Research on Key Evaluation Technology for Face Recognition Based on Public Security Traffic Management Business

Gao Jianming, Tang Yichen, Wang Zhengcheng

Abstract

With the continuous improvement of face recognition technology, it has been widely applied in various important scenarios, including public security traffic management. Although preliminary results have been achieved in face recognition technology, there is still a lack of authoritative testing and evaluation for the quality of face recognition algorithms. The testing standards for face recognition systems used in face model training and algorithm testing are generally associated with specific application scenarios. Due to the lack of a systematic and standardized general performance testing specification for face recognition systems oriented towards the field of public security traffic management, this paper mainly analyzes the face recognition scenarios in public security traffic management. It aims to study the key evaluation technology methods and indicators in conjunction with different business application scenarios, according to the relevant industry standards of face recognition, and to build a test library for various face recognition scenarios. This will further improve the application effectiveness of face recognition systems in the field of public security traffic management.

Keywords Face Recognition, Standardization, Public Security Traffic Management, Test Library

1. Introduction

With the rapid development of technologies such as image acquisition and artificial intelligence, along with the continuous improvement of face recognition technology, it has been widely applied in important scenarios such as large-scale public safety prevention, public behavior supervision, and intelligent security. Among them, certain application effects have been achieved in the field of public security traffic management. In December 2018, to standardize the handling of traffic violations and curb the behavior of buying and selling points, various regions built a face recognition technology support service system in accordance with the "Construction Requirements for the Comprehensive Application Platform of Public Security Traffic Management and the Internet Traffic Safety Comprehensive Service Management Platform Face Recognition Technology Support Service System" (hereinafter referred to as "Construction Requirements"). This system realizes the consistency comparison of person and certificate during the handling of traffic violation windows and self-service business processing, effectively preventing and discovering behaviors such as using someone else's identity or substituting for points to accept traffic violation processing. It curbs the illegal act of "buying and selling points" of driving licenses from the source and has been unanimously praised by the public. In addition, under the active exploration of building an intelligent traffic management system, the face recognition system has also achieved preliminary results in other actual traffic management work, such as driver's license examination, full score review education learning, and road traffic monitoring and other business application scenarios.

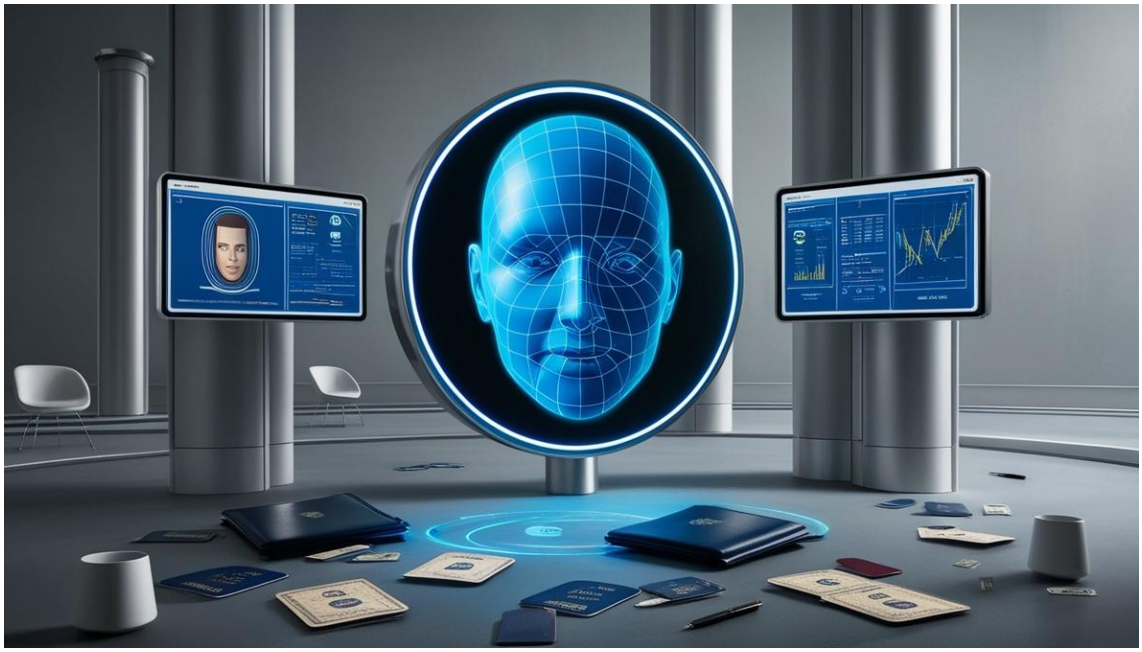
The core of the face recognition system lies in the quality of the face recognition algorithm, which will directly determine the results of the consistency comparison of person and certificate in the business processing process, thereby affecting the service quality of the face recognition system's support for traffic management business. This paper aims to build a test library for various face recognition scenarios according to the

various indicators in the "Construction Requirements," the interface specifications in the "Interface Specifications for Face Recognition Technology Support Service System" (hereinafter referred to as "Interface Specifications"), and the relevant testing standards of face recognition, and to study the key evaluation technology methods in conjunction with different traffic management business application scenarios.

