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# Design of Civil Aviation Security Check Passenger Identification System Based on Residual Convolution Network

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## Abstract

INTRODUCTION: A civil aviation security check passenger identification system based on residual convolution network is designed to improve the efficiency of airport passenger security check service.
OBJECTIVES: The system uses the basic resource layer to provide communication and configuration services, collects the basic information of passengers, the images of passengers' faces and whole body, and the images of baggage security X-ray machine through the data layer, and stores the collected results in the unstructured database;
METHODS: The image processing module of the business service layer calls the data in the database, and takes the STM32F103VBT6 microprocessor as the image processing control chip to complete the image data processing. The person, baggage, X-ray machine image and passenger basic information are associated through the person, baggage and X-ray machine information binding service module, and the association results are uploaded to the person and certificates integration unit of the client application layer.
RESULTS: The face recognition module identifies the passenger identity through the residual convolution network with the attention mechanism, and realizes the ReID identification of passengers and baggage and the association of people and baggage through the transmission control unit.
CONCLUSION: The experimental results show that the system can accurately identify the identity of civil aviation security passengers, and the identification efficiency of security passengers can reach more than 27 frames per second.

**Keywords:** Residual convolution network; Civil aviation security check; Passenger identification; System design; A transmission control unit; Image acquisition module

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## 1. Introduction

The increasing passenger traffic volume of civil aviation has brought new demands and challenges to the safety and efficiency of the existing security inspection system [1]. How to ensure the convenience, speed, safety and comfort of passenger travel is the key to measuring the service of civil aviation airports and building smart and safe airports.

Each major hub airport has launched its own self-service security inspection scheme, for example, based on the security inspection demand of "people bag association" of airport passengers, with the help of face (biology) recognition, radio frequency identification (RFID) and information fusion technologies [2]. It has developed a passenger self-service security inspection system with integrated and interconnected security inspection information to reduce passenger queuing time and improve security inspection efficiency. However, most of these systems are still in the experimental stage, and greatly depend on the performance of face recognition technology.

There is no effective solution to the problem of face recognition (mask occlusion, unclear face shooting, etc.) [3]; Passengers still need to follow the password to cooperate with the machine frequently, which will prolong the time of passing the inspection in the peak period of security inspection. As a "supplement" to the defects of face recognition technology, pedestrian attribute recognition based on attribute correlation can analyze the overall body shape characteristics of passengers (clothing, appearance, hair style, etc.) to achieve real-time retrieval and recognition of target images [4].

In recent two years, some new security inspection systems have been applied and are being promoted to the market [5]. In the actual security check link, the security check function is realized through identity recognition, but these systems still have some problems. On the one hand, for those who are unfamiliar with the security check process and are boarding for the first time, especially those whose faces are obscured or unrecognized, the security gate relying only on face recognition will reduce the traffic speed [6]. On the other hand, before the baggage storage area, passengers must cooperate with the camera face recognition again to complete the information binding of people and trays (bags). In addition, in the entire security inspection process, there is a lack of effective means to track special security inspection objects and on-site events [7].

To solve the above problems, ReID technology can be used in combination with face recognition to solve the defects of single face recognition technology and complete the long-distance dynamic real-time recognition and location tracking of passengers under multi cameras. ReID can realize cross view (cross camera) information correlation. By means of feature extraction and measurement learning, the changing characteristics of people (such as undressing and wearing masks) can be handled in different cameras, and match with the known pedestrian image features; Return the coordinates of pedestrians in the panoramic image to achieve real-time recognition, tracking and positioning.

For identity recognition system, Sadeghzadeh et al. proposed a pose invariant face recognition method based on matching three-dimensional universal model alignment and no occlusion area [8]. This method can accurately recognize faces, but the recognition efficiency is poor due to the complexity of the recognition process; Gunawan et al. proposed a lightweight end-to-end pose robust face recognition system with depth residual equivariant mapping [9]. Combined with the lightweight multi pose method of depth residual equivariant mapping to recognize faces, and finally determined the recognition target by comparing the recognized image data and the data in the database. Although this method can recognize faces, it is limited to the image data in the image database, resulting in low recognition accuracy.

This paper designs a passenger identification system for civil aviation security inspection based on residual convolution network through the integration of residual convolution network and attention mechanism. It can realize "intelligent and insensitive" security inspection without password and active cooperation, quickly complete the binding of passenger baggage and passenger information, and make full use of passenger ReID identification and positioning information in security inspection scenes to achieve accurate query and track tracking of security inspection object field data. The proposed method improves the efficiency of security check and the experience of passengers passing the check, provides effective means for tracking special security check objects (such as suspected criminals, incompetent people, etc.), and reduces the work intensity of security inspectors.

