Access Control Management System Integrating Deep Learning Face Recognition and RFID Technology

Mu-Lin Tsai[1], Jia-Xian Jian [2], Chuin-Mu Wang[3,*]

ABSTRACT

The development of the access control system of the cram school was still in a more traditional way, and these methods have their bottleneck. Faced with the problem of student roll-calling, a common approach was to use RFID cards to roll-call. When students enter the classroom, they can take the previously registered RFID card for roll call, which can reduce the time spent on verbal roll call. However, the use of RFID for roll call does not ensure that the person who uses the card for roll call is the person who is calling. If the face recognition system is used to replace the RFID for roll call, it is unavoidable that misjudgment will occur during face recognition.

In this paper integrating deep learning face recognition and RFID technology was proposed to solve one of these problems, which studies and analyzes traditional face recognition technology and deep learning neural network recognition technology. The proposed method in this paper can accurately identify the entrance of a cram school with crowded people and avoid man-made omissions to make up for the situation when the traditional access control system cannot judge. Through comparison and analysis, it is proved that it can effectively improve the efficiency of entrance and exit control.

Keywords: Face Recognition, RFID, Roll Call System, Access Control System.

I. INTRODUCTION

In the past, roll call and access control systems often used paper registration, which often consumed more time and labor costs. Therefore, in the design of access control systems, papers compiled by Qiu Shaowei, Wang Xiasheng, and Cai Jialun [1] and by Wu Wenqin and Ke Bochang In the paper [2] compiled by Huang Qingfu, Chen Junliang, and Chen Nongkun [3], as well as the paper compiled by Liu Dingguo and Yang Zhonghuang [4] Using RFID to design an access control system to bring the past traditions The paper verification method of identity.

RFID has a high-speed reading speed and can read data in harsh and harsh environments. Therefore, it is widely used in the access control system of various workplaces on the market today, but when the RFID card used for identification is lost or picked up by others And malicious use, the access control system cannot detect it.

Therefore, a follow-up author proposed that two or more identification technologies can be used to verify identity. In the paper compiled by Qin Yucheng and Wang Degui [5], a facial recognition system and QR-Code are used for roll call, and students scan QR-Code. Carry out roll call and capture student's face photos for identification, and detect whether there is a sign-in situation at the same time.

Based on the above-mentioned literature discussion, this article retains the characteristics of RFID's rapid and environmental adaptability, and uses the second identification technology to solve the problem of RFID's inability to confirm the true identity. In this article, the current high accuracy and mature development are selected. Face recognition technology is used as the second technology to verify the identity of the call.

In the next section, RFID and related technologies of face recognition will be explained in detail.

II. TECHNOLOGY

Because this paper uses a combination of RFID and face recognition to implement the student's name-calling access control system, this chapter will explain the technology used in this article, and explain the Haar, HOG, and Dlib in the RFID technology and the traditional face recognition technology. Features and SSD, MTCNN, ArcFace technology in deep learning face recognition technology.

2.1 RFID principle

The full name of RFID is Radio Frequency Identification, which is a wireless communication technology. It has the advantages of fast speed, long transmission distance and high environmental adaptability.

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In principle, it can be divided into electromagnetic induction type and electromagnetic wave back propagation type, mainly divided into reading Both the fetcher and the tag are non-contact transmission methods. The electronic tag sensor (tag) can be used to store data. It usually contains a small chip, which is mainly divided into two types: active (Active) and passive (Passive).

The former connotation point holder can actively send data to the reader, but it is larger in size, higher in price, and longer in communication distance. The latter converts the signal transmitted by the receiving reader into the electric energy inside the electronic tag to return data. The advantage is that it does not require an external battery, and is smaller and cheaper, but the communication distance is shorter than that of the active tag. The reader is a tool that reads data from the tag and sends it to the computer system, or stores the data in the tag.

2.2 Face recognition technology

The face recognition technology can be divided into traditional face recognition technology and deep learning recognition technology. In order to compare the accuracy and effect of the two, three methods of Haar, HOG and Dlib are used in the traditional face recognition technology. , In addition, SSD, MTCNN and ArcFace three methods are selected for technical description in the deep learning method.

2.2.1 Haar features

The full name of Haar features is Haar Like Features[6], It was first proposed by Viola & Jone and expanded by Rainer Lierhart to add a 45-degree tilt feature. All Haar feature filters are shown in Figure 1 below.

