Face Indexing On Image Data, Recognition, Tracking And Modeling

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Abstract

In practical application, the result of face recognition not only depends on the static face recognition algorithm, but also depends on the dynamic face recognition algorithm. In a face recognition system, face image acquisition equipment and algorithm processor hardware will also affect speed and effect of the recognition. Therefore, when evaluating face-recognition technology, we should not only carry out the static test of algorithm, but also carry out the dynamic face recognition test of actual faces. At the same time, considering the influence of hardware configuration, hardware configuration parameters of face recognition products or systems should be paid more attention. In the future, the development trend of evaluating face-recognition technology will become both static test in algorithm level and dynamic test of recognition effect to actual faces in application level should be carried out. Even the videotaped face-recognition test and system hardware configuration check should be carried out simultaneously.

Introduction

Face-recognition is a computer technology which can make use of visual characteristic information of human for identification. Since it has many characteristics, such as direct, friendly and convenient, face recognition technology has become a hot research topic in the field of pattern recognition and artificial intelligence currently. As one of the important biometric identification technology of human body, its maturation and improvement will bring brand-new management ways for state security, social security, bank financial security, social welfare and electronic currency payments. According to incomplete statistics, the existing theories and methods of face detection and location include three categories: the method based on face gray level distribution of knowledge rules, the method based on visual features of geometric and the method based on template matching. The theories and methods of face

feature extraction and recognition include three categories, which are the method based on geometric features, the method based on algebra feature and the method based on machine learning. Among these theories, the method based on algebra feature include principal component analysis (PCA), PCA algorithm based on genetic algorithm optimization, etc. The method based on machine learning include artificial neural network technology, support vector machine (SVM), frequency spectrum analysis, the hidden markov model (HMM), and other species. On the basis of the above theories and methods, a variety of research methods are emerged, such as the methods of eigen face, the methods based on the porter of the elastic matching, the flexible model of the separation between shape and gray model

Literature Survey

FOREIGN EVALUATION OF FACE-RECOGNITION TECHNOLOGY

1. FERET(1994,1995,1996)

At present, the most concern about the test evaluations of face-recognition technology are FERET and FRVT and FRGC

in the USA. A. FERET(1994,1995,1996) FERET is the abbreviation of Face-Recognition Technology, it is a face-recognition test launched by the U.S. Department of Defense in 1994. The first FERET test was carried out in August 1994. After six months of March 1995, the second FERET test was started out [4]. Then, the third FERET test was carried out in September 2006, which aimed

2. FRVT(2000,2002,2006)

FRVT (Face Recognize Vendor Tests), which was developed on the basis of FERET tests (1994,1995,1996)[5], had organized three large-scale tests in 2000, 2002, 2006. FRVT 2006 had attracted 22 units from 10 countries. The most famous face-recognition companies, such as Cognitec System GmbH of Germany, the Identix Inc of United States, the Viisage and the Neven Vision, which was acquired by Google recently, attended the tests. Some international famous companies, such as Samsung of Korea, Toshiba of Japan participated in the tests too. In China, Tsinghua University and Peking University participated in the tests. 2D face images, 3D face images and the iris images were tested by FRVT 2006 for the first time, and the comparable results was given. The test results of FRVT 2006 showed that the automatic facerecognition technology had made new progress in the

aspect of improving recognition rate(especially under the condition of changing illumination).

3. Gallery 2008

From April 1, 2008 to July 1, 2008, the Science and Technology Bureau of the Ministry of Public Security, Exit and Entry Administration Bureau of the Ministry of Public Security, the First Research Institute of the Ministry of Public Security, Exit and Entry Administration of Guangdong Province and other units jointly organized face-recognition test of millions level. The test was carried out based on object library, query library A and query library B. Among them, the object library depended on the free album software Gallery, which capacity was 10 million. Query library A, which had a capacity of 100000, was for the Legitimate Probe set test and it aimed at testing False Reject Rate(FRR). Query library B, which had a capacity of 50000, was for the Imposter Probe set test and it aimed at testing False

Acceptance Rate(FAR). The test results of Gallery□2008□were not satisfactory. It caused administrative department worry about the practical application effect of face-recognition technology. The Science and Technology Bureau of the Ministry of Public Security considered that face-recognition technology was not mature and far from the extent to practical application. In order to avoid the unpredictable harm and negative effect to public security management by practical application of face recognition technology, the Science and Technology Bureau of the Ministry of Public Security published a document which forbade the two subordinate Testing Centers of First Research Institute and the Third Research Institute of the Ministry of Public Security from evaluating professional face-recognition products and systems. Of course, the formal inspection reports about face-recognition products and systems shouldn't be issued yet. In some sense, the unsatisfactory results of Gallery (2008) hindered the practical application process of face recognition technology partly.