## 2. Design of passenger identification system for civil aviation security inspection

The passenger identity recognition system for civil aviation security inspection is a new intelligent security inspection system, which is based on the complex scene of the security inspection area of the civil aviation airport. It integrates the passenger identity cards and the automatic collection of security inspection information, constructing by rapid identification of passenger and accurate tracking of location, the control and empty frame transmission of the conveyor, and the association of baggage tray, baggage security inspection data and passenger data. From the perspective of data application, the system will design information platform software, which will be used as the interface display of the data of each security inspection link and subsystem of the system. Real time and historical security inspection related information of passengers is displayed visually.

## 2.1 Overall logic structure design of the system

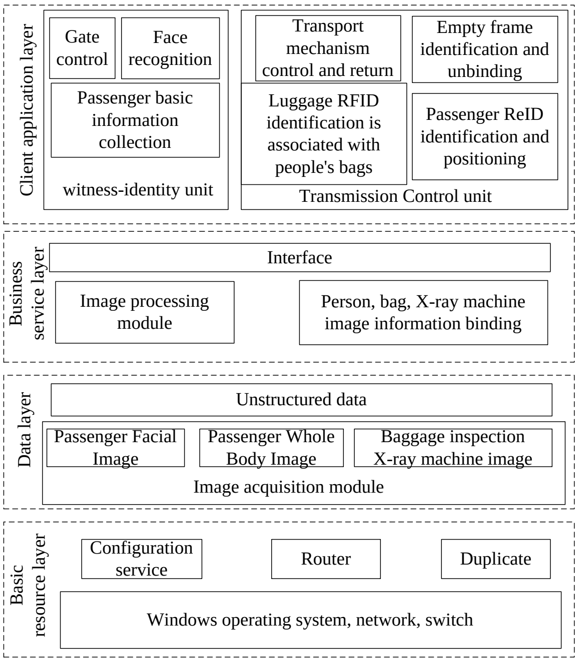



**Figure 1.** Civil Aviation Security Check Passenger Identification System

Based on the hardware functional requirements and software architecture, the civil aviation security check passenger identification system is divided into client application layer, business service layer, data layer and basic resource layer, as shown in Fig. 1.

The basic resource layer in Fig. 1 is the server, network, operating system and other basic resources, providing basic services and technical support for the data layer to collect passenger identity information; The customer application layer is the passenger end, which collects the passenger identity information through the data layer; The data layer sends the collected information to the business service layer through the network; The business service layer analyzes and processes passenger information and updates it in real time. Each part of the civil aviation security check passenger identification system is introduced as follows:

### 2.1.1 Client application layer design

The client application layer is composed of person and certificates integration unit and transmission control unit, which is mainly responsible for data interaction with users and feedback of background processing results to users. The person and certificates integration unit and transmission control unit are system modules that can operate independently by combining software and hardware.

**1. Person and certificates card integration unit**

a) Face Recognition:
During the verification of the passenger's certificate, the image acquisition module [10] is used to collect the whole-body photos of the passenger through the camera according to the data layer, and capture the dynamic face image set (including the infrared image of temperature measurement) for face recognition [11]. After successful identification and verification, call the information binding service to associate the basic information of passengers and face photos.

b) Gate Control:
The gate control complies with the communication protocol of each component, carries out communication signal transmission and reception, and has alarm functions such as anti tailing.

**2. Transmission control unit**

a) Real Time Identification and Positioning of Passenger Reid:
The passengers enter the security inspection channel until they leave, the monitoring cameras around the security inspection scene collect the panoramic images of the passengers, calculate the ReID recognition results (similarity and passenger image coordinates) of the passengers, calculate the real-time real coordinates of the passengers according to the rules defined by the coordinate mapping service, and update and store them in the database.

b) Baggage RFID Identification and Person- Baggage Association:
After the baggage is placed in the baggage tray, the system will identify the information marked by the RFID of the tray, and conduct real-time ReID identification and positioning of passengers. The concept of integrated passenger identification model based on machine learning technology [12] is applied to reduce or eliminate the risk related to the misclassification of smart phone users as measuring passengers. If the passenger identification is successful at this time, call the service to associate the RFID information of the baggage tray, the basis of the person and the identification information; If ReID recognition fails, cooperative face recognition is performed. The RFID information of the baggage tray entering the X-ray machine is recognized by the RIFD reader arranged in the front and back of the X-ray machine. At the same time, the appearance image of the baggage is collected, and the binding service and storage service are called to complete the association and storage of the image information of people, baggage and baggage security.

c) Empty Frame Identification and Unbundling Passengers:

When picking up baggage, the tray located at the empty frame recovery port is suspended from transmission. The camera collects the tray image to identify and determine the empty frame image. After confirming that there is no baggage, the tray is identified by the RFID reader under the empty frame recovery port, and the tray binding information is released.

d) Transmission Mechanism Control and Return:

For suspicious baggage, RFID at the rear of the X-ray machine identifies the tray number, and controls the motor to automatically shunt to the unpacking table for unpacking inspection; For the baggage still suspicious after unpacking, it shall be rechecked again before being returned to the X-ray machine through the recheck line conveyor. The tray identified as empty by the system will be automatically returned to the baggage claim area by the return line at the lower level of the conveyor. The calling of RFID reader, infrared sensor, motor, code scanner and other equipment on the whole transmission machine shall follow the programmable logic control mode.

