Exploration of building online control simulation training platform

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Abstract. In this paper, it is suggested to build an online air traffic control simulator training platform and incorporate it into the air traffic control simulator training system. The platform is a distributed multi-user training system, which can realize the goal of free remote training for air traffic control students on the computer. Air traffic control students access the platform through a browser and independently train control simulation skills. Teachers can query students' training results online and in real time through the information management service platform, and give comments and remote guidance. Online control simulation training platform can enrich the training methods of air traffic control students control practical skills, effectively alleviate the problems of geographical space limitation, training time limitation, training teachers shortage and so on in control simulation training, improve the practical ability of students, and promote the safe and high-quality development of air management industry.

1. Introduction

With the increasingly complexity of airspace environment that air traffic control faces and the increasing security pressure, the demand for high-skilled control personnel from control units is becoming more and more urgent. In order to train high-quality air traffic control personnel to meet the needs of China's civil aviation, the Civil Aviation Administration of China issued the "General Plan for Teaching Reform of Civil Aviation Air Traffic Control Specialty" in 2011, proposing the implementation of 12 reform projects. The fifth item is "strengthening applied practical ability" and requires "increasing the hours of simulator practical courses" to improve the control practical skills of control students.

According to the reference [1], ATC instruction plays a major role in the overall quality of controllers. Therefore, training the basic control skills of controllers becomes the most important. High quality control simulator teaching can lay a solid foundation for control students to engage in control work after graduation. The training of practical skills of control students is mainly carried out through control simulator teaching. Control simulator equipment provides students with realistic video environment and voice environment for control work, and it plays an irreplaceable important role in the cultivation of practical skills of control students by cultivating the ability of comprehensive application of control
theoretical knowledge. In 1998, Wang Chao etc. developed a radar area control simulation training system with the main functions of DRS-93 radar simulator, which is suitable for operation and Practice on an independent computer [2]. Li Nan etc. developed a desktop airport tower control simulation system, which simulated all aspects of the airport tower control, and provided a virtual reality training environment for the air traffic control students [3]. But the simulation training for online is not involved.

2. Teaching Status of Air Traffic Control Simulator

2.1. Teaching Status of Air Traffic Control Simulator Abroad
Internationally, control simulators are widely used to train controllers’ control skills. Taking France as an example, the French Civil Aviation Institute uses the control simulator produced by Thomson Company to train the control skills of the control students, and trains the control command ability of the students by providing realistic control scenes. In addition, some countries have developed a series of simulation games on regulatory themes. Japanese game maker Techno Brain has developed Air Traffic Control 3, a control simulation software. The software is based on the development of three-dimensional graphics. The system sets the program level according to the rules of easiness, difficulty, and progressiveness. Players complete the specified goals and obtain the corresponding points for customs clearance. The game combines fun and regulatory expertise, and is a regulated game with a certain reputation in the regulatory industry.

2.2. Current Situation of Control Simulator Teaching in China
At present, there are three universities in China that have the qualifications to train civil aviation air traffic control personnel: Nanjing University of Aeronautics and Astronautics, civil aviation university of china and China Civil Aviation Flight College. In the undergraduate training of control students, control simulator equipment is used to train the control skills of control students.

China's major manufacturers of control simulator equipment are Wisesoft Co., Ltd. and Nanjing LES Information Technology Co., Ltd. Some civil aviation universities have also developed control simulators for teaching. Take China Civil Aviation Flight College as an example, the control simulator for control teaching was jointly developed by Wisesoft Co., Ltd. and Civil Aviation Flight University of China. It can simulate the scene of air traffic control realistically. The pilot position of the control simulator matches with the control position to realize the training of control skills, which limits the training of control practical skills in terms of equipment site and training time.

All of air traffic control units in civil aviation attach great importance to the training of control skills for on-the-job controllers. For this reason, all regional air traffic control bureaus have set up control simulation rooms in training centers. However, with the rapid growth of flight flow and the rapid increase of control personnel, the limited number of control simulators is still a drop in the bucket compared with the huge group of controllers. The limitation of control simulator equipment and training time restricts the training quality of on-the-job controllers. In addition, due to the influence of the system and environment, most of the local airports are not equipped with control simulators, and lack of personnel training and skills training, which affects the quality of skills training of the control personnel.

