Application of Face Recognition Technology in The Computer Examination System of Higher Education Self-Study Examination

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ABSTRACT
In order to improve the intelligence of the computerized examination system for the higher education self-study examination and simplify the process of verifying the identity of the candidates, this paper proposes a design method of the computerized examination system for the higher education self-study examination based on face recognition. The requirements of the system are analyzed, and then the structure and functions of the system as well as the key technologies used in face recognition are further elaborated. Finally, the role of the system in the examination process is introduced. Research has shown that the computerized examination system for higher education self-study examinations based on face recognition can realize intelligent management of various links in the examination, improve the efficiency of examinations, and play an important role in identity verification and other links.

Keywords: *face recognition, identity verification, self-study exam, technical exam system*

1. INTRODUCTION

In modern society, industrialization has gradually replaced traditional handicrafts. Today, with the rapid development of various technologies, people have gradually become the role of using machines to create value in social production. In order to be able to prove whether you have a certain skill, obtaining a certificate through an exam has become an important way.

Exams are a way of assessing whether a person has mastered knowledge in certain fields. In traditional exams, many links rely on invigilators. With environmental initiatives, in many exams, paperless exams, such as filling out answer sheets on a computer, have replaced paper-based exams [1]. With the continuous popularization of applications, the structure of the total server-test center server-test room server-client is constructed. Usually, the client is responsible for providing the environment for answering questions, and the test room server is responsible for managing the client in the current test room, verifying the answer sheets and submitting the answer sheets to the test center server. The main server is responsible for summarizing and storing the answer sheets. At the same time, in the higher education self-study exam (hereinafter referred to as the self-study exam), more and more candidates have to be tested for their hands-on ability, such as the practical operation of various professional software, etc., which requires a computer-based exam.

The current computer-based exam simplifies the manual process of issuing, collecting, and summarizing exam papers in multiple exam rooms. But at the same time, it also has omissions. For example, it fails to simplify the process of identifying candidates. At the same time, with the emergence of more and more types of social exams, conflicts between social candidates and exam organizers over identity verification are prone to occur.

In order to solve the problem of examinee's identity verification, this paper introduces face recognition technology into the self-study examination system. Face recognition technology is one of the more popular technologies in the field of artificial intelligence. Many scholars at home and abroad have conducted in-depth research and formed a large number of research results. At the end of the 19th century, Galton published an article on the use of face for identification, and first proposed the concept of face recognition. Then in the mid-20th century, the first report on automatic face recognition was published. Until today, face recognition technology has

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been gradually improved. At present, face recognition technology includes three parts, namely face detection, face tracking, and face comparison [2]. Face detection refers to a method of separating facial objects in a complex environment; face tracking is a technology to track detected faces in a dynamic environment; face comparison is to compare faces with one or more specified ones. A comparison is made to confirm whether or not there is a consistent target. This paper uses face detection and face comparison technology in the examination system to detect faces from pictures and compare them with each target in the candidate database to confirm whether they are consistent.

2. FACE RECOGNITION TECHNOLOGY

Face recognition is a kind of biometric identification technology based on human face information. Face recognition technology determines whether there is a human face in an image or video, and then gives the position, size and position information of each main facial organ of each face. And based on this information, the identity features contained in each face are further extracted and compared with known faces to identify the identity of each face.

The process of face recognition is divided into image acquisition, face detection, face key point detection, face correction, face feature extraction, and image comparison [3].

2.1. Image Acquisition

As input, the quality of face image acquisition is proportional to the time of image processing, and at the same time, it has an important impact on the quality of feature extraction. At the same time, the shooting environment also determines the detection rate of face detection. In high-resolution images, the processing program is required to process more pixels, increasing the processing time accordingly. At the same time, when the face is in a more complex environment, a higher eyeball is proposed for the face detection process. When performing feature extraction, images with lower resolution may not be able to extract key feature information. Therefore, when acquiring an image, it is necessary to be in a monochromatic environment as much as possible and in sharp contrast with the face, and at the same time, a trade-off in resolution is made to take out a resolution with obvious features.