### 2.1.2 Business service layer

The business service layer is responsible for defining the service content, using the image acquisition module to get the whole body photos of passengers, and the image processing module completes the processing of business logic. The business service layer provides all required services to the upper client application, including: Passenger basic information collection service: receive the identification signal of the device on the gate, analyze and process the identification information, and complete the interaction and intercommunication between the client and hardware data such as the combination of person and certificates. The person, baggage and X-ray machine information binding service module is to associate the person, baggage and X-ray machine images sent by the upper client with the passenger basic information in the database, and update and feed back the association results in real time.

### 2.1.3 Data layer

The data layer mainly completes the collection of passenger basic information, passenger face and whole body images, baggage security X-ray machine images through the data collection module, and stores the collected data through the non relational database.

Among them, the basic information collection of passengers is based on the design of the existing double bar gate in the market. According to the prompts of the on-site voice or prompt board, passengers complete the information collection of boarding pass scanning code, ID number, passport number, on-site face picture of passengers, equipment address, sending time and other information in the document scanning area.

The data layer provides the unstructured data persistence function, which is stored through a non relational database. It mainly stores the basic information of passengers, passenger ID card, baggage related information, passenger site graphics, luggage X-ray machine photos, etc.

The basic resource layer provides various basic resources such as servers, networks and operating systems for the system.

## 2.2 System hardware design

### 2.2.1 Image acquisition module

The image acquisition module is located in the data layer of the system. The image acquisition module is like the eyes of the civil aviation security check passenger identification system, and is the core module of the whole system [13]. The quality of the acquired image will directly affect the complexity of the subsequent image processing algorithm, and then affect the recognition speed and detection accuracy of the system. The image acquisition module is mainly composed of a camera and an optical lens [14].

**1. Camera**

The essence of the camera is to convert optical signals into electrical signals that can be processed by the computer. It is the key device of the civil aviation security check passenger identification system. Its role in the image acquisition module is equivalent to the retina of the human eye. Therefore, the first step in the design of the civil aviation security check passenger identification system is to select the appropriate camera. The main parameters and categories of the camera are described below, and the camera selection is carried out.

a) Main parameters

The resolution is the number of pixels of the image captured by the camera. The digital camera directly corresponds to the number of pixels of the photoelectric sensor, while the analog camera depends on its video system; Pixel size: the smaller the pixel size, the greater the manufacturing difficulty. The digital camera is generally between 3 microns and 10 microns; Pixel depth: the number of bits occupied by each pixel data, most commonly 8 bits, 10 bits, 12 bits, etc.; Maximum frame rate: the rate at which the camera collects and transmits images. For linear array cameras, the number of lines collected per second; for area array cameras, the number of frames collected per second; Exposure mode and shutter time: area array cameras have frame exposure, field exposure and other modes. Linear array cameras are line by line exposure. Digital cameras generally provide the function of external triggering to collect images. The shutter time is generally several tens of microseconds.

b) Camera classification

Cameras can be divided into two categories according to photosensitive chips: CCD cameras and CMOS cameras. CCD (Charge coupled device) has the advantages of high resolution, good imaging quality and fast imaging, but it has high power consumption and high price. CMOS (Complementary metal oxide semiconductor) is a complementary metal oxide semiconductor. Its advantages are low price and low power consumption, but its disadvantages are high noise. CCD camera is selected for this system.

The digital camera has data transmission interfaces such as IEEE1394 and USB3.0. The IEEE1394 interface occupies less CPU resources and has stable transmission speed, but it is gradually fading out of the market due to its low penetration rate; USB3.0 interface is the most commonly used transmission interface in recent years due to its high penetration rate, small resource occupation and stable transmission speed. The passenger identification system of civil aviation security inspection requires high detection accuracy and real-time performance. Therefore, the mer-050-560u3c camera of Daheng company is selected in this paper, which is a color CCD camera. The camera has high resolution and definition, and can collect and transmit high-quality passenger identity images in real time. Its main parameters and characteristics are shown in Table 1.