Methodology

Numerous face tracking methods focus on face appearance and they are developed based on appearance model. Stern et al. [17] developed an algorithm to adaptively change the color space models throughout the tracking sequences. This methodology can be used to find the optimal combination of color space model and color distribution model, which is robust in tracking faces under

varying illumination. In [15], Lui et al. combined a local linearity of an appearance manifold with a new criterion to select a tangent plane for appearance updating in face tracking. This face tracker obtains good performance even when tracking faces undergo large appearance changes. In order to incorporate more face prior into tracker, Wang et al. [20] combined an off-line trained generic face model and an online-learned specific face appearance model in a dynamic Bayesian network.

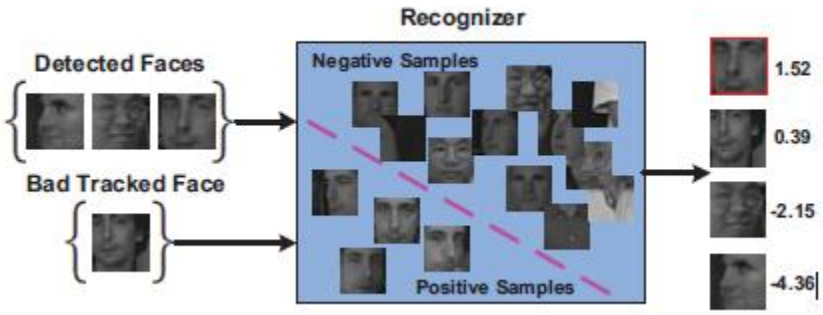

Fig. 1. The function illustration of our recognizer. The recognizer selects the most confident face as the final result from the pool of detected faces and tracked face, hence the bad tracked face will be corrected. The score is the confidence of every face given by our recognizer, and the face with red bounding box is the selected final result.

The recognizer is the key component in our tracking framework. Its most important function is to effectively combine the detection and tracking results, that is to decide which face state is the most confident one among the set of detected faces and tracked face. When the tracking outputs are less confident, for example, the tracker totally loses the target or drifting away happens, the tracked face xT provided by the tracker is un-trustable. Instead, the detected faces set {xiD}n1 provided by the detector is more useful to re-find the initial target face, because at least the detected objects are confident faces and less background will be included.After performing recognizer on {xiD}n1 and xT , the most confident candidate will be recognized as the target face $x*$ if

Algorithm 1 Person-Specific Face Tracking

1: Initialize Boosting+Haar feature based tracker.
2: Initialize LASVM+CCA feature based recognizer.
3: while run do
4: Perform face detector to get detected face set {xiD}n1.
5: Perform tracker to get tracked face xT .
6: Perform recognizer on detected face set {xiD}n1 and get the confidence set {conf iD} n1. Find the face state xmax D with maximal confidence conf max D .
7: Perform recognizer on tracked face xT and get its confidence conf T .
8: if conf T < θr and conf max D > θr then
9: Accept xmax D as the final target face x ∗, and its confidence conf x∗ = conf max D .
10: else
11: Accept xT as the final target face x ∗, and its confidence conf x∗ = conf T .
12: end if
13: if conf x∗ > θu then
14: Update Boosting tracker with x ∗.
15: Update LASVM recognizer. x ∗ is trained as positive sample, and the other faces in {xiD}n1
which has
no overlap with x ∗ and some randomly selected background patches are trained as negative samples.
16: end if
17: end while