The filter framed by the red block in Figure 1 is used to extract the edge features of the face in the image, the blue block in Figure 1 is used to extract the linear feature of the face in the image, and the orange block in Figure 1 It is used to extract the central feature of the face in the image, and the last green block is used to extract the diagonal feature of the face in the image.

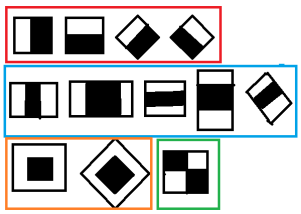

Figure 1. Haar characteristic filter

The Haar feature can be located at any position in the image, and the size can be changed at will. Therefore, the output features of different design filters and placement positions will also change. The larger filter extracts fewer features, but It is also less affected by the complexity of the background, and it is less easy to extract too much background noise data.

2.2.2 Hog features

The full name of the HOG feature is Histogram of Oriented Gradient. It is currently the most commonly used feature of computer vision to describe the local texture of an image. In design, the local area orientation gradient histogram in the image is calculated. To form facial features.

After obtaining the HOG feature vector in the image, it is common to combine the SVM classifier for image classification. At first, SVM and HOG were widely used in pedestrian detection.

2.2.3 Dlib features

Dlib is a modern C++ tool library that is used to solve machine learning algorithms, including robots, embedded systems, mobile devices, etc....

If you want to use Dlib for face recognition, the main steps are as follows [7]:

1. Call the Dlib library to perform face recognition, call shape_predictor_68_face_landmarks.dat, to mark the 68 feature points of the person's face, including the nose, eyes, eyebrows, face contour, mouth and other facial features.

2. Annotate the 68 feature points on the face of the input image, and save the coordinates of the 68 feature points in the image as a method to detect the face in the image.

3.Call dlib_face_recognition_resnet_model_v1.dat, which is a pre-trained ResNet face recognition model for face feature extraction.

4. Perform feature extraction on the face to be recognized to obtain facial feature points.

5. In the follow-up, only the Euclidean distance between the face to be recognized and the feature vector of the previously extracted face is compared to obtain the face similarity.

2.2.4 MTCNN

MTCNN [8] is a multi-task CNN face recognition deep learning network, the network model includes PNet, RNet and Onet.

The full name of PNet is Propose Network. After passing through a convolutional neural network, a picture will output a lot of candidate boxes, and then the IOU value of the candidate boxes will be calculated, and then NMS processing will be performed to filter out redundant or wrong candidates frame.

The input images are 12 × 12 × 3, 24 × 24 × 3, and 48 × 48 × 3 based on PNet, RNet, and ONet. In the use of convolutional layers, ONet is different from PNet and RNet. It has one more hidden layer than the latter two in number. The output of the network architecture is mainly designed for three types of output, namely the classification of faces and the selection of candidate frames. Return to training, the coordinate position of the face.

Because the calculation method of MTCNN needs to continuously filter the candidate frames that are repeatedly

selected, although it has a higher accuracy, it takes a longer time to process an image.

2.2.5 SSD

The full name of the SSD network is SingleShot Mulibox Detector [9]. It first appeared for object recognition, and it can also be applied to face recognition today.

The Backbone of the SSD convolutional neural network is the VGG-16 convolutional neural network. In the SSD network, Its architecture is shown in Figure 2 below. the size of the convolution kernel of the VGG-16 [10] pooling layer is 2 × 2 is changed to 3 × 3, the step length is also changed from 2 to 1, and the final two-layer weight connection layer also changes the size of the convolution kernel to 3 × 3 and 1 × 1. The SSD design is changed to the original VGG -16 The Dropout layer and the eighth fully connected layer in the neural network are removed, and four more convolutional layers are added to it

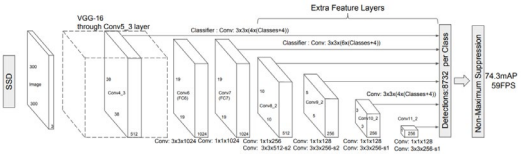

Figure 2. SSD Architecture[9]

2.2.5 ArcFace

ArcFace was compiled by four authors, Jiankang Deng, Jia Guo, Niannan Xue, and Stefanos Zafeiriou[19]. The paper shows that face recognition is divided into four processes, mainly face detection, face alignment, feature extraction, and feature matching. .

The text shows that in the past classification problems encountered in the past, the Softmax loss function was used to classify many times, but after expanding the sample, it was found that there is still a lot of room for the distance between the classes in the Softmax loss function, so it is designed in this paper A new loss function is also called Arcface.

