An Application of Face Recognition Technology in University Classroom Teaching

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***Abstract*—In view of the problems of the classroom attendance system in the current college, such as time-consuming, error-reporting, and so on, through the face recognition technology, the face data of college students are trained, the model is established, and a college classroom intelligent attendance system is designed according to the classroom attendance function requirements. The resulting model is applied to the attendance system. Based on the Unity development environment, the model and attendance system were programmed and implemented, and applied in the classroom. The practice has proved that the system saves more time and makes more effort, and is more accurate and effective.**

Keywords—face recognition, intelligent attendance, model training, university education

I. INTRODUCTION

Artificial intelligence has brought a lot of convenience to people's life. Face recognition technology belongs to the key branch of artificial intelligence - machine vision[1] application field. The technology has been relatively mature and has been widely used.

In addition, with the development of modern society, all walks of life use attendance management to evaluate personnel. On campus, students are often recorded in real time by signing in or calling. However, this method wastes learning time due to large number of personnel, the attendance statistics method is complex and unable to query and analyze in time, and the attendance data is wrong due to individual students' fishing in troubled waters, so that there are time-consuming and false report problems in the attendance of university class roll call, which cannot meet the needs of information-based teaching and the urgent needs of smart campus, but it still exists.

Intelligent attendance system has been widely used in enterprises, schools, institutions and other places, and attendance system based on face recognition technology is the research hotspot[2]. With the rapid development of artificial intelligence technology, deep learning has made rapid progress in face recognition, which provides a new idea for the realization of classroom intelligent attendance system.

II. RELATED WORKS

Face recognition is not a very difficult technology, but also in the classroom attendance system. Fang Guan-nan[3] researched and implemented a class attendance system based on video stream face recognition technology. The system obtains the absolute position information of face by multi task cascaded convolutional neural network face detection method. Combined with the classroom scene segmentation and camera control method proposed by the system, the cloud platform control method based on face target search is completed, which effectively guarantees the requirements of face area image size (pixel). In order to improve the effectiveness and robustness of the face recognition system, the image quality evaluation is introduced into the traditional face recognition system. The algorithm design has a theoretical depth, but from the experimental point of view, the effect is not very ideal in practice, and its popularization value is limited. Jing Zhou et al.[4] designed and implemented an intelligent classroom roll call system based on face recognition, which uses face recognition technology to realize the function of students' regular attendance in class. Compared with fingerprint recognition and iris recognition, the system uses face information as the basis of attendance, which has the advantages of easy access, friendliness and easy discrimination. However, there are some problems in this system, such as low accuracy of multi face detection, high rate of face recognition error, and the corresponding features extracted are easily affected by the attitude, light and expression. Li Wei [5] proposed a classroom face recognition system based on Android mobile terminal, and identified the students' faces collected by mobile camera through Haar face detection method and VGG face feature extraction network method. However, due to the limited shooting area of the system, it does not play a role in urging students to attend class. In reference [6], AdaBoost face detection algorithm is used to obtain single face area image, and principal component analysis (PCA) algorithm is used to realize class attendance system. However, PCA algorithm is sensitive to light, age, expression and other conditions, which cannot guarantee the consistency of extracted face feature information, and the recognition effect is poor.

A. Single Face Recognition

Single face recognition is to put forward a recognition method according to the characteristics of single face. At present, the face recognition technology applied in the market is basically single face recognition algorithm. In reference [7], a single object face recognition algorithm based on DWT-DCT average face and adaptive threshold is proposed. The algorithm first uses skin color model and face geometric features to detect, locate and normalize the inner face, then extracts face features by DWT and DCT transformation, calculates DWT-DCT average face, and finally uses adaptive threshold for face recognition. Experimental results show that the method has recognition validity and authentication reliability. On this basis, many researchers have carried out the research of face recognition technology based on wavelet transform [8-15], and achieved practical research results.

Wavelet transform is the inner product of the basic wavelet function and the signal f (x) to be analyzed in different scales. In image processing, discrete wavelet transform (DWT) is commonly used. The 2D DWT of

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The Ph.D. Research Initiation Fund of Nanchang Institute of Science and Technology (No. NGRCZX-18-01). The Science and Technology Project Fund of Jiangxi Provincial Department of Education (No.GJJ181055, No.GJJ181062)