Table 1. MER-050-560U3C camera parameters

| Parameter name | Parameter |
|---|---|
| Sensor type | CCD |
| Image size | 1/1.8" |
| Resolution | 800(H)×600(V) |
| Pixel size | 4.8μm×4.8μm |
| Frame rate | 560FPS |
| Pixel depth | 10Bit |
| Data interface | USB3.0 |
| Clarity | >585 lines |
| Shutter time | 20-1000ms |
| Lens mount | C |

## 2. Optical lens

The main function of the optical lens is to image the target on the photosensitive surface of the image sensor, which is equivalent to the lens of the human eye in the image acquisition module. If the lens is not suitable, the camera cannot acquire a clear image. Therefore, the selection of optical lens [15] is also very important for civil aviation security inspection and passenger identification system. Generally, parameters and properties such as focal length, image plane size, distortion degree, working distance and zoom ability shall be considered when selecting lens. The following three factors are mainly used for lens selection:

a) Image plane size: that is, the size of the imaging area of the lens should be fully matched with the image plane size of the camera to make full use of hardware resources. If the size cannot be fully matched, at least the principle of "large compatible with small" should be met, that is, the image plane size of the lens should be larger than the image plane size of the camera.
b) Resolution: refers to the ability of the lens to clearly distinguish the details of the photographed object. The higher the resolution, the more details will be retained, and the better the image quality.
c) Distortion: distortion refers to the bending of light at the lens edge, resulting in image distortion. In order to improve the measurement accuracy, the lens with small distortion should be selected as much as possible.

Since the civil aviation security check passenger identification system in this paper needs to be applied in the airport and the lens needs to be frequently adjusted to obtain clear images, the KOWA Xinghe LMZL1236AMPDC-XF zoom lens is selected to automatically adjust the lens and aperture. The main parameters are shown in Table 2.

Table 2. LMZ1236AMPDC-XF zoom lens parameters

| Parameter name | Parameter |
|---|---|
| Image size | 1/1.8" |
| Focal length | 12-360fmm |
| Aperture range | F2.6-22 |
| Zoom | Automatic |
| Distortion | 1.3% |
| Horizontal viewing angle | 33.4°-1.14° |
| Diagonal perspective | 41.1°-1.43° |
| Interface Type | C |

The image plane size of the lens is 1/1.8 Inch, which is exactly the same as that of the MER-050-560U3C camera. It conforms to the principle of lens selection and can be used with the camera.

### 2.2.2 Design of image processing module based on STM32F103VBT6 microprocessor

STM32F103VBT6 microprocessor is the core of the whole image processing module, which is located in the business service layer. Stm32f103vbt6 is an enhanced chip, which is a 32-bit ARM core based microcontroller with 64 or 128K bytes of memory. The microcontroller has the characteristics of high performance, low power consumption and fast motion speed.

The image processing module is a device with STM32F103VBT6 microprocessor as the core. The peripheral circuits include: power supply circuit, key circuit, display circuit, reset circuit, JTAG interface circuit, serial communication circuit, I2C interface circuit, alarm buzzer circuit, image acquisition module, etc. The peripheral circuit of the image processing module is shown in Fig. 2.

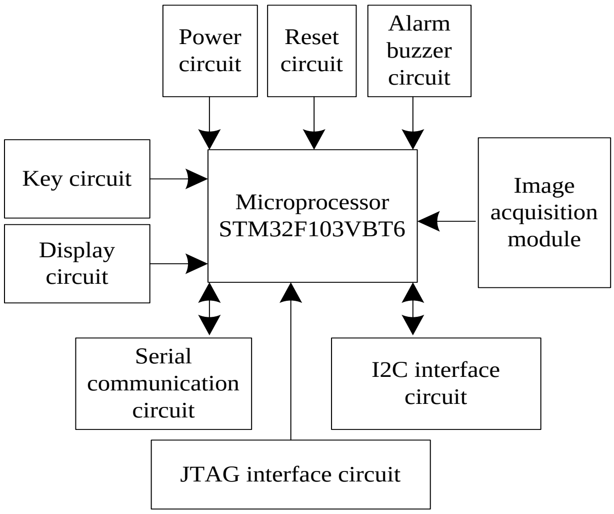



**Figure 2.** Image processing module peripheral circuit

STM32F103VBT6 microprocessor chip includes USB, CAN, 7 timers, 2 ADCs and 9 communication interfaces.

Some functions of STM32F103VBT6 microprocessor:

1. The STM32F103VBT6 microprocessor core is a 32-bit CortexTM-M3CPU, which provides additional code efficiency and exerts the high performance of the ARM core on the storage space of the general 8 or 16 bit system. Its working frequency is up to 72MHz, and it can reach 1.25Mips/MHz when the memory is accessed with zero waiting period. It can perform single cycle multiplication and hardware division.

2. Built in flash memory. It can perform 64K or 128K byte flash memory programs for storing programs and data. And it has up to 20K bytes of SRAM.