Softmax function that is generally used for classification tasks and the loss function designed in this paper. It can be found that the distance between the class and the class has become larger by using the loss function designed in this paper. The distance within the class has also been reduced a lot, so the number of people who can be identified is more than in the past, and there are fewer misjudgments, and the accuracy has also been improved a lot.

III. EXPERIMENT

First, I will first explain the software operation flow chart and body structure diagram of this article, and conduct experiments and result analysis on the face recognition technology.

3.1 Software operation process

This paper proposes a roll call system that combines face recognition and RFID readers. The flow chart of the proposed roll call system is shown in Figure 3. When students are at the front end of the roll call system, they will read the students' RFID identification card tags and capture them at the same time. The face image of the student, the student data that is finally identified and read will be compared.

If the two discriminating results are the same, the time of the student roll call will be entered into the database for storage. When the data is inconsistent, it will be The staff at the counter will be notified to confirm the student's identity and enter the roll-call time into the database. The above-mentioned method can achieve the purpose of confirming the student's identity at the time of roll-call.

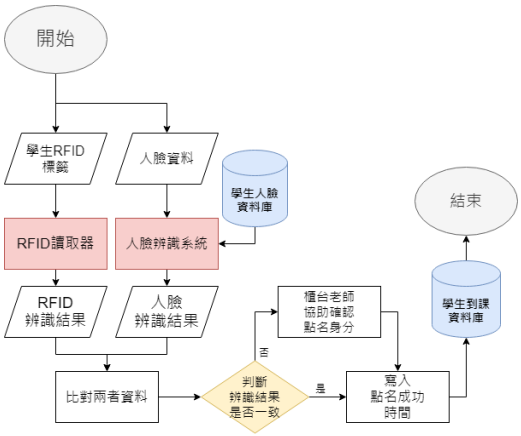

Figure 3. System flowchart

3.2 Hardware architecture

The hardware architecture diagram proposed in this article is shown in the figure. The architecture diagram is mainly composed of a camera, a screen, a display screen, and an RFID reader, as shown in Figure 4.

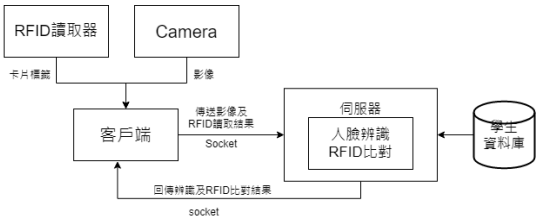

Figure 4. Hardware architecture diagram

3.2 Face recognition experiment

In the traditional face recognition database, in order to improve the accuracy of subsequent recognition, before recognition, each person takes 5 photos and conducts training. The shooting angles are from top to bottom, from left to right, and then from top to bottom. Angle shot (A), elevation angle shot (B), front face shot (C), left shot (D), right shot image (E), for training and identification, as shown in Figure 5.

Figure 5. Face recognition dataset

The output results of the hog method, haar method, and dlib method are shown in Figures 6, 7, and 8.

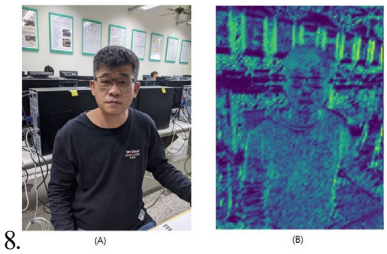

Figure 6. Hog result digram

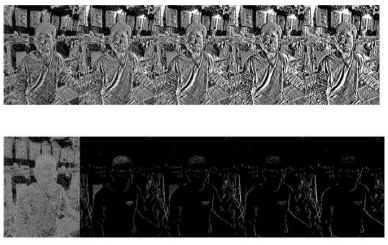

Figure 7. Haar result digram

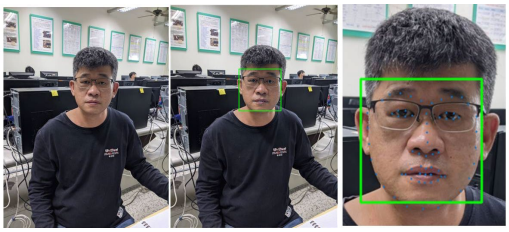

Figure 8. Dilb result digram

Next, we will study the face recognition technology in the deep learning method. This article uses SSD neural network, MTCNN neural network and ArcFace neural network for face recognition.