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function f (x, y) with dimension m × n can be expressed as follows:

$$\begin{cases} W_{\varphi}(j_0,m,n)=\dfrac{1}{\sqrt{MN}}\sum\limits_{x=0}^{M-1}\sum\limits_{y=0}^{N-1}f(x,y)\,\varphi_{j_0,m,n}(x,y) \\ W_{\varphi}^{i}(j,m,n)=\dfrac{1}{\sqrt{MN}}\sum\limits_{x=0}^{M-1}\sum\limits_{y=0}^{N-1}f(x,y)\,\varphi_{j,m,n}(x,y) \\ i=\{H,V,D\} \end{cases} \quad (1)$$

In the above formula: $W_{\varphi}(j_0,m,n)$ represents the corresponding low-frequency sub graph of the image $W_{\varphi}^{i}(j,m,n)$ and $i=\{H,V,D\}$ represent the high-frequency subgraphs of the image in the horizontal, vertical and diagonal directions respectively, and the size of each subgraph is a quarter of the original sub image.

The multi-resolution decomposition of the face image is based on the two-dimensional discrete wavelet transform DWT. The characteristics of the multi-resolution decomposition of the wavelet are basically consistent with the visual perception process of the image. After wavelet transform decomposition, two parts of data are generated, one is wavelet approximation sub graph (LL), the other is wavelet subdivision sub graph (HL, LH and HH). The wavelet approximation sub graph can represent the best approximation to the original face image under the maximum scale and the minimum resolution determined by the wavelet decomposition series. In addition, most of the energy of the original face image in LL is approximated by wavelet, and its wavelet coefficients have good stability. HL, LH and HH can represent the horizontal edge, vertical edge and oblique edge of the original face image. Moreover, most of the energy of detail sub graphs is concentrated on the wavelet coefficients corresponding to the details such as the edge of the original face image, and the coefficients are easily affected by external factors, resulting in poor stability. Therefore, from the perspective of the robustness of face recognition, the feature information of face image should be selected by wavelet approaching the sub image region. The specific algorithm steps are as follows:

(1) First of all, through the skin color features of the face, we can judge whether there is a face in the image. In this step, we use the face recognizer trained by deep learning.

(2) On the basis of the first step, the image is collected by camera, de-noised, binary coded, gray-scale image is formed, skin color block in binary image is merged, proportion and structure of image target area are analyzed, non-face area information is removed, face data set is constructed, or standard face image training set is adopted;

(3) The face image is segmented to get the inner face region including eyes, eyebrows, nose and mouth, and the inner face region is normalized;

(4) The inner face image of a single face is decomposed by wavelet, and the low-frequency sub image is taken as the object of face feature extraction. The low-frequency sub image of each training sample or test sample is obtained, and the final feature vector is obtained by discrete cosine transform (DCT) of the low-frequency sub image;

(5) Through square statistics or histogram statistics, we measure the similarity of the feature vector, calculate the Euclidean distance between the face to be tested and the face to be trained, and compare it with the adaptive threshold value of the specific face object. The sample less than the threshold value is judged as the face to be tested, which means the recognition is successful.

This method can recognize the face identity by comparing the face features and realize the function of single face recognition. It can describe the whole face image by describing the local level texture features of the face image. Compared with PCA, NME and other algorithms [10,13], the calculation amount is relatively small, and the calculation time is relatively short. When calculating face features, it can be accurate to small details, which is more beneficial to face recognition.

B. Multi Face Recognition

On the basis of single face recognition technology, considering the real-time nature of students' attendance in class, it is necessary to study multi face recognition technology [16-20] to determine students' early leave, sleep and other attendance problems. This includes dynamic multi face detection and automatic face tracking, which are mainly composed of image recognition, face detection and dynamic tracking. The core of this method is based on the principle of face detection algorithm of single face recognition, and the key point is the initialization of automatic face detection. Combining the single face detection algorithm with the Cam Shift Tracking algorithm can improve the tracking efficiency. Because of the location of the video acquisition equipment of the face image, and the large image of the face image caused by the illumination in the classroom, the collected face image should be preprocessed before feature extraction, such as image enhancement, normalization and image restoration.

Cam Shift Algorithm [20] has a very high self-regulation performance in the gradient of dynamic density function distribution. It uses the transformation of image color between frames to track the image, and uses the back projection technology to map the probability distribution of the tracking image and the predicted occurrence area to the observation image. This operation page allows zooming, which solves the problem of face deformation caused by distance. LBP [21-26] is a local feature extraction algorithm, which studies the variability of face patterns, focusing on the invariance of translation, scale, distortion and rotation.