2.3. Problems in Teaching Control Simulator
The problems existing in the training of control simulators in China's civil aviation are mainly reflected in the following aspects:
(1) Limited teaching hardware facilities of control simulator
Take China Civil Aviation Flight College as an example, it is equipped with 30 control simulators, including 20 airport/radar control simulators and 10 non-radar control simulators.
(2) Space limitation of control simulator
As control simulation training equipment, the place where the control simulator is fixed is the control simulator laboratory, which limits the teaching of control simulation training in terms of geographical space and training time.
(3) Control teacher resource shortage

The limited resources of civil aviation colleges' control simulator teachers restrict the quality of control simulator training for students.

Based on the survey of Civil Aviation Flight University of China, Civil Aviation University of China and Nanjing University of Aeronautics and Astronautics, statistics on the number of air traffic control graduates and the number of students signing air traffic control contracts in the four years from 2014 to 2017 in the above three institutions are obtained, as shown in Table 1 below.

**Table 1.** Statistics of the total number of air traffic control graduates and the number of air traffic control students of the three civil aviation universities from 2014 to 2017

| School                                      | Total number of graduates | Number of air traffic control units |
|---------------------------------------------|----------------------------|-------------------------------------|
| Civil Aviation Flight University of China    |                            |                                     |
| 2014: 579                                   |                            | 330                                 |
| 2015: 587                                   |                            | 272                                 |
| 2016: 603                                   |                            | 284                                 |
| 2017: 619                                   |                            | 302                                 |
| China civil aviation university             |                            |                                     |
| 2014: 572                                   |                            | 278                                 |
| 2015: 614                                   |                            | 240                                 |
| 2016: 725                                   |                            | 271                                 |
| 2017: 699                                   |                            | 220                                 |
| Nanjing university of aeronautics and astronauts |                        |                                     |
| 2014: 135                                   |                            | 36                                  |
| 2015: 97                                    |                            | 56                                  |
| 2016: 92                                    |                            | 33                                  |
| 2017: 113                                   |                            | 39                                  |

Take Civil Aviation Flight University of China as an example, there are currently 24 air traffic control simulator teachers and about 600 air traffic control graduates in 2017. There are about 300 students of air traffic control units and about 300 students of other civil aviation units.

According to the requirements of the Training Program for Air Traffic Control and Aeronautical Information of Civil Aviation, there are 24 radar control simulation trainings for each student in the air traffic control major. There are 24 nonradar control simulation trainings for each student and 12 airport control simulation trainings for each student, as shown in Table 2.

**Table 2.** Quantity requirements for air traffic control simulation training

| Radar control simulation training (number/student) | Nonradar control simulation training(number/student) | Airport control simulation training (number/student) |
|---------------------------------------------------|----------------------------------------------------|-----------------------------------------------------|
| 24                                                | 24                                                 | 12                                                  |

In the undergraduate teaching of air traffic control major, all students of air traffic control major are required to complete 10/student airport control simulation training, 12/student nonradar control simulation training and 8/student radar control simulation training.

In the undergraduate teaching of air traffic control major, the quantity of control simulation training required for students in air traffic control major and non-air traffic control major is shown in Table 3.
### Table 3. Control simulation training quantity requirements of air traffic control major students

| Air traffic control students (number/student) | Non-ATC students (number/student) |
|---------------------------------------------|-----------------------------------|
| 60                                          | 30                                |

Then the average number of simulator teaching hours completed by each control teacher is:

\[
\frac{60 \times 300 + 30 \times (600 - 300)}{24} = 1125
\]

In addition, the air traffic control teachers also have to undertake the theoretical teaching courses of the whole school's air traffic management major. The shortage of control teachers' resources has affected the teaching quality of control simulator to some extent.