The database used is the LFW face recognition database for experiments. The output results of the three network architectures are shown in Figures 9, 10, and 11 respectively.

Figure 9. SSD identification result

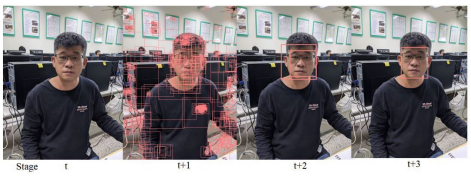

Figure 10.MTCNN identification result

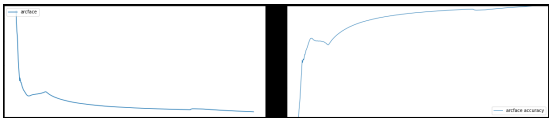

Figure 11. ArcFace Training result

This paper mainly studies the Hog, Haar, and Dlib methods in traditional face recognition technologies. In addition to understanding the face feature extraction methods of each technology.

we also see the shortcomings of the past methods, which are vulnerable to background complexity. The recognition accuracy and accuracy are reduced due to the influence of, the following is a search for the accuracy comparison table of the three traditional face recognition methods, as shown in Table 1, but for the Dlib with the highest accuracy in the traditional face recognition method, judge It takes 0.15s for a 320*240 size picture, which is too long to judge.

Table 1. Accuracy of traditional face recognition methods

Method	Accuracy
Hog	92.68 %
Haar	78.23 %
Dlib	99.38 %

It can be seen from Table 2 that although SSD has faster execution performance compared to ArcFace, it is much worse than ArcFace in recognition accuracy, and ArcFace is better than the former two in terms of execution

performance and recognition accuracy. In addition, compared with traditional recognition methods, the accuracy is also higher, so ArcFace is finally used as the face recognition neural network in this article.

Table 2. Accuracy of CNN face recognition methods

System	Model	Accuracy	Processing time
SSD (VGG-16)	300 x 300	77.2 %	0.021s
	512 x 512	79.8 %	0.052s
MTCNN	P-Net	94.6 %	0.031s
	R-Net	95.4 %	0.458s
	O-Net	95.4 %	1.347s
ArcFace	SE-LResNet50E-IR	99.78 %	0.013s

IV. ADDITION VALUE

In addition, during the implementation process, it can be found that when registering a face image, you can wear a mask for training. When recognizing a face, you can use the ArcFace face recognition network to determine whether a mask is worn.

As shown in Figure 12, using the image of a face wearing a mask for input, the input image will first undergo facial feature extraction (A), and the extracted facial features will be learned through the Internet, and then subsequent identification. It will be detected when wearing a mask (B). If the user does not wear a mask (C), it will not be detected.

(A) (B) (C)

Figure 12. Mask identification

In addition, in the design of the roll call system, an additional parent APP function is also added. Parents can use the mobile phone APP to know the time when their child arrives in class and the attendance status of the cram school in a week, as shown in Figure 13.

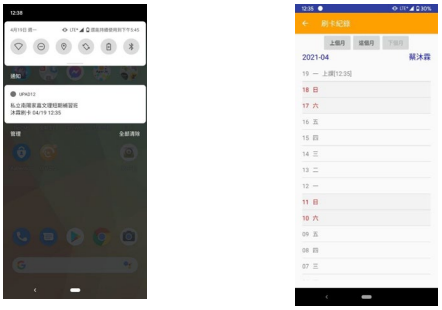

Figure 13. Parent APP

V. CONCLUSIONS

This paper studies other methods and found that RFID can be used to assist students in roll call. However, if only RFID is used for roll call, the RFID card reader cannot confirm whether the person using the card is the student himself, so it proposes to use face recognition to roll the student's name.

However, if you simply use the face recognition system for roll call, it is inevitable that face recognition may cause misjudgments.

Therefore, this article proposes to use a combination of RFID and face recognition methods for student roll call. When students roll the call, they need to perform face recognition and RFID card reading at the same time. When the two discriminant data are consistent, the roll call is successful.

In this paper, the traditional face recognition and deep learning methods are studied, and the ArcFace network model with higher accuracy and faster judgment speed is finally selected as the neural network for face recognition, and at the same time, it can identify whether students are wearing masks. Finally, the mobile phone APP is combined with the application. When the student rolls the name, a notification will be sent to the parents' mobile phone immediately, so that the parents can instantly know the status of the children at home.

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