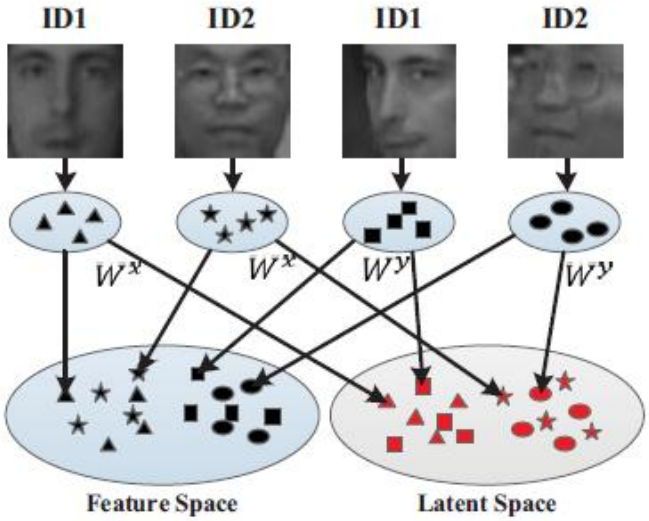

Fig. 2. The illustration of feature space and latent space projected by CCA technique. The feature distance between the faces with different poses of same identity is closer in latent space than that in original feature space. Therefore, pose-invariant face recognition is available in the latent space.

Experimental Analysis and Result

Different from the previous tests mainly used images comparison or static face-recognition, the FRME adopted real time dynamic face-recognition test for field application and videotaped face-recognition test, which was carried out by comparing standard video playback. The test site was selected in the entrances and exits of metro turnstiles. In the test, the independent construction database included 999 face images, which was classified into video capture images, the second generation ID card images and digital images. The number of all kinds of images was 333 in equal. Among them, 47 face images were target person face images, and the others were for interference. The test process of FRME was divided into three stages. The first and second stage were the test of field application, the third stage was the test of videotaped face-recognition. The first stage started on April 15, 2009, and it lasted for 14 days. The measured target persons passed 26896 times during 14 days. According to the results of first stage test, participating enterprises adjusted system parameters adaptability. Using new images database and changing new target person face images, the second stage test carried out for 5 days. The measured target people passed 19935 times during 5 days. Metro live video data and corresponding registration database was adopted in the third stage, and it lasted for 3 days, multi-objective persons appeared 144 times in the video. Considering practical demand, the FRME test did not adopt the Preferred Recognition Rate and N Choices Recognition Rate, even if they are common performance evaluation project in the face-recognition field

