International Civil Aviation Organization

Thirteenth Meeting of the Air Traffic Management Sub-Group (ATM/SG/13) of APANPIRG

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Agenda Item 8: Any other business

TRAINING PERFORMANCE IMPROVEMENT BASED ON AIR TRAFFIC CONTROL SIMULATOR WITH AI PILOT

(Presented by China)

SUMMARY

The AI Pilot Intelligent Control Simulator addresses challenges in traditional ATC training concerning limited scenarios and low interactivity. It generates dynamic simulations, delivers stable command outputs, and adapts training programs to meet evolving industry needs. By efficiently creating realistic scenarios and enabling precise training, it significantly enhances instructional efficiency. The ATMB CAAC has made notable progress in this field, including the development of new simulators and advancements in speech recognition technology. Going forward, efforts will focus on refining standards, upgrading technologies, optimizing speech recognition applications, and enhancing training methodologies to support talent development across the global aviation sector.

1. INTRODUCTION

1.1 Traditional air traffic control (ATC) simulator training relies heavily on either human role-players acting as pilots or rigid, fixed-procedure simulations. These approaches suffer from limited scenario diversity, low interactivity, and insufficient risk controllability. Hence, AI-driven pilot agents in control simulators are being developed to overcome these fundamental shortcomings.

1.2 Satisfy the Requirement of Rapid Development of Traffic Volume. With the explosive increase in global and China domestic flight volumes, air traffic controllers are confronted with denser airspace operations and more complex coordination challenges. In this case, AI pilots can replicate emerging scenarios such as high-density air traffic conflicts and emergency landings involving coordination among multiple aircraft. This ensures that ATC training remains closely aligned with real-time operational requirements. Moreover, standardized AI-driven training programs help to reduce human variability. The resulting standardized training programs allows for a relatively rapid and large-scale cultivation of skilled controllers to address the industrial talent shortage.

1.3 Break the Limitations of Traditional ATC Training. In real world operation, pilots' decisions are influenced by multiple factors including weather conditions, mechanical failures, and air traffic, and even sudden events such as emergency procedures or communication errors. Traditional simulation-based training often struggles to fully replicate complex situations, such as emergency landing requests during extreme weather or coordinated instructions during equipment failures. In contrast, AI pilots, in contrast, can generate comprehensive scenario database via predefined algorithms, covering nearly 100 training scenarios including routine operations, unexpected failures, and severe weather conditions. This allows controllers to train in a more interactive and realistic environments.

2. DISCUSSION

Improvement of Training Performance

2.1 The AI pilot-based simulator boosts training efficiency through three key pathways: scenario innovation, data-driven insights, and intelligent feedback. It can generate dynamic, complex scenarios—such as convective weather or sudden mechanical failures—to closely simulate real operation environments. At the same time, it adaptively adjusts training content based on each trainee's weaknesses, ensuring higher relevance and significantly improving the overall quality of controller training.

Show More Training Scenario including Emergency Situation

2.2 Compared with preset procedures and scenarios applied in traditional training systems, AI can quickly generate a wide range of dynamic scenarios (such as extreme weather, airspace conflict, mechanical failure, etc.). This approach replaces time-consuming manual scenario design and enables coverage of some uncommon but high-risk situations which tends to be omitted in the current practice.

Achieve a Higher Accuracy and Less Consumption

2.3 AI analyzes ATC trainees' commands and operations in real time—such as decision-making speed and certain deviations to identify specific weaknesses such as scheduling errors during thunderstorms. It then automatically targets these weak points with scenario-specific retraining, avoiding unfocused repetition and supporting skill improvement.

Avoid Distribution Caused by "Human Variable" at Training

2.4 During long training process, human role-playing pilots may suffer from fatigue or fluctuating physical states, leading to inconsistent command outputs and reduced training effectiveness. AI pilots, however, are free from such physiological limitations, delivering consistent, standardized instructions that guarantee repeatable scenarios and allow for more objective evaluation of trainee performance.

More Efficient Feedback and Maximize Training Resource

2.5 Traditional training approach typically relies on instructors for evaluation, whilst AI agent can provide immediate performance scores and feedback to trainees. For instance, control instruction response efficiency: 80 points, fault-handling compliance: 90 points, altitude command delay:2 seconds. In this way, trainees can be corrected against mistakes instantly, preventing the reinforcement of incorrect habits. In addition, the system can operate 24/7 and support parallel training for multiple ATC trainees. Therefore, waiting times are expected to be decreased remarkably.

2.6 At present, China made some progress in developing AI pilot-based ATC training system, in terms of standards, technology and training programs.

Developing Standards for ATC Simulators with AI Pilot

2.7 Specifications for AI pilot simulators are being developed to promote high-quality manufacturing and standardized production. Efforts include improving the standards system in alignment with ICAO guidelines and fostering collaboration between industry and academia. In particular, key simulator components are undergoing localization to better align with domestic operational characteristics.

Application of Speech Recognition and Synthesis

2.8 Speech recognition and synthesis technologies are being integrated into AI pilot simulators, enabling partial automation of controller instructions. Enhanced conflict-detection algorithms with lower computational complexity are also developed to improve system efficiency. The system can replicate weather conditions and assess controllers' emergency response accurately in a more realistic environment.

2.9 Besides, pilot workstations in the system have evolved toward fully mouse-operated GUI interfaces, moving closer to fully autonomous AI pilots. Current systems can simulate tower, approach and regional control procedures and equipped with techniques such as wireless instructor control, facial recognition, adaptive training program assessment, and realistic scenario simulations. These features improve training effectiveness, raise overall training quality, and advance the shift toward smarter, more refined air traffic control training.

2.10 Voice recognition is also applied in intelligent communication modules, enabling voice understanding, text processing, and natural speech generation in training.

Units Upgrade of ATC Simulation System

2.11 AI, digital twin, and other advanced technologies are also integrated to enhance scenario generation and decision simulation. This allows for more precise real-time evaluation and feedback during training. Improvements in system efficiency, operational interfaces, and scenario diversity further expand the training system capabilities, enabling multi-role and multi-procedure simulations that reflect real operational complexity.

Optimization of ATC Training Performance

2.12 Currently, personalized, full life-cycle talent training model centered on AI pilot simulators is being developed. This approach is capable of increasing training efficiency and quality while accelerating the cultivation of skilled professionals to meet the growing needs of the industry.

3. ACTION BY THE MEETING

3.1 The meeting is invited to note the information contained in this paper.

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