3. The built-in nested vector interrupt controller can handle up to 43 maskable roads and 16 priorities. The entry address of the interrupt vector directly enters the kernel, allowing early processing of interrupts. It supports the tail link function of interrupts. When an interrupt returns, it will automatically recover without additional instruction overhead. It provides flexible interrupt management with minimal interrupt delay.

4. Flexible universal DMA can manage data transfer from memory to memory, device to memory and memory to device. The DMA controller supports the management of the ring buffer to avoid the interruption caused when the controller transfers to the end of the buffer. DMA can be used for main peripherals: SPI, I2C, USART, etc. Each channel has special hardware DMA request logic, and each channel can be triggered by software. The transmission length, source address and destination address can be set separately by software.

5. Up to 2 internal I2C bus interfaces can work in multi master mode or slave mode, supporting fast and standard modes. I2C interface supports 7-bit or 10 bit addressing, and dual address addressing is supported in 7-bit slave mode. Built in hardware CRC generator / verifier.

6. The communication rate of universal synchronous / asynchronous transceiver (USART) interface can reach 4.5 Mbit / s, and the communication rate of other interfaces can reach 2.25 Mbit / s. USART interface has CTS and RTS signal management of hardware, supports IrDASIRENDEC transmission decoding, is compatible with ISO7816 smart card and provides LIN master / slave function. All USART interfaces can operate with DMA.

7. A device controller compatible with full speed USB is embedded in the processor, which follows the standard of full speed USB devices. The endpoint can be configured by software and has standby / wake-up function. The 48MHZ clock dedicated to USB is directly generated by the internal master PLL.

Through the structural design of the above identification system, the specific process of identification can be understood. The image acquisition module is used for the data layer of the system. The STM32F103VBT6 microprocessor is used for the business service layer. The introduced modules are applied to the hardware structure to complete the design process of the identification system combining software and hardware.

## 2.3 Algorithm design of face recognition software in client application layer based on residual convolution network

The face recognition module of the client application layer uses the residual convolution network to recognize the face information of the security check passengers of the civil aviation airport and determine the identity of the security check passengers of the civil aviation airport.

### 2.3.1 Basic principle of residual convolution network

The characteristic of the residual network is that it is easy to optimize and improve the accuracy by increasing the depth. Its internal residual blocks use jump links to alleviate the problem of gradient disappearance caused by increasing the depth in the depth neural network. When traditional neural networks transmit information, there are more or less problems such as information loss and loss, which may also lead to gradient disappearance or gradient explosion, making deep networks unable to train. The residual neural network can optimize this problem and protect the integrity of information by directly bypassing the input information to the output.

The appearance of residual convolution network means that the neural network model begins to develop in depth [16]. In the traditional neural network structure, if the calculation accuracy is improved by increasing the network depth, the network gradient disappears, explodes and the accuracy decreases. Residual convolution network [17] can use identity mapping in the added network layer of the constructed deeper network model and use the learned network model in the original network layer. The significance of this method is that the training error of the deepened network model is lower than that of the shallow network model, and a residual mapping is fitted by the multi-layer network to solve the problem of accuracy degradation.

Use $H(x)$ to represent the desired actual mapping, that is, use stacked multi-layer nonlinear networks to represent the mapping relationship fitting, then the multi-layer network will gradually approach the assumption of a complex function and be equivalent to its approaching residual function. The expression obtained is:

$$F(x) = H(x) - x \quad (1)$$

In formula (1), $x$ is the input of the first layer in the multi-layer network, and $F(x)$ represents the residual function. The actual mapping relationship expression is:

$$H(x) = F(x) + x \quad (2)$$

Set the current network as $X$, the deep network as $Y$, the network $X$ and the front part of the network $Y$ are completely the same, and add an identity map to the rear part of the network $Y$, then the performance of the network $Y$ and the network $X$ are the same in theory, and the idea of deep residual learning is also generated. Since the different parts behind the network $Y$ and the network $X$ are identity maps, the prior of this part is added when training the network model, so by adding a shortcut connection in the process of constructing the network, The feedforward neural network that adds shortcut connection to formula (2) is realized. The output of each layer is not the mapping of the input in the traditional neural network, but the superposition of the mapping and the input, as shown in Fig. 3.

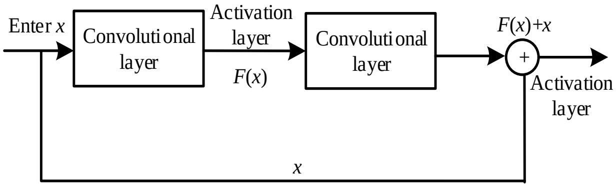



**Figure 3.** Residual network structure

### 2.3.2 Identification algorithm based on residual convolution network

In view of the problems of dense faces and mask wearing in the application of civil aviation security check passenger identity recognition, in order to obtain deeper image parameters, this paper proposes a recognition algorithm using residual convolution network as the backbone network and introducing attention mechanism [18].