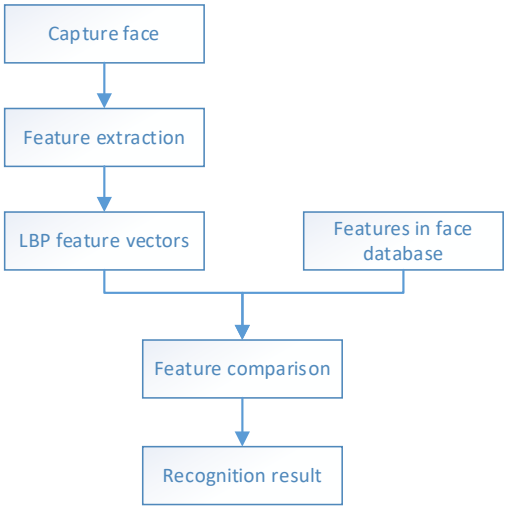

Fig. 1. Multi-face recognition flow chart

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Multi face detection and recognition technology is the focus of research in the field of biometrics, and also the need of the development of artificial intelligence. By combining LBP optimization and comparison method with DWT based single face detection algorithm, a multi face recognition algorithm is proposed. The specific algorithm flow is shown in Figure 1.

III. Design and Implementation of Attendance System

According to system demand analysis, attendance system functions include information management (student information management, classroom information management, face information management), attendance rule setting (shift definition, exception definition, holiday definition), attendance record statistics (by class, by period, by student number), attendance record query (by class, by period, by student number) and other functional modules, as shown in Figure 2.

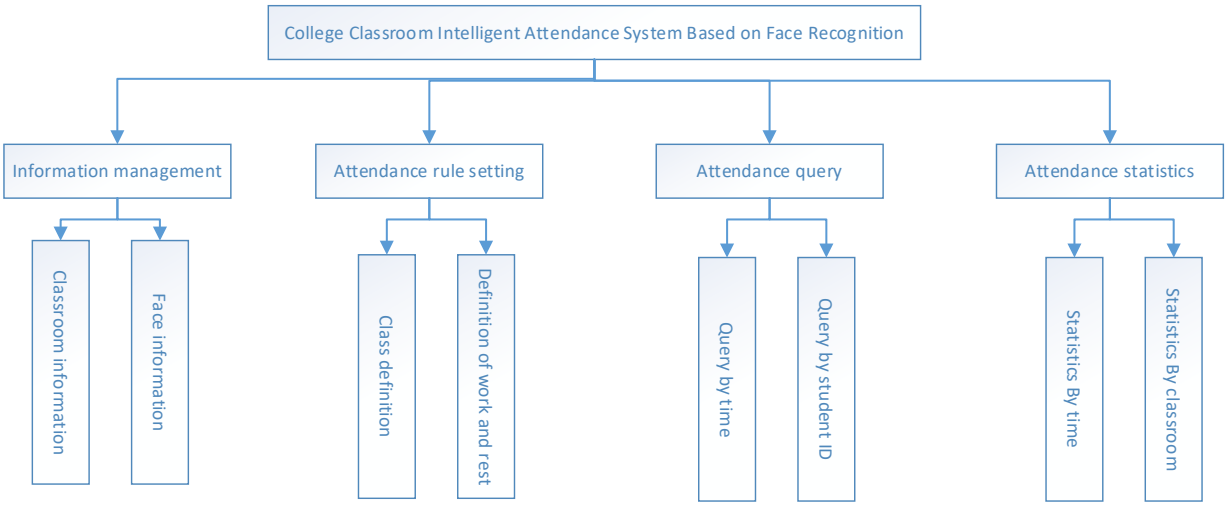

Fig. 2. Functional design diagram of intelligent attendance system

With unity as the development platform and C# as the programming language, face recognition algorithm and application program functions are realized by coding, including interface UI design, face data collection, sign in function coding, attendance management function modules are realized, and are deployed and operated on the PC side. The system development is completed, and the main interface in operation of the software is shown in Figure 3. As shown in the Figure 3, the names, student numbers and check-in status of the students in class a1661 are given. The software is Chinese version, suitable for domestic universities in China. The welcome interface of this system can directly carry out face recognition, and realize comparison, and calculate the attendance results of students.