2.2. Face Detection

Face detection is the process of dividing the face and the background. The separation methods generally include: reference template method, face rule method, sample learning method, skin color model method, and eigenface method. In simple environments, segmentation by the skin color model method is one of the most commonly used methods. The method performs detection according to the relatively concentrated distribution of facial skin color in the color space. The greater the gap between the background color and the skin color, the higher the detection accuracy.

2.3. Key Point Positioning Technology

The cheek, left eyebrow, right eyebrow, nose, right eye, left eye, mouth and outline of the face, these 8 parts can be represented by 68 key points, as shown in the figure 1. This method divides the face into internal key points and contour key points to predict separately, which can improve the accuracy of detection. At the same time, the internal key points are predicted by different CNNs for each organ, thereby reducing the amount of calculation. It has better performance in recognition performance and recognition accuracy.

2.4. Face Correction

Face key point detection, there are many ways to achieve, currently the more representative is to use regression to complete. In this paper, Dlib is used for face detection, and the key point detection algorithm [4] used is realized by one of the regression methods. This algorithm uses cascaded regression trees to achieve key point detection, which has good results in speed and accuracy. The core of the algorithm is to use two-layer regression to establish a mathematical model, and the following formula (1) is the iterative formula of the first-layer regression.

$$S^{t+1} = S^t + \gamma_t(I, S^t) \quad (1)$$

Among them, S is the shape vector, which stores the positions of all key points of the face, γ_t is a regressor of one layer, and its input is the current shape vector and the training image, and its output is the update amount of all the key point positions.

In the cascaded regressor of the first layer, after each level of cascaded regressor, the positions of all key points are updated to achieve a more correct position.

The second-level regression is a regression process within γ_t. The algorithm adopts the Gradient Tree Boosting Algorithm method to obtain a series of regression trees. The object is the difference between the current predicted value and the true value.

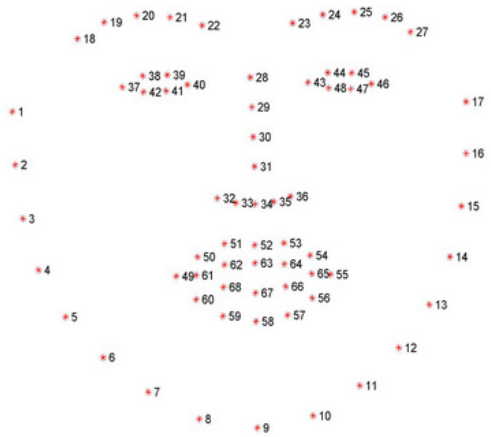

Figure 1 68 Key Points of the Face

The figure shows the positions of the 68 key points of the face finally identified by the above method. The positions and meanings of the numbers are determined. For example, 1-17 marks the lower contour of the face, and 28-36 marks the nose.

2.5. Facial Feature Extraction

The wavelet coefficient matrix is used to extract the features of the face, and the original image is divided into $n \times n$ regions. Let the external evidence image of the face be T, the size is $A \times B$, the sub-region is $T_{i,j}$, the size is $(A/n) \times (B/n)$, then the average value of the wavelet coefficients of each sub-region coefficient is expressed as formula (2).

$$\overline{\omega}_{i,j} = \sum_{T_{i,j}} \omega(x,y), \quad 8 < i < n, 8 < j < n, n > 8 \tag{2}$$

Among them, $\omega(x,y)$ represents the wavelet coefficients, and the feature matrix is represented as formula (3).

$$K = \begin{bmatrix} \overline{\omega}_{1,1} & \cdots & \overline{\omega}_{1,n} \\ \vdots & \ddots & \vdots \\ \overline{\omega}_{n,1} & \cdots & \overline{\omega}_{n,n} \end{bmatrix} \tag{3}$$

Finally, the feature vector V is calculated for the matrix K, and the feature vector is used to represent the features of the face. By adjusting the division granularity n, the dimension of the final feature vector can be controlled, and it is necessary to determine the optimal dimension through experiments.