After the first convolution pooling, the input image is transferred to the residual block. In each subsequent stage, the convolution plus normalization (Conv+Batch Norm) operation, i.e. Conv Block, is performed. Then, the input image is subjected to multiple Identity Block with the same input and output dimensions. After the convolution from the second stage to the fifth stage, it passes through AVG pool of size 7×7 into the Flatten layer to compress the data into a one-dimensional array, and then connected to the full connection layer.

In this paper, the complete connection layer in the residual convolution network [19] is deleted, and two branches of the complete convolution layer are added to predict the pixel level boundary box and the confidence score respectively. At the end of the fourth stage of the residual convolution network, a step size of 1 and a kernel size of 512 are added × three × three × 1, then perform linear interpolation to adjust the feature map to the original image size, and finally align the feature map with the input image to obtain a channel feature map with the same input image size. The S-shaped cross entropy loss is used to regress the generated confidence heat map on the feature map.

To predict the boundary box heat map, a convolution kernel size of 512×3×3×1 was added at the end of stage 5 of the convolution network [20], similar to stage 4, the feature map is adjusted to the original image size and aligned with the input image. In addition, the insertion of the relu layer ensures that the prediction of the boundary box is non negative, and the prediction boundary is optimized together with the IOU loss function. The final loss is calculated as the weighted average of the losses of the 2 branches.

The reason why the confidence branch is connected at the end of stage 4 of the residual convolution network and the boundary box branch is inserted at the end of stage 5 is that the boundary box of the IoU loss calculation is a whole, so a larger receptive field is required, and the boundary box of the object can be intuitively predicted from the confidence heat map. Therefore, the bounding box branch is regarded as a bottom-up strategy, which can abstract the bounding box from the confidence heat map.

In this paper, the attention mechanism is introduced into the convolution block of the network structure. Given the intermediate feature map as the input $I \in R^{C \times H \times W}$, the trunk part is composed of two groups of residual units, and the branch part is composed of a group of residual units, channel attention modules and spatial attention modules, as shown in Fig. 4.

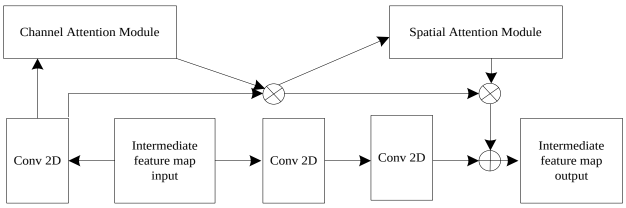



**Figure 4.** Attention mechanism of convolution block

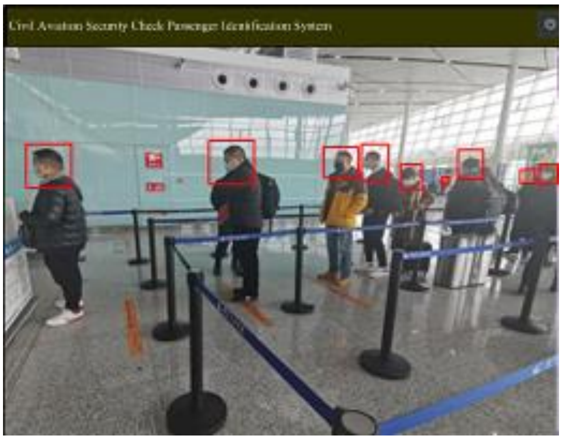
In Fig. 4, the intermediate feature map is input and converted into 2D, and a one-dimensional channel attention map $W_C \in R^{C \times 1 \times 1}$ is generated through the channel attention module; $\otimes$ is the multiplication of the corresponding matrix elements, and the 1-D channel attention map is expanded to $W_C \in R^{C \times H \times W}$ to multiply the corresponding matrix elements; Then, a two-dimensional spatial attention map $W_S \in R^{1 \times H \times W}$ is generated through the spatial attention module, which is also expanded to $W_S \in R^{C \times H \times W}$ along the channel dimension, and then the corresponding matrix elements are multiplied; $\oplus$ represents fusion. The 2D spatial attention map is fused with the intermediate feature map after 2D transformation to obtain the output result of the intermediate feature map.

The above process is the combination of channel and spatial attention learning. By maximizing mutual information among levels, the model is guided to identify more significant identity related information in iterative training.