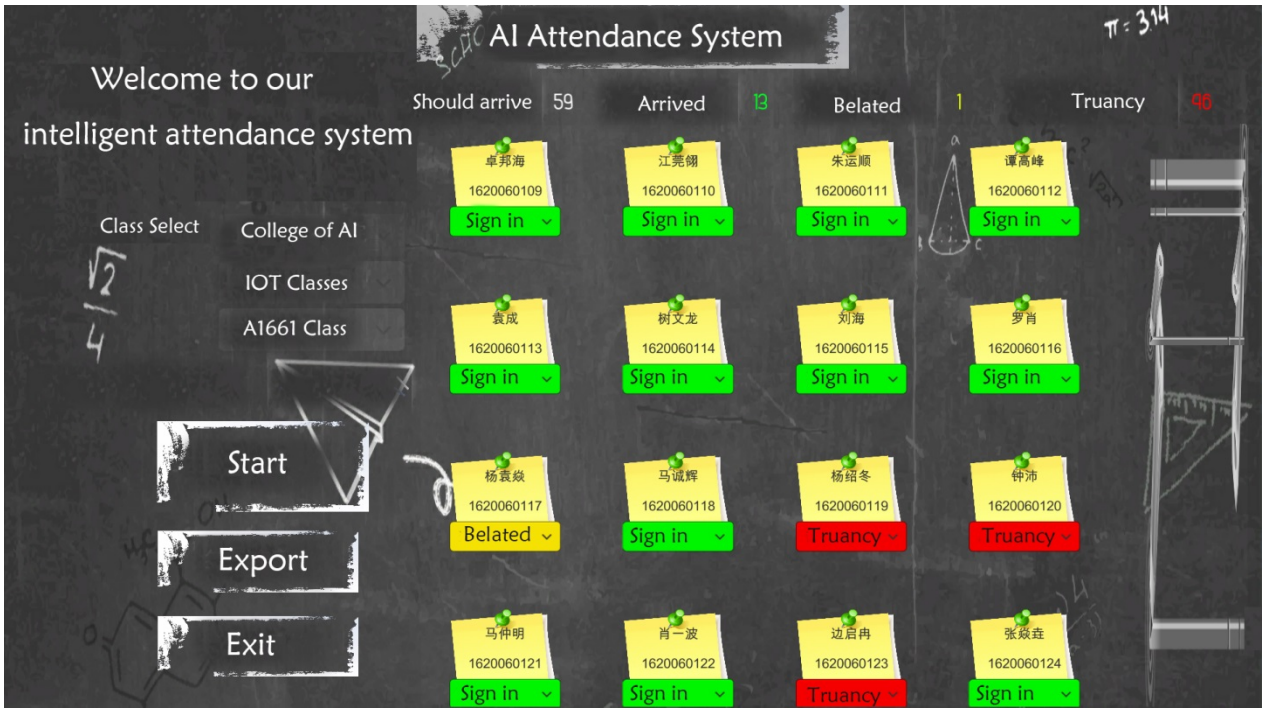

Fig. 3. Functional run result of intelligent attendance system

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IV. Application Result

After the system is developed and tested in the laboratory, the recognition rate of single face can reach 100% in the fixed face database. After the completion of the test, the application test was carried out in the class of 2018, 2017 and 2016 of AI college. The overall performance is good, and the class arrival rate of each class can be accurately calculated. In the system application test period, 2016 students are faced with graduation, irregular classroom behavior and high facial similarity of some students, which leads to a gap in the system attendance statistics and the existence of recognition errors. However, after the classroom teacher assisted attendance or re brushing the face, the problem of error in the attendance statistics can be completely avoided.

V. Conclusion

Class attendance is an effective way to manage the class. It can supervise students to attend and leave class on time, supervise late and leave early, and ensure the class attendance rate and attendance rate. At present, the attendance of students is realized by the way of teaching staff's manual call point and irregular spot check. This traditional way, which consumes a lot of manpower and time, cannot monitor students' attendance behaviors such as late, early leave, substitute and truancy in real time.

In view of the problems of time-consuming and false report in the attendance of university class at present, through the research of face recognition technology, the face data of university class are collected, a single face recognition model is established, and according to the functional requirements of attendance in class, the comprehensive analysis is made that in the classroom, the students' non-stop motion attitude will lead to the fuzzy motion of the face area image in the video sampling frame To solve this problem, a multi face recognition algorithm is proposed, and an intelligent attendance system is designed. The results of face comparison are applied to the attendance system. Based on the Unity development environment, the method and attendance system are coded and applied in the teaching classroom. Practice shows that the system is time-saving, labor-saving, accurate and effective.

However, from the perspective of application effect, there are still problems of students' classroom behavior recognition and attendance misreporting, such as students' standing up, turning around, sleeping on the table and other phenomena cannot be identified and monitored, which will be the next intelligent attendance problem to be solved.

Acknowledgment

This paper is supported by the Ph.D. Research Initiation Fund of Nanchang Institute of Science and Technology with the Project (No. NGRCZX-18-01). The research is supported by the science and technology project fund of Jiangxi Provincial Department of Education (No.GJJ181055, No.GJJ181062).

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