2.6. Image Comparison

Different from generalized image classification, face recognition has strong characteristics. In generalized image classification, the model needs to further strengthen the classifier through higher-dimensional feature extraction. In the face recognition process, after the face features are extracted, the identity can be confirmed by comparing the features. Especially in the system of this paper, since the reference person of each examination room is determined, the identity of the reference person can be confirmed by comparing the features and calculating the similarity [5].

After face feature extraction, a feature vector is generated for each face data, and feature vector comparison is commonly implemented by calculating Euclidean distance. The Euclidean distance is the straight-line distance between two vectors in space. The smaller the Euclidean distance, the closer the two vectors are, that is, the smaller the difference between the two vectors. The calculation formula of Euclidean distance is shown in formula (4).

$$d(x,y) := \sqrt{\sum_{i=1}^{n} (x_i - y_i)^2} \tag{4}$$

In the formula, $x(x_1, x_2, x_3, \ldots, x_n)$ and $y(y_1, y_2, y_3, \ldots, y_n)$ represent two vectors respectively, and $d(x,y)$ is the Euclidean distance between the two vectors.

3. SELF-STUDY EXAMINATION SYSTEM

Self-study examination system is an online examination system that can provide candidates with examination environment through software and network. In the self-study test, it is divided into two parts: the server and the client, and the server is divided into the test area server that manages the test area and the test room server that manages a single test room. The main functions of the server include maintaining the question bank and test data, candidate information management and examination room status management. The client is responsible for the authentication of candidates, the management of test questions and the management of test status.

This article mainly introduces the candidate information management module of the server and the identity authentication module of the client.

3.1. Candidate Information Management Module

The candidate information management module is a module that manages all candidate information in the current examination area. In the pre-exam preparation, it is necessary to import the information of all candidates in the current examination area into the system, and the system will distribute the candidates' information to the examination room server of each examination room. The examination room server will manage the status of all candidates during the examination, including login status, examination status, etc.

3.2. Identity Authentication Module

In the current examination system, identity authentication is used, which is completed through the admission ticket and the self-verification of candidates. Those who take the test need to enter the admission ticket number on the login interface by themselves, and verify their personal information after logging in. In addition, the invigilator is required to manually compare the candidates' documents with those of the candidates to confirm whether the candidates participate in the examination in person. After all candidates log in to the system, they also need to manually compare the sign-in information with the login information in the system.

4. APPLICATION OF FACE RECOGNITION TECHNOLOGY IN THE COMPUTER EXAMINATION SYSTEM OF HIGHER EDUCATION SELF-STUDY EXAMINATION

In this paper, face recognition technology is applied in the self-study examination. The registration photos of the reference personnel are used as input, and the features of each candidate's face are extracted through the technology of key point positioning and feature extraction. When the examination room is allocated for the examination, the candidate information together with the characteristic information is distributed to the candidate list of each examination room, and the information of all the candidates in the examination area is entered into each server.

4.1. Identity Authentication Process

With the addition of face recognition technology, the process of identity authentication of candidates has changed. The identity authentication and seating arrangements originally handled by invigilators are now completed by the candidates themselves.

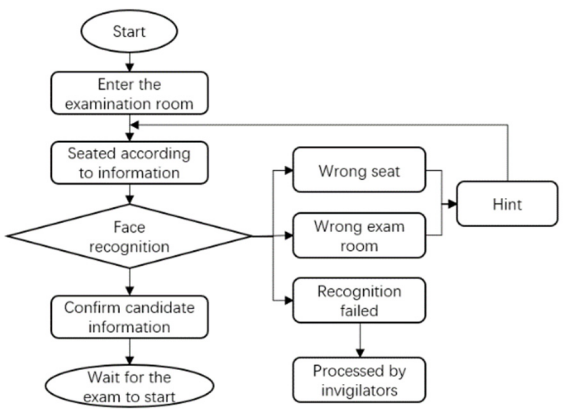

Figure 2 Identity Authentication Process

The identity authentication process is shown in the figure 2. After the candidates enter the examination room, they first take a seat according to the information on the admission ticket, and conduct identity authentication through face recognition. When the correct authentication information is provided, the system will authenticate successfully, and extract the examinee's examination information, and the examinee will enter the system after confirmation. And if there is a problem with the authentication information, the authentication will fail. If the certification is successful in this test room, but the seat information certification fails, the wrong seat will be given and the correct seat number will be informed; if the certification in this test room is unsuccessful, but the test center certification is successful, the test room error will be prompted to guide the candidates to the The correct test room. In addition, when the examinee fails to pass the examination center examinee identity authentication, the invigilator needs to verify the identity of the examinee, and enter the examination system through manual comparison and admission ticket number login.