## 3. Experimental results

### 3.1 Passenger face recognition

(a) Identification of passengers without masks



(b) Identification of passengers with masks

**Figure 5.** System identification results

In order to verify the performance of the above system design, the system is applied to a civil aviation airport. Due to the complex environment of the civil aviation airport, considering that the passengers are often accompanied by staff during the security check, and there are interference reasons such as wearing masks and the passengers do not face the camera directly during the identification process of the passengers, the experiment intercepted two video clips in the security check video of a civil aviation airport on the same day (video comes from the network), namely, the passengers without masks and the passengers with masks. The system in this paper is used to identify the two types of security check passengers in this video clip, and the results are shown in Fig. 5.

From the observation of Figure 5, it can be seen that the passengers are not facing the camera directly in the two pictures. Figure 5(a) shows the identification of passengers without masks by the civil aviation security check passenger identification system. In the figure, there are two airport staff members. The system distinguishes the staff members from the passengers by their clothing characteristics. After excluding the staff members, the identity of passengers without masks can be accurately identified; Figure 5(b) shows that the system can identify the passengers wearing masks in the airport. As shown in the figure, the system can still accurately identify the passengers who wear masks and are dense.

## 3.2 ROC curve and frame rate change per second

In the field of target recognition, ROC curve (Receiver Operating Characteristic curve) and frame rate per second (Frame Per Second，FPS) are often used to objectively evaluate the recognition ability of the algorithm for human faces. ROC curve shows the relationship between true positive rate and false positive. Wherein, the calculation formula of the $\rho$ (True Positive Rate) is:

$$\rho = \frac{TP}{TP + FN} \times 100\% \quad (3)$$

In formula (3), the true positive (TP) represents the number of positive samples recognized as positive samples; False positive (FP) indicates the number of negative samples recognized as positive samples; False negative (FN) indicates the number of positive samples recognized as negative samples. The security check video of the day in the civil aviation airport is selected in the experiment, and the data of 500 face image are obtained by intercepting some images. Windows operating system, VS project 32-bit debug compiler, libcurl (supporting https), openssl, jsoncpp, opencv and other dependent libraries are used to implement the changes of ROC curve and FPS.

The system in this paper is compared with the privacy protection face recognition system based on homomorphic encryption in document [8] and the lightweight end-to-end gesture robust face recognition system in document [9] through the ROC curve. The results are shown in Figure 6.

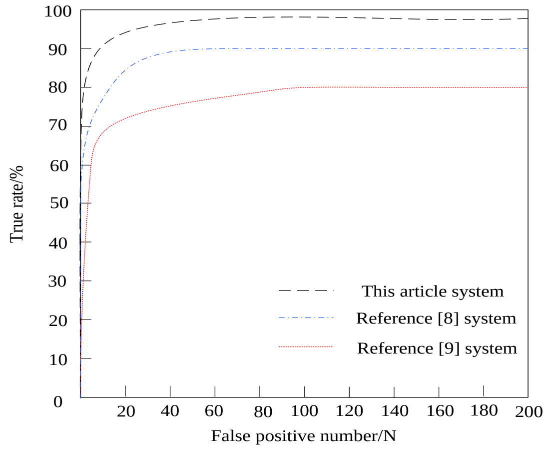



**Figure 6.** ROC curve comparison

It can be seen from the observation of the ROC curve in Figure 6. When the false positive is 20, the true positive rate of face recognition can reach more than 90% and keep stable; Using the literature system [8], when the number of false positives is 40, the true rate of face recognition is barely 90%; The real rate of face recognition using the document system [9] is always 80% or less. When the false positive is 200, the real rate of the system in this paper is 98%, and the real rate of the literature system [8] and the literature system [9] are 90% and 80% respectively. It can be seen that the face recognition using this system is obviously superior to the other two systems, and the recognition result accuracy is high.

Frame per second (FPS) indicates the number of pictures processed per second, which is used to measure the recognition efficiency of the algorithm. In the process of image acquisition, there are light changes caused by different reasons such as weather and angle. The experiment verifies the effectiveness of the system by recognizing the image recognition speed under different light conditions such as normal light, high intensity light and low intensity light. The results are shown in Figure 7.

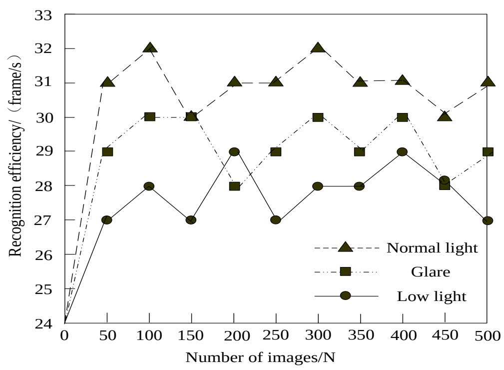



**Figure 7.** Face recognition efficiency under different light

The efficiency range of conventional image recognition is 10-30 frames per second. According to Figure 7, due to the influence of light and complex environment, the system in this paper presents different recognition efficiency when it is used to recognize 500 face images with different light. When the light of the face image is normal light, the recognition efficiency is 30-32 frames per second, which is higher than the conventional image recognition efficiency; When the light of the face image is strong light, the recognition efficiency is 28-30 frames per second through the system in this paper; When the light of the face image is weak, the recognition efficiency is 27-29 frames per second. Therefore, the recognition efficiency of the system in this paper is hardly affected by light when it is used to recognize face images with different light. The recognition efficiency can still reach more than 27 frames per second when the image light is weak. The system in this paper has high efficiency for face recognition.

