Joint Identification Method Research of Access System Base on RFID and 3D Face Recognition

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Abstract. In this paper, the main contents of radio frequency identification, 3D(three-dimensional) face recognition, associative recognition algorithm based on radio frequency and 3D face recognition. The associative recognition method combined with radio frequency identification and 3D face recognition proposed in the paper, It can combine the advantages of stable radio frequency identification and high recognition rate and the advantages of 3D face recognition identity security to achieve the purpose of security, high recognition rate and strong operability of the entrance guard system. Therefore, it has broad application prospects in the access control system.

1. Introduction
Radio frequency identification is an automatic identification technology that uses non-contact two-way data communication through wireless radio frequency to identify targets and obtain relevant data. Radio frequency identification technology has the advantages of being able to work in various harsh environments, fast recognition speed and recognition of multiple labels. With the development of technology, radio frequency identification technology has been widely used in logistics, warehouse management, intelligent transportation, automatic identification management of parking lot and entrance guard systems and other fields [1-2].

Face recognition is a process of identifying a portrait identity confirmation in a test image by using a computer according to a certain algorithm to compare and match the obtained image with the image library stored in the computer. The face features are unique. Everyone's face is different. Even the faces of the twins are different. This shows that it is very feasible to use the face for identity confirmation (biometric identification). Therefore, face recognition technology has been widely used in national security, military security and public security, intelligent entrance guard, intelligent video surveillance, customs identification and other fields [3-4].

However, when the radio frequency identification technology is applied to the entrance guard system alone, if the identification card is lost, evildoer can enter the entrance guard system when the radio frequency identification card is detected, thus losing the identity recognition function [5]. 3D face recognition technology is one of the important means of identity identification, but its recognition rate is insufficient and limited to use under the current conditions [6]. To this end, this paper combines the advantages of stable radio frequency identification and high recognition rate and the advantages of 3D face recognition identity security, to achieve associative recognition, in order to achieve the goal of safe, high recognition rate and strong operability of the entrance guard system.
2. Flow graph and joint identification principle of joint identification system

![Flow graph and joint identification principle of joint identification system](image)

**Figure. 1.** Block diagram of the joint recognition system

2.1. The Part of Face Recognition

i. Image acquisition
The face recognition system collects faces through video cameras placed in parallel and performs digital storage. Due to the limited capacity of the video data storage, the evaluation of the current day's data was completed within 48 hours. Video data cannot be kept for too long. On the basis of the quality of the captured images, in order to realize 3D face detection, the images required to be acquired are also three-dimensional. For this reason, we use the handheld 3D laser scanner FastSCAN produced by Canadian Polhemus Company.

ii. Video server
The video server includes 3D face detection, image feature space decomposition and extraction, face matching and sorting, etc.

a. 3D face detection system
The 3D face detection system in this paper mainly uses the geometric features of the depth image itself, uses the depth image processing technology to analyze the geometric features such as the curvature of the surface of the surface, and performs the segmentation of the concave and convex surface and the extraction of the edge of the front side contour. Through the 3D face detection system, the following four functions are mainly required:

First: face detection and segmentation. Detect the presence of a face from any scene and locate it, extracting a face and parts of each area. The feature points we need are automatically marked on the person's face.

Second: the standardization of the face. The changes of the face in terms of scale and rotation are calculated, and the actual position of the face in the process of imaging is obtained, and the three-dimensional model of the face in the library is also changed to the same position. This is a key issue in geometric feature recognition.

Third: face representation. Some methods are used to represent known faces and detected faces in the database. The usual methods are geometric features, algebraic features, feature faces, fixed feature templates, and so on. A multi-level description method is adopted for the feature points of the same photo to form a plurality of geometric feature vectors. This multi-level description method can effectively reduce the occurrence of misunderstanding in the face recognition process. Similarly, the process of identification is also a pattern recognition method that uses multi-classifier cooperation.
Fourth: face recognition. According to the representation method of the face, an appropriate matching strategy is selected to compare the obtained face with the known face in the database. According to the obtained feature points of the face photo, the deflection angle of the deflection of the face is calculated, and a plurality of feature vectors are calculated, and the known face feature point information is taken out from the data inventory to construct a three-dimensional face feature point topology model. The contrast model is deflected to match the environment of the 2D face photo. A plurality of feature vectors of the 3D model is calculated, and the similarity measure is performed on the projection result and the two-dimensional corresponding photo by the multi-level description of the feature features and the pattern recognition method of the multi-classifier cooperation. When identifying, set a threshold for each classifier, set a threshold for the results of all feature vectors, and set a threshold for the results of all feature vectors, once all measurements have reached the valve. The requirement of the value, that is, the identification is successful, otherwise continue to read data from the database for identification [7].

