



ICAO

**Seventh Meeting of the Surveillance Implementation
Coordination Group (SURICG/7)**

Video Teleconference, 24 – 27 May 2022

- Agenda Item 8:** Update on surveillance activities and explore potential cooperation opportunities
- a) States/Administrations

**SURFACE SECURITY ENHANCEMENT APPLICATION BASED ON VOICE AND
PHOTOELECTRIC INTELLIGENT ASSISTANCE**

(Presented by China)

SUMMARY

This paper briefly describes the exploration and application of various new technologies by China and puts forward the application of panoramic photoelectric video and two-way recognition technology of tower control voice, to realize the application of airport scene intelligent security enhancement.

1. INTRODUCTION**1.1 Operation Background**

1.1.1. With the rapid development of the global economy, and the increasing passenger flow of air transport, large and medium-sized airports are increasingly busy, and the scene security of the airport is also becoming more and more important. The Advanced Surface movement Guidance Control System (A-SMGCS) is an important technical means of airport surface safety management, and supports access to multi-source surveillance data, but due to the terminal shelter monitoring blind area, can't establish "No Dead Angle" airport operation scene, and can't give consideration to both the scenario of the controller's "mistake, forget and leak" and the crew's misoperation.

1.1.2. Shanghai Hongqiao International Airport is one of the top ten busiest airports in CAAC, and the number of daily flights has reached 800 at one point. And also the Hongqiao Airport runway has a complex configuration, the daily peak of flights crossing the runway reached 400. In addition, due to the early construction of Hongqiao Airport, there was no perfect A-SMGCS, so for now it was difficult to ensure the safety of scene operation.

1.1.3. CAAC has actively explored and independently developed the intelligent surface security assistant system, which was applied and verified in Hongqiao Airport. The system has multi-source data fusion processing, basis on the monitoring and alarm functions of the A-SMGCS, it adopts the panoramic photoelectric video and two-way voice recognition, to establish a more complete scene for airport surface control and aircraft operation, provide effective early warning, and improves the security and availability of the system.

1.2 Background of new technology application

In recent years, the application of video image recognition technology and automatic speech recognition technology has gradually matured.

At the same time, the camera sensor technology has undergone breakthrough updates. SONY VB770 series cameras have excellent 4K low-light effects, providing hardware support for application scenarios.

2. DISCUSSION

2.1 System Design

2.1.1. Under the above operating background and requirements, CAAC has built the intelligent surface security assistant system, which is independently operated at Hongqiao Airport. It mainly consists of photoelectric video equipment, voice acquisition equipment, and computing network. Has the following basic functions:

- Monitor surface operation information through multi-source surveillance data and photoelectric technology.
- Judge the consistency of voice information between the controller and the crew, and combine the Electronic Flight Strip information to judge the conflicted relationship between the scene and the intention.
- Provide real-time warnings of aircraft crossing runway-holding position or road-holding position, readback error, and allowed round taxi type error, as well as post-event analysis and review.

2.1.2. Overall system architecture

System integration infrastructure, using IBM WEBSHERE MB as a middleware platform to hang on various service and computing modules, using VMWARE infrastructure to improve the overall reliability and redundancy of the system, using an independent GPU server for video and voice signal processing, signal integration Source and surrounding system operation data to complete the integrated calculation and alarming of multiple data sources.