2. Current Status of Face Recognition Evaluation 1.1 Overview of Face Recognition Technology

Face recognition technology is a widely applied biometric identification technique. It acquires images of individuals through imaging or video capture devices, extracts faces from the images, and automatically detects and tracks faces within image or video streams. Subsequently, it employs recognition algorithms to compute and analyze facial features, using certain matching strategies to compare with facial prototypes in existing databases, thereby determining the identity information of the face to be recognized. The algorithmic process of a face recognition system mainly includes: face image acquisition and preprocessing, face detection and tracking, face alignment, facial feature extraction and learning, feature similarity matching, and face identity recognition.

In the research process of face recognition technology, a critical factor indispensable to the implementation of algorithms, model training, algorithm testing, and system performance testing is the large-scale face image database. The scale of the portrait library used for model training and the changes in environmental conditions have a significant impact on the accuracy and robustness of the recognition algorithm. Similarly, the scale of the test set and the facial attributes relied upon for algorithm and system performance testing also have a decisive influence on the scientific and effectiveness of the testing.



2.2 Current Status of Face System Evaluation Development

In the training and performance testing of face recognition algorithms for international face applications, large-scale face image databases that are frequently used include the FERET, LFW, and FRVT series of test sets, which are mostly designed and published by

universities or research institutions. Given the significant differences in facial features between Eastern and Western individuals, the application of international face image databases dominated by Western individuals in the field of face recognition in Asia may have adverse effects on research and application. In recent years, Asian researchers have created some large-scale, multi-attribute Asian face databases for refined fields, such as the Chinese Academy of Sciences' CASPEAL face database, the Chinese University of Hong Kong's WIDER FACE face database, and South Korea's KFBD face database. Currently, there are no government departments or authoritative institutions in our country that have conducted blind testing of face recognition algorithms and systems based on non-public face image databases.

3. Face Recognition Scenarios in Public Security Traffic Management

The application of face recognition technology in public security traffic management scenarios is mainly divided into on-site window and self-service terminal self-service business processing, Internet full score education and review education, driver's license examination, and road traffic monitoring, etc. Facial images are collected through on-site cameras or road traffic monitoring, and compared with ID card face images or existing driver face image libraries for 1:1 and 1:N face recognition to standardize the handling of traffic management business and to detect illegal acts such as substitute testing and unqualified driving.

3.1 Window and Self-service Business Processing

To resolutely curb the behavior of buying and selling points, identity verification through face recognition and other technologies is required during the handling of traffic violations, vehicle management, and other business windows, as well as during self-service business processing. The consistency of the applicant's identity is compared, as shown in Figure 1. Identity verification is carried out before handling the business, strengthening the pre-audit by collecting ID card photos through ID card reading devices, and collecting on-site facial photos through cameras to achieve consistency comparison between the person and the certificate.

3.2 Internet Full Score Education and Review Education

In order to carry out full score education and review education in accordance with the requirements of the "Work Standards for the Full Score Education and Review Education of Motor Vehicle Drivers Violating Regulations and Scoring," real-time capture of the driver's portrait image information and automatic 1:1 comparison with the driver's face library should be conducted to verify the driver's identity information, to achieve precise supervision, and to ensure that the driver himself continues to receive education online, and to detect behaviors that disrupt the teaching order such as being late and leaving early.

3.3 Driver's License Examination

The face recognition scenario for the driver's license examination is used to compare the consistency of the person and the certificate to eliminate the phenomenon of substitute testing and proxy testing. There are mainly: (1) In the driver's license examination and full score learning examination, the driver's theoretical examination is signed before the exam, and before the exam starts and during the exam, the consistency of the person and the certificate is compared through face recognition technology. (2) In the subject two and subject three examination supervision system, when entering the examination room turnstile, signing in before the exam, and before starting the exam, it is required to

compare the consistency of the person and the certificate through face recognition technology.

3.4 Road Traffic Monitoring

The road traffic monitoring scenario currently mainly includes: (1) High-definition face recognition devices are enabled at intersections to capture, identify, expose, and investigate the traffic violations of pedestrians and non-motor vehicles running red lights, as shown in Figure 2. (2) Vehicle passage images are collected through road card mouth equipment, and the driver's face feature information is extracted using deep learning algorithm models, and compared with the backend driver's face feature database in real time for 1:N comparison to confirm the identity of the driver, and further obtain the driver's license status information according to the ID number to determine whether the driver has unqualified driving behavior, as shown in Figure 3. Relatively speaking, the face recognition technology in this scenario has certain requirements for the quality, clarity, and size of the picture, and also has a strong dependence on lighting and angle.