4.2. Experiment Procedure

In this paper, a face recognition module is added as a verification in the self-study examination of a university. For a batch of 300 candidates who participated in the examination, they log into the system through face recognition to enter the examination. Before the test, facial features were extracted from the photos of the 300 candidates through face detection, key point location, and feature extraction, and stored in the database. During the exam, the face is collected by the camera installed on the exam machine, and compared with the face data in the database to extract the face data with the highest matching degree.

4.3. System Design

Through the above algorithm design, this paper designs a face recognition function that matches the self-study examination system. The system flow is shown in the figure. Before the test, the feature vector is calculated and generated for the face picture entered by the person taking the test, and stored in the database. When initializing the examination room, import the face data into the database of the examination room. When the person taking the test is verified, the feature vector is calculated for the input picture and compared with the database.

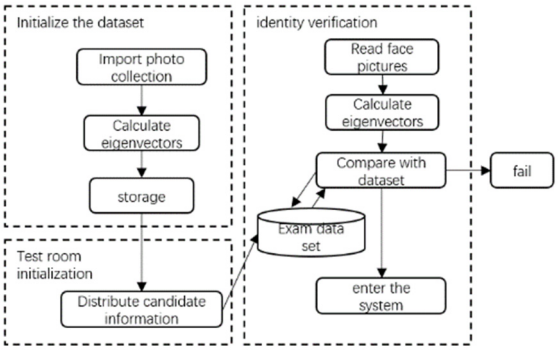

Figure 3 Self-study examination system identity authentication process

In particular, calculating the Euclidean distance can compare the distance between the input data and each data in the known data set, but when the input data does not exist in the known data set, it needs to pass a threshold judgment. In Dlib, the recognition rate for Asians is relatively low, so this threshold needs to be appropriately lowered. In this paper, the first is to compare the Euclidean distance between the candidate's feature vector and all faces in the data set in the test room. Select the most matching one, and then compare it with the threshold to see if the threshold condition is met. Those who are satisfied can be directly compared and passed, and those who are not satisfied can be forced to match and judge with a lower threshold after being verified by the staff to confirm that they are indeed candidates in the examination room. Therefore, this system designs two thresholds for comparison. One is to improve the correctness of successful identification and ensure one-to-one correspondence, so the threshold for automatic identification is increased; the second threshold is a low-threshold matching under the supervision of the staff, and the highest matching degree in the current examination room is matched. Information output and used for comparison.

4.4. Experimental Results

In this paper, by adding face recognition as an auxiliary means of identity verification in the self-study examination computer examination system, it is found that compared with the unused situation, when the number of people in the examination room is 30, the total time spent on pre-exam preparation is reduced by about 30%. %, from 30 minutes to about 20 minutes. Facial recognition is about 96 percent accurate, including seat errors or exam room errors. In the remaining failed cases, 70% were candidates who did not match the photos they applied for and failed to pass the verification. The rest of the results are mostly due to the poor feature extraction results caused by the irregularities of the photos.

5. SUMMARIZE

The experimental results show that the face recognition system can successfully complete the task of identity verification of candidates in the self-study exam. Through the analysis and research of this paper, the application of face recognition technology to the self-study examination computer examination system can improve the efficiency of identity verification, reduce the workload of invigilators, and enable invigilators to focus more on the management of the examination room. After experiencing COVID-19, some exams have been postponed or cancelled in order to avoid the concentration of people. The application of face recognition technology to the self-study exam system can meet the needs of avoiding close foundations. In the future, when using external devices such as cameras, remote examinations can be conducted through monitoring, reducing the safety risk of close contact or being in a closed environment. Face recognition technology has many possibilities in all aspects of the test, which can provide a broader and more convenient space for the test.

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