b. Image feature space decomposition and extraction

The image feature space decomposition and extraction method in the design system adopts a non-negative matrix decomposition method that combines category information. This method is a new supervised non-negative matrix factorization method that we have deliberately studied for the non-negative matrix factorization method, which does not make full use of the category information of training samples in the feature extraction process. Although this method still uses the same mathematical formula as the non-negative matrix factorization method, it can fully utilize the category information of the training samples, so that the recognition rate is better than the original non-negative matrix factorization method [8].

c. Face matching and sorting

A face image obtained in advance in face image matching is referred to as a base image, and an image obtained online or in real time during the matching process is referred to as a real-time image. The reference image can be larger than the real-time image or smaller than the real-time image. When the reference image is larger than the real-time image, the matching process is a process of searching for the real-time image position in the reference image; when the real-time image is larger than the reference image, the matching process is a process of finding the target image as a target in the real-time image. The reference image is larger than the real-time image [9] as shown in Figure.2.

![Figure. 2. Base image and real time image](image_url)
A baseline image and a real-time image are approximate descriptions of the same object that are different, set and set as benchmarks, respectively. The grayscale distribution of image and real-time image, without considering the influence of care transformation, has the following relationship

\[ f_r(x, y) = f_b(x + d_x(x, y) + d_y(x, y)) + n(x, y) \] (1)

Of which, \( n(x, y) \) is white noise, can be filtered through a certain method of filtering. \( d_x(x, y) \) and \( d_y(x, y) \) is called location noise, the position deviation in direction \( x \) and \( y \) on the point of \( f_r(x, y) \) and. The position deviation is often caused by the geometric deformation of the image.

There are many methods for image matching. The process of searching for matching sub-images in another image (such as reference image) is called template matching from the known pattern, that is, template image (such as real-time image). Generally speaking, image template matching can be divided into two categories: greyscale based method and feature extraction method. In this paper, we will adopt template matching based on feature extraction, and there are many types in template matching based on feature extraction [10].

**iii. Database servers**

The system database server used in the project is a 3D model system developed by Visual C and OPENGL. The data server has three characteristics:

a. The original 3D face model is obtained by laser scanner or structural light camera. Because the 3D data coordinates obtained are not uniform, in order to be easy to calculate and use, the coordinate should be unified. Through the platform, the original model is smooth and smooth, coordinate transformation, according to the resolution requirements, the 3D face surface data is generated.

b. In addition, a face database server is developed based on Visual C++, OPENGL and DirectShow. Firstly, the video stream is analyzed by DirectShow, and the human face is detected automatically and segmented from the image. After finding the face, the ASM active shape model implemented by VC is used to calibrate the feature points automatically. After the feature points are obtained, the shooting angle is calculated according to the location of the main feature points. After reading the 3D data using OPENGL to construct the abstract 3D model of human face, at the same time, according to the changing model of shooting angle. When the plane projection of the 3D model and the rotation angle of the face in the two-dimensional photograph are the same, the recognition is realized by the method of multi-feature vector generation, multi-classifier discrimination and threshold setting[11].

c. The database server realizes the unified storage of three-dimensional spatial information and attribute information, and the query and retrieval of massive data by using its good storage ability of heterogeneous data and the processing ability of large amount of data.

**2.2. Part of Radio Frequency Identification**

In Figure.1, from the electronic tag to the reader, the hardware device system is as follows:
Figure 3. Structure of electronic tag and reader hardware system

i. **Electronic tag**
The electronic tag is also called the radio frequency card (MI card in the figure). This paper adopts the Mifare S50 radio frequency card, this card contains 1K data storage area, has the data key protection function. The electrical part of the card consists of only one antenna and ASIC. Of which:

ii. **Reader**
RFID card reader is an automatic identification device, its function is to read and write electronic radio frequency data. RFID card reader uses an automatic identification technology, its identification process does not need to contact the card. This RFID reader adopts the MFRC522 series of Mifare RF chip made by NZP of the Netherlands. The reader chip has the advantages of low energy consumption, low working voltage, small size and low price.

iii. **The principle of reading and writing**
By reading and writing registers in the card reader chip, single-chip microcomputer can control the card reader chip. After the system is initialized, the card reader and the radio frequency card enter the reading-card preparation stage, in which the system will search for the card, prevent collision, select the card and verify the password, if the password is verified, The system can apply the operation code to do the desired operation, such as writing data to the card, backing up the data in the card and other functions [12]. The flow chart of the principle of reading and writing is shown in Figure 4.
The MFRC522 reader reads out the data of the identification of the electronic tag and compares it with the database of the legitimate electronic label. If the identity is legitimate, the output is correctly identified and converted to the logical level "1". Or illegitimate, output error recognition and convert to logic level "0".

3. Principle of Joint Recognition
The feature extraction method of 3D face recognition system in the joint recognition system is based on the nonnegative matrix decomposition algorithm of combined category information. The 3D face recognition system consists of three parts: face image acquisition, video server and database server. The video server analyzes the video stream from the image acquisition device, extracts the face feature data, and finally compares with the database server to make 3D face recognition judgment. In the part of 3D face recognition, it is very important to set the threshold value of eigenvalue contrast recognition error. In the case of joint recognition, it is generally set to 30%, and the face recognition output needs to be converted to logic level output, that is, the correct output is high level. Logic value is 1, error output is low level, logic value is 0.