4. Public Security Traffic Management Face Recognition Evaluation Platform

The key to evaluating face recognition applications is a large-scale face image dataset and a scientific face recognition evaluation method. To this end, the Public Security Traffic Management Face Recognition Evaluation Platform is built around the analysis of different face recognition scenarios and the characteristics of portrait images in different scenarios, in accordance with the current state of domestic and international evaluations. The platform mainly consists of a portrait database and three parts: application scenario capture photos, data interfaces, and result analysis modules. The portrait database mainly includes the management and annotation of portrait data; the data interface complies with the "Interface Specification" requirements, suitable for two protocols: associated and not associated with the population database; the result analysis module mainly analyzes and evaluates the face recognition algorithm according to the test results.

4.1 Test Database

The portrait database is divided into a standard ID photo library and a multi-scenario capture photo library, as shown in Figure 4(a), where one ID photo corresponds to multiple scenario capture photos. The standard ID photo library should include portrait photo data such as ID cards and driver's licenses. The multi-scenario capture photo library includes portrait photo data for application scenarios such as vehicle and driver management services, driver's license examinations, pedestrian red light violations, and checkpoint applications as required by the construction plan, as shown in Figure 4(b) for the vehicle and driver management service scenario corresponding ID photos and on-site capture photos; Figures 4(c) and (d) are corresponding ID photos and capture photos for pedestrians and non-motor vehicles running red lights.

The portrait database is built in reference to GB/T35678-2017 "Public Safety Face Recognition Application Image Technology Requirements," meeting the following requirements:

(1) Gender distribution is 50% male and 50% female, with a tolerance of ±5%;

(2) Age distribution is 80% between 18 and 65 years old, with a tolerance of ±5%, and 20% above 65 years old, with a tolerance of ±5%;

(3) Regional distribution is 90% Han ethnicity and 10% for ethnic minorities with facial features close to the Han ethnicity, with a tolerance of ±5%;

(4) The interocular distance in the scene capture photos is not less than 30 pixels, with most not less than 60 pixels; the scene capture photos' occlusions do not cover eyebrows, eyes, mouth, nose, and facial contours;

(5) The scene capture photos meet the requirements of multi-pose face recognition scenarios such as horizontal rotation angle, pitch angle, tilt angle, etc.;

(6) The facial area has no editorial modifications, meeting the requirements of geometric distortion, motion blur, Gaussian blur, and other face recognition scenarios.

4.2 Test Dataset Extraction

Since face images are the main basis for face recognition, the characteristics and quality of the face images used in the evaluation of the face recognition algorithm are the main factors determining the difficulty of the evaluation. Therefore, when selecting the test dataset, it is necessary to closely combine the capture photos under the corresponding test scenarios and randomly extract data from the portrait library according to the attributes of the portrait photos such as quantity, gender ratio, age range, ethnic ratio, posture (no angle, rotation angle, tilt angle, pitch angle), and lighting, so as to select the corresponding scenario library for testing when evaluating the application of the face recognition system in different scenarios.

4.3 Test Result Analysis

According to the similarity comparison results returned by each pair of tested photos (as shown in Figure 5), the False Acceptance Rate (FAR) and False Rejection Rate (FRR) of this face recognition evaluation are generated. The Detection Error Tradeoff (DET) curve of different algorithms is drawn with the false acceptance rate as the horizontal axis, using a logarithmic coordinate for the horizontal axis, and the false rejection rate as the vertical axis, as shown in Figure 6. The inflection point of the curve in the figure is used to evaluate whether the face recognition algorithm complies with the algorithm indicators in the "Construction Requirements," meeting the requirements of a false acceptance rate ⩽ one in 100,000 and a false rejection rate ⩽ 5%.

5. Conclusion

Although face recognition systems have achieved certain results in assisting public security traffic management work, the false acceptance rate and false rejection rate of the face recognition algorithms within the system are key to the recognition algorithms. In order to further improve the effectiveness of face recognition systems, due to the lack of a systematic, standardized, and targeted general performance test specification for face recognition systems oriented towards public security traffic management applications in China, this paper constructs a test library for various business application scenarios of face recognition in public security traffic management, and proposes a method for evaluating the algorithmic indicators in the "Construction Requirements." This provides reference value for the standardized research of face recognition system evaluation in public security traffic management and other application fields.

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Author Biographies

Gao Jianming, Master's degree, Research Intern, research direction is traffic management software evaluation and standardization.

Tang Yichen, Master's degree, Intermediate Engineer, research direction is traffic monitoring product testing and standardization.

Wang Zhengcheng, Master's degree, Research Intern, research direction is traffic monitoring product testing and standardization.

Public Security Bureau Traffic Management Science Research Institute