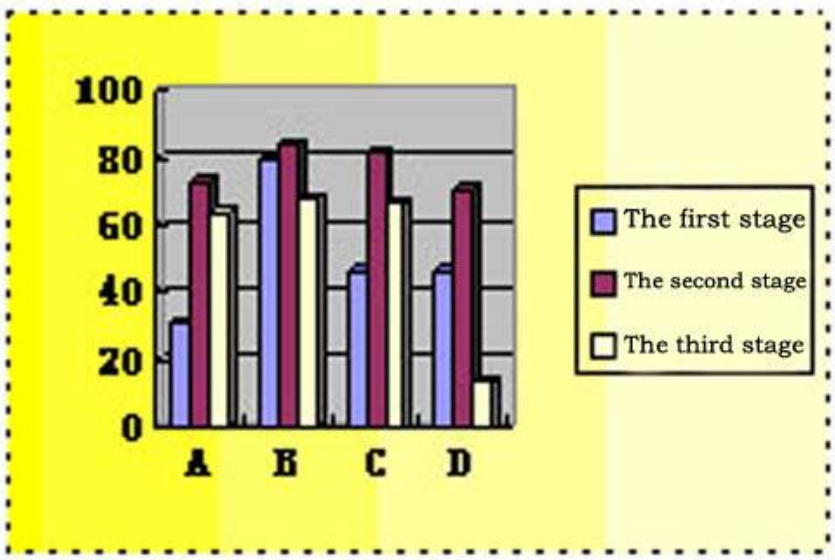

Figure 1. The test results of Target Correct Recognition Rate

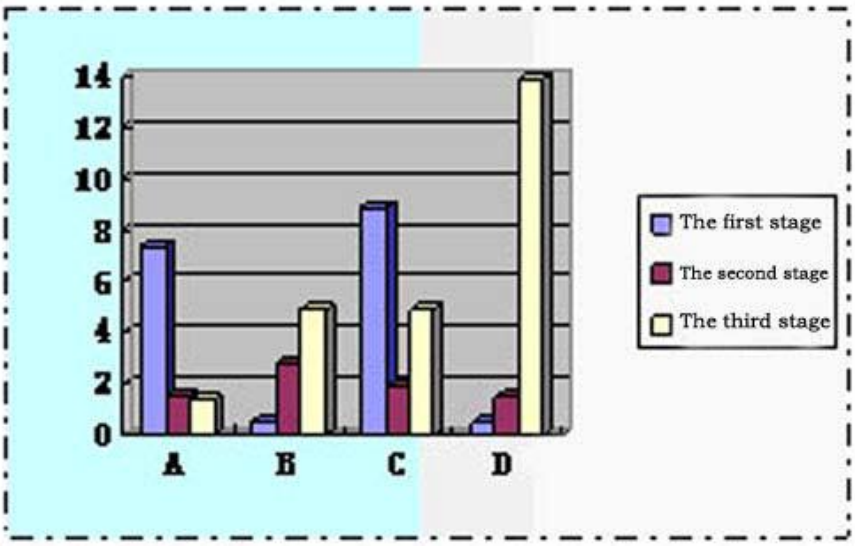

Figure 2. The test results of Target False Recognition Rate

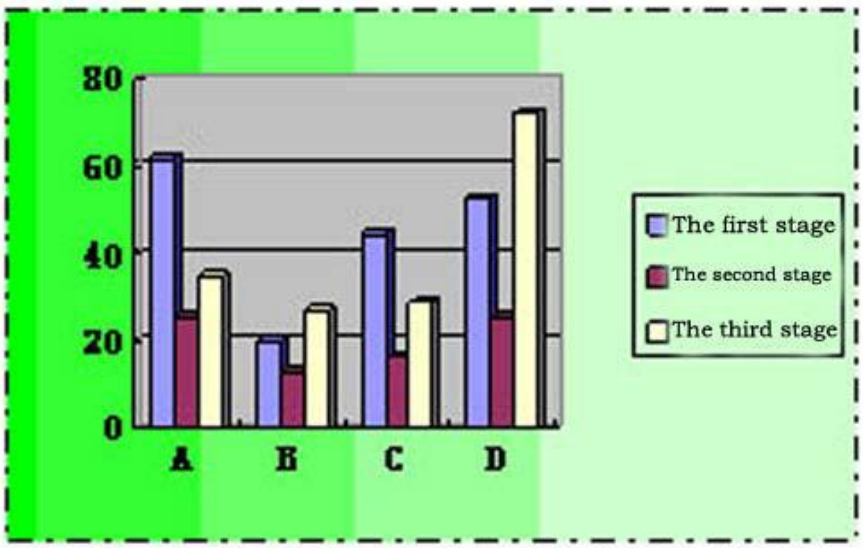

Figure 3. The test results of Target False Negative Rate

Above results indicate that Chinese face-recognition systems won out in the FRME test. Especially in the videotaped face-recognition test of third stage, the Target Correct Recognition Rate of three domestic systems changed roughly between 63%-69%. However, the Target Correct Recognition Rate of Cognitec was only 13.9%, less than 20% of three domestic systems numerical results. Unfortunately, there is a big gap between the test results and the expectations of users, even if to the best one of four systems. Considering the regulation of face-recognition evaluation is forbidden in relevant documents, the Test Center & the Third Research Institute of the Ministry of Public Security did not issue evaluation conclusion for the FRME test, only instead of witness reports of four systems, which merely recorded the test results in accordance with the facts.

Conclusion

A novel person-specific face tracking method is proposed in this paper, in which an off-line face detector, an online tracker and an online recognizer are efficiently combined. Boosting is applied as the classifier in detector and tracker, and the features are MB-LBP and Haar respectively. Considering the good performance of Canonical Correlation Analysis in pose-invariant face recognition, we incorporate it into our online recognizer, combined with an online classifier LASVM. The superior performance in challenging sequences proves the robustness of our framework.

In the practical application of face-recognition technology, the effect of face-recognition is decided not only by static face recognition algorithm, but also by dynamic face-recognition algorithm. In a face-recognition system that used as product, the hardware of human face image acquisition equipment and face-recognition algorithm comparison assembly will also affect the product's actual recognition rate and recognition effect. The test case of FRME (2009) has typical demonstration significance for the evaluation of face-recognition systems. The development trend of face-recognition product evaluation will become static face-recognition algorithm test and dynamic.

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