Joint recognition system in face recognition is also need for radio frequency identification at the same time, in a radio frequency identification system, radio frequency card is an electronic tag through reading and writing after reading out identity and legal status data compare with RFID electronic tag database output, by the same token, the RFID also need to be converted into output logic level output, namely the correct output for the high level, the logical value of "1", error output for the low level, the logical value of "0". Face recognition and rfid output are connected with the gate circuit, and the final output is the joint recognition output result, that is, only when face recognition and RFID output are correctly identified, the joint recognition will output the correct identification result.

4. Experiment
The joint identification of RFID and the 3 d face entrance guard system, electronic label use Mifare S50 card, read and write device adopts the MFRC522 chip, 3D face recognition system is developed, including the image characteristics of spatial decomposition and extracting method combined category information nonnegative matrix decomposition method, the system when used alone, face recognition is not high (less than 70%), and the experimental test results as shown in Table 1:
Table 1. Results of system identification test.

| The test conditions         | Ambient temperature | Ambient humidity | Storage environment temperature | Storage environment humidity | Portrait Angle | Radio frequency identification distance | Input voltage       |
|-----------------------------|---------------------|------------------|---------------------------------|-----------------------------|----------------|--------------------------------------|---------------------|
|                             | 0°C~50°C            | 20%~60%          | 10°C~65°C                       | 20%~80%                     | ≥30°C          | ≤7cm                                  | AC 180-240V         |

| Test results                | The RFID system alone USES the recognition rate | The recognition rate of 3D face recognition system is used alone | Joint recognition rate | Recognition speed |
|-----------------------------|------------------------------------------------|-----------------------------------------------------------------|------------------------|-------------------|
|                             | ≤70%                                             | 99.5%                                                           | ≤1                     | Seconds/person    |

5. Conclusion
At present, most of the entrance guard identification system in the market is a single RFID system, especially in the community or unit more applications. There are few face recognition systems in public places such as station and airport. Although the rfid access control system is stable in recognition, security problems are caused by the loss of the radio frequency card and other reasons, while the face recognition is not stable, which requires repeated collection and scan recognition, leading to the low efficiency of access control. Therefore, combining the advantages of radio frequency identification and 3d face recognition, this paper proposes a method of joint recognition based on radio frequency identification and 3d face recognition, which can improve the security and efficiency of access control at the same time.

6. References
[1] Seco F., Jiménez A. R.: Smartphone-Based Cooperative Indoor Localization with RFID Technology. J. Sensors. 18,1-7(2018)
[2] Yu J., Chen L., Zhang R, et al.: On Missing Tag Detection in Multiple-group Multiple-region RFID Systems.J. IEEE Transactions on Mobile Computing. 99,10-18(2019)
[3] Best-Rowden L., Jain A. K.: Longitudinal Study of Automatic Face Recognition.J. IEEE Transactions on Pattern Analysis & Machine Intelligence.28,148-162(2018)
[4] Zhang L., Kakadiaris I. A.: Local classifier chains for deep face recognition[C]/ IEEE International Joint Conference on Biometrics. IEEE,( 2018)
[5] Liu X., Xiao B., Li K, et al.: RFID Estimation With Blocker Tags. J. IEEE/ACM Transactions on Networking.25(1),224-237(2017)
[6] Goswami G., Ratha N., Agarwal A, et al.: Unravelling Robustness of Deep Learning based Face Recognition Against Adversarial Attacks. J. IEEE Transactions on Image Processing.65,34-40 (2018)
[7] Wang W., Wang R., Huang Z, et al.: Discriminant analysis on Riemannian manifold of Gaussian distributions for face recognition with image sets. J. IEEE Transactions on Image Processing.65,46-52(2018)
[8] Zhang L., Dou P., Kakadiaris I. A.: A Face Recognition Signature Combining Patch-based Features with Soft Facial Attributes. J. (2018)
[9] Duan Y., Lu J., Feng J., et al.: Context-Aware Local Binary Feature Learning for Face Recognition. J. IEEE Transactions on Pattern Analysis & Machine Intelligence.27,31-41(2018)
[10] Tang B., Jin W., Randi F. U, et al.: Face recognition using decision fusion of multiple sparse representation-based classifiers. J. Telecommunications Science. 51,38-46 (2018)

[11] Braun E., Radkohl A., Schmitt C, et al.: A Lightweight Web Components Framework for Accessing Generic Data Services in Environmental Information Systems. J. 29,18-28 (2018)

[12] Liu X., Xie X., Li K, et al.: Fast Tracking the Population of Key Tags in Large-Scale Anonymous RFID Systems. J. IEEE/ACM Transactions on Networking.53,21-34(2017)