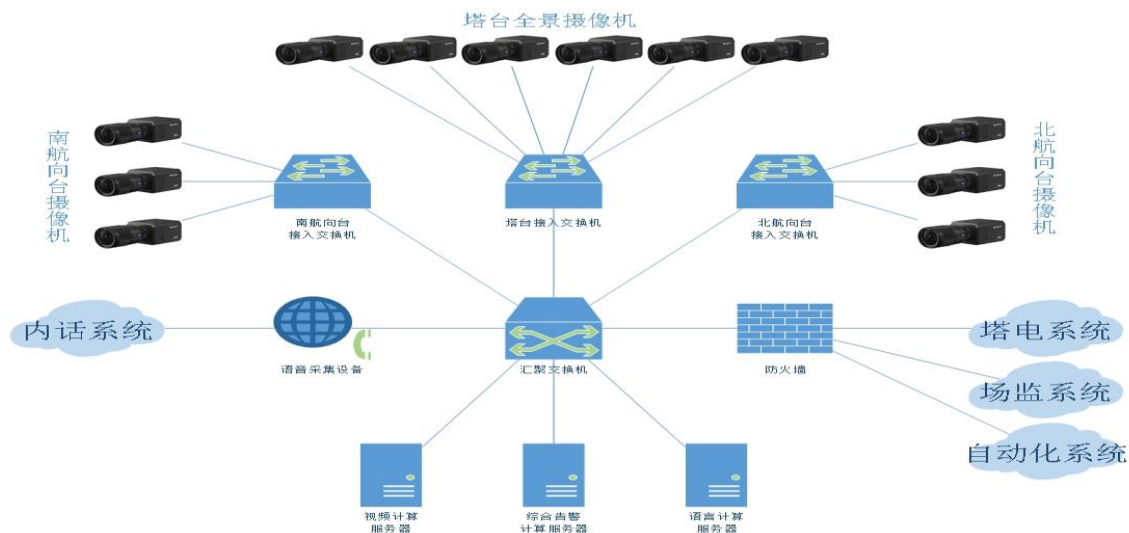


Figure 1 System Architecture

2.2 Key technology implementation

2.2.1. The main functional modules of the intelligent surface security assistant system include the photoelectric video enhanced panoramic monitoring module, the voice recognition module based on the ATC command, the security alarm module, and the recording and replay module.

2.2.2. The main data input of the system is photoelectric video, ground-air voice, multi-source surveillance data, and flight plan data.

2.2.3. In addition, the flight status information is also imported from the tower Electronic Flight Strip. When the tower controller operates the Electronic Flight Strip, the flight status change information generated will be transmitted to the intelligent surface security assistant system on the scene in real time; and the alarm information generated by the intelligent surface security assistant system. It will also be pushed to the tower Electronic Flight Strip.

2.2.4. Photoelectric video enhanced panoramic monitoring module

Panoramic video of airport surface

➤ Six 4K high-definition cameras are installed on the outer ring of the command floor of Hongqiao Tower to provide panoramic video of the air traffic control area of Hongqiao Airport, and to perform dynamic identification and grid-based positioning of aircraft on the surface.

➤ Combined with multi-source surveillance data and Electronic Flight Strip, the aircraft on the spliced image is marked and tracked in real time, and the operation conflict of H4 is monitored at the same time.

➤ The panoramic video covers 2 runways and multiple taxiways, and can truly restore the night scene. The runway is monitored and recorded 7x24 in all weather conditions, and the runway can be viewed at any time. Complete panorama stitching and video playback, flight identification and flight pending orders, video target position matching with multi-source surveillance data coordinate positions, and runway intrusion warnings.