The restriction of geographical space, training time and training teachers of control simulation training affects the quality of simulation training for air traffic control students and also restricts the improvement of practical skills of control students. In order to improve and consolidate the training quality of control skills, it is necessary to explore new teaching methods of air traffic control simulators. Therefore, an online control simulation training platform can be built to overcome the geographical space limitation of fixed simulation laboratory and the time limitation of specific simulation training time. At the same time, the online control simulation training platform can realize the students' independent remote simulation training, effectively reduce the teaching burden of the control teachers, and improve the practical skills of the control students.

### 3. Design of Online Control Simulation Training Platform

#### 3.1. The Principles of Online Control Simulation Training Platform

The online control simulation training platform shall meet the following principles:

1. **Practicability**
   - The online control simulation training platform needs to meet the practical requirements, making the control of students and teachers easy and simple to operate.

2. **Stability**
   - The online control simulation training platform needs good stability. The data of students and teachers should have automatic backup function. The data of the server is stored in the network database, which can be backed up regularly.

3. **Maintainability**
   - The system should have the characteristics of easy maintenance. Each module in the system is relatively independent. When the system has problems, it can quickly find the functional modules that have problems and solve them in time to ensure the normal operation of the system.

4. **Scalability**
   - The system should meet strong scalability. Some functions need to provide corresponding interfaces to provide technical support for control simulation training and system upgrade and expansion under different scenarios.

#### 3.2. System Architecture of Online Control Simulation Training Platform

The online control simulation training platform consists of two parts: the control simulation training system and the information management service platform, as shown in Figure 1 below. Among them, the control simulation training system is used to control students' control skills. The information management service platform mainly manages the information of administrators, teachers and students,
and can query the training results of students, carry out notification management and user authentication, etc.

**Figure 1.** Online control simulation training platform system composition

(1) Architecture-Control Simulation Training System
Control simulation training system is the core component of online control simulation training platform, and its component modules are shown in Figure 2.

**Figure 2.** Control simulation training system module
Environmental simulation module: This module mainly simulates airspace, airport runway and flight flow.

Logic judgment module: This module makes logic judgment according to whether the separation between the aircrafts meets the separation standard, whether the flight time of the aircraft in the airspace exceeds the specified time, whether the aircraft flies over the sector boundary, whether the aircraft crashes, etc., and realizes automatic scoring function according to scoring rules.

Navigation element control module: This module mainly controls the speed, altitude, heading and other navigation elements of the aircraft, and then adjusts the flight intervals between the aircraft.

The control simulation training system formulates corresponding scoring rules in accordance with the Civil Aviation Air Traffic Management Rules (CCAR-93-R5) of China's civil aviation professional regulations. According to the logic judgment module, the scores are counted. After the exercise, the scoring results of the exercise will be synchronously saved to the information management service platform for teachers to query online.

(2) Architecture information management service platform

The information management service platform can be accessed through a browser to manage information such as students and teachers. The platform can be divided into two parts:

① Student certification network service

After the students enter into the system, firstly they need to register their accounts, and then they can carry out the control simulation training operation after passing the certification.

② Information management service platform

The information management service platform is shown in Figure 3.

![Figure 3. Information management service platform](image)

Administrators, teachers and students can log into their own systems through web browsers to view information such as student training records and training rankings. Teachers check students' training results and other information through the network to guide students online. Through the information management service platform, students' training performance management is realized. The controller uses the platform to realize account management, password modification, announcement management and other functions.

4. Proposal

At present, air traffic control system is under great security pressure, and short-board effects such as lack of air traffic control team capacity are also constantly appearing in the development process of air traffic control. In order to improve the control ability of air traffic control teams, it is necessary to focus on strengthening the training of control practical skills of control students. In the training of air traffic control students' control skills, problems such as limited resources of control simulator equipment,
limited space for fixing simulation machine rooms, limited time for specific simulation training time, and shortage of control simulator teachers are common, which restrict the improvement of practical skills of air traffic control students.

Building an online control simulation training platform and incorporating it into the air traffic control simulator training system can enrich the control simulation training modes for control students in civil aviation colleges and various air traffic control units. So as to strengthen the flexibility of control simulation training, greatly increase the hours of simulator practice courses, improve the quality of control students' practice teaching, greatly improve the control ability of control students, and realize the high-quality development of air traffic control.

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