### 3.3 Passenger identification at different windows

When the system runs for 100 minutes, the results of identifying the identity of civil aviation security check passengers at different windows such as security check port 1, 2, and 3 are shown in Table 3.

From the experimental results in Table 3, it can be seen that the identity of civil aviation security check passengers can be accurately identified within 100 minutes of the system running. Only one case of civil aviation security check passenger identity identification error occurred in window 2. Table 3 experimental results verify that the system can effectively identify the identity of civil aviation security check passengers, and has high identification accuracy in the actual identification of civil aviation security check passengers. The identification accuracy of civil aviation security check passengers in this system is high, which can be applied to the practical application of civil aviation security check and improve the service level of civil aviation security check.

## 4. Discussion

A civil aviation security check passenger identity recognition system based on residual convolution network is designed to provide technical support for the identification of civil aviation security check passengers. Through experiments, it is verified that the system can realize accurate identification of civil aviation passengers and has high applicability. The airport security inspection system is one of the important systems of the airport security inspection department. It provides a comprehensive, safe, accurate, convenient and reliable solution for the airport security inspection, is conducive to improving the security inspection service and management level, and provides an effective information management platform for the airport security inspection. Therefore, the research and development of the airport security inspection system is an arduous and significant task.

1. Improve the comprehensiveness, accuracy and reliability of airport safety information data

The airport security inspection system makes comprehensive use of computer network technology, multimedia technology, video monitoring technology, facial feature recognition technology, second-generation ID card information identification and extraction technology, public security control information data extraction and other technologies to track and store passengers' entry and exit customs clearance through the computer and the airport internal LAN, and process the image and video information of passengers and their luggage. The original information is stored in the database, which can be comprehensively, accurately and

Table 3. Identification results of passengers in civil aviation security check

| Time/ min | Security checkpoint 1/N | | Security checkpoint 2/N | | Security checkpoint 3/N | |
|---|---|---|---|---|---|---|
| | Actual number of passengers | Identify the number of passengers | Actual number of passengers | Identify the number of passengers | Actual number of passengers | Identify the number of passengers |
| 10 | 185 | 185 | 165 | 165 | 181 | 181 |
| 20 | 254 | 254 | 285 | 285 | 305 | 305 |
| 30 | 394 | 394 | 384 | 384 | 415 | 415 |
| 40 | 485 | 485 | 506 | 506 | 528 | 528 |
| 50 | 586 | 586 | 615 | 615 | 635 | 635 |
| 60 | 678 | 678 | 735 | 735 | 728 | 728 |
| 70 | 718 | 718 | 865 | 865 | 846 | 846 |
| 80 | 925 | 925 | 975 | 975 | 934 | 934 |
| 90 | 1035 | 1035 | 1053 | 1053 | 1035 | 1035 |
| 100 | 1165 | 1165 | 1265 | 1264 | 1286 | 1286 |

reliably provided to the decision-making level to deal with safety emergencies at any time, and can be used as reliable evidence for the investigation of safety accidents.

2. Upgrade traditional security inspection methods to improve security inspection efficiency and prevention capacity

The traditional means of using X-ray machine for manual operation in security inspection makes the security inspection staff have high labor intensity, low efficiency, easy to make mistakes, and also affects the quality and service level of security inspection. Research on automatic and information-based security inspection system can improve the ability to prevent aviation safety hazards.

3. Provide interfaces with other relevant business systems to make management more efficient and fast

The data interface interacts with external systems to realize the integration of airport applications. According to the actual situation of the airport, appropriate adjustments and modifications can be made to adapt to the actual needs of the airport business, so as to share information resources among various business systems.

## 5. Conclusion

This paper put forward a new design of civil aviation security check passenger identity recognition system. The system integrates face recognition and RFID recognition and data transmission technology, and introduces ReID recognition and location tracking technology to solve the problems of poor face recognition effect and low inspection experience caused by frequent machine passwords in the actual application of the security check system, and realizes the rapid binding of the image information of passengers, baggage and X-ray machine during the security check process, and forming a senseless security inspection mode. By applying the system to an airport, the high accuracy and efficiency of the identification designed by the system are verified, and the intelligent level of the airport security inspection system is improved, which plays a reference and promotion role for the research and landing of intelligent security inspection.

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