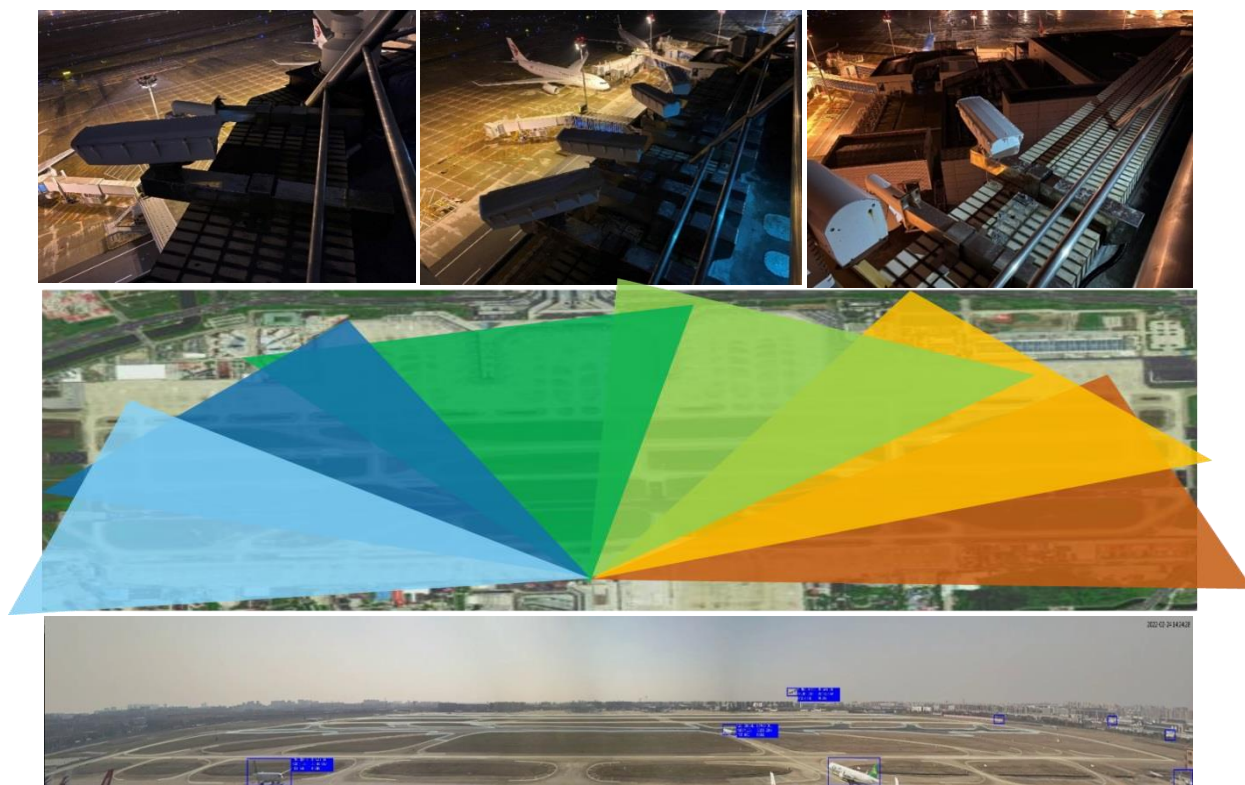


Figure 2 Hongqiao Airport panoramic camera coverage

Airport Surface Blind Spot Enhancement Surveillance

- Three cameras are installed at the positions of the south and north gliding platforms and heading platforms of Hongqiao Airport.
- The south side monitors the operation conflict between the H6 H7 taxiway and 36L, and the north side monitors the operation conflict between H1H2 and 18R. Line (90 meters from the runway centerline), accurate position and movement trend of aircraft crossing the runway using H6, and H2 for effective, real-time and accurate monitoring.



Figure 3 Key taxiways of Hongqiao Airport

- In 2021, Q3 and Q4 Hongqiao Airport's route south and route north (round taxi) have been launched in succession, and the round taxi can only be used by aircraft below the C category. According to the rules of the round taxi and the configuration of the lighting system for the round taxi, judge the type of taxiway B in the H1 and H7 areas.

- After accurately judging the type of aircraft on taxiway B, the stop bar lights on the round taxi will be automatically controlled to ensure that only aircraft of the C category can enter the round taxi.
- The classification of the existing Electronic Flight Strip is not detailed enough, and there may be errors in the flight plan records, considering to use photoelectric video technology to analyze the wingspan of the aircraft in real time to determine whether it is suitable for the round taxi.

2.2.5. The voice recognition module based on the ATC command

- Real-time two-way translation of voice converts the voice into a text sequence by recognizing the ATC voice in Chinese and English. The artificial intelligence automatic speech recognition technology can achieve high-quality and high-speed voice recognition, accurately and timely convert radiotelephony communication into analyzable text.
- By processing the text sequence obtained by voice recognition, the control intention is extracted, and the control voice is verified, and the occurrence of runway intrusion events can be prevented by checking the voice command.
- The system can recognize the command intention in the voice, and identify the risk of runway intrusion through the core algorithm of artificial intelligence. When a risk is identified, the alarm will be displayed on the UI and synchronized to the tower Electronic Flight Strip.

#	时间	时长	场景	管制员/机组	识别结果	识别意图
1	05/09 11:27:18.853	4.93s	建立盲降,进离港首次联系	CCA1519	国航五五九虹桥塔台你好继续进近跑道三六右修正海压么洞洞八	CCA1519 虹桥塔台你好 继续进近 跑道36右修正海压1008
2	05/09 11:27:29.713	3.39s	进离港脱波	管制员	上航九三九联系塔台么么八点六五再见	CSH9391 联系塔台118.65 再见
3	05/09 11:28:00.363	4.48s	建立盲降,进离港首次联系	CQH8958	春秋八九五八虹桥塔台你好继续进近跑道三六右修正海压么洞洞八	CQH8958 虹桥塔台你好 继续进近 跑道36右修正海压1008
4	05/09 11:28:14.436	2.62s	跑道脱离	管制员	锦绣六六拐么 BRAVO 两脱离	UEA6671 B2脱离
5	05/09 11:28:50.179	4.67s	落地许可	管制员	国航五五九地面风两六洞四米跑道三六有可以落地	CCA1519 地面风 风向260度 风速4米/秒 跑道36 有可以落地
6	05/09 11:28:57.361	4.29s	进离港脱波	管制员	通锦绣六六拐么 BRAVO HOTEL 么前等联系塔台么么八点六五再见	通 UEA6671 BH1前等 联系塔台118.65 再见
7	05/09 11:29:39.682	4.16s	建立盲降	管制员	吉北么两羽九台你好继续进近跑道三六右修正海压么洞洞八	吉北1209台你好 继续进近 跑道36右修正海压1008

Figure 4 Real-time voice recognition

2.2.6. The Safety Warning Module

- The main alarm types of Hongqiao Airport A-SMGCS mainly include restricted area warning, restricted area warning, suppression area warning, runway intrusion warning, taxiway conflict warning, parking stand warning, wake warning, and command warning, etc.
- The safety warning module of this system is responsible for enhancing the runway intrusion and command alarm, and at the same time, the alarm function related to round taxi is added.
- The system realizes the alarm calculation by photoelectric and voice technology. The photoelectric intelligence includes panoramic cameras deployed on the tower command floor and a high-definition camera deployed on the side of the runway hold line. The cameras take samples at

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4K30FPS; the background server analyzes the aircraft's size, position, and movement trends in real time; the voice recognition module is connected to the VