result: $FPR = 0{,}001$, $TPR = 0{,}7938$, for USC MAR 97 algorithm. Our result is $FPR = 0{,}001$, $TPR = 0{,}922$ and $TPR = 0{,}515$ at $FPR = 0$.

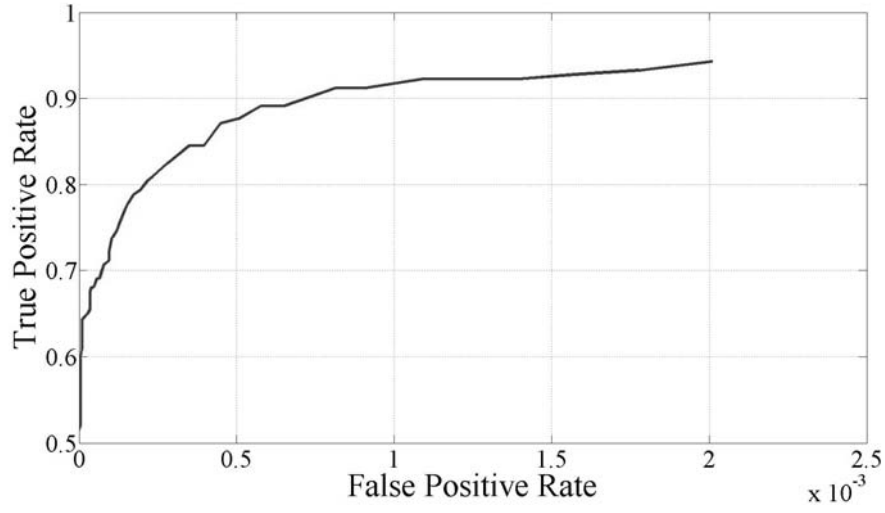

Fig. 4. ROC curve for FERET (fa-fc)

3.3. Test Face94 Directory

The Face 94 Directory contains 20 female, 113 male persons and 20 male staff. There are 20 images for each person. Gallery is formed by random choice one image from every subject and consists of 153 images. Remained 2907 images forms Query. The test result for $FPR \in [0; 0{,}03]$ is presented in figure 5. In the article [11] the result is $FPR = 0$, $TPR = 0{,}61$, provided that for the test database two images for 28 persons randomly were chosen and for the training database six images for 40 persons. We have $FPR = 0$, $TPR = 0{,}91$ under more tough conditions.

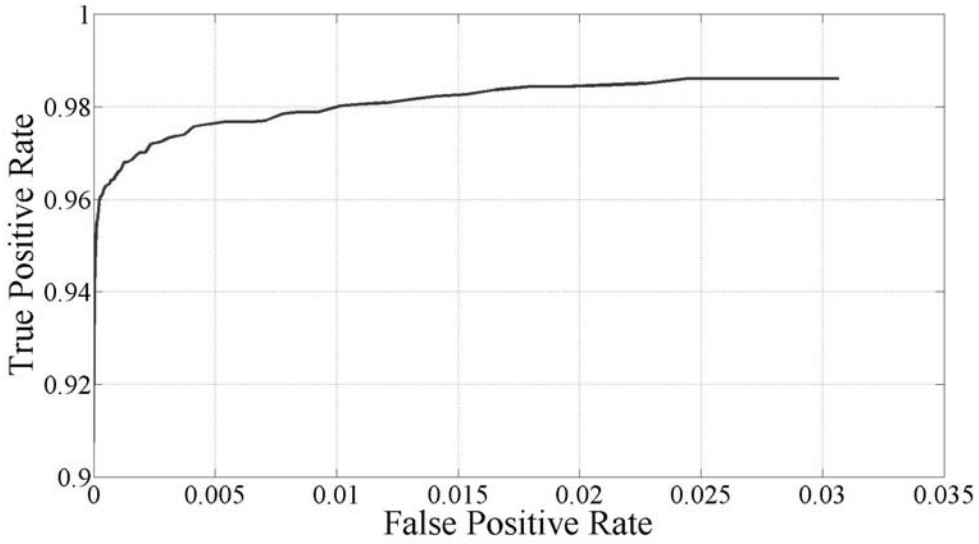

Fig. 5. ROC curve for Face94 Directory

4. Conclusions

Our algorithm without training for a particular database shows high and robust results in the carried out experiments. However, the possibility exists of learning procedure by variation of the classifier parameters for given Gallery, but robustness depends on the size of Query and the method to obtain this database. It will be of interest to study the algorithm in case of frontalization of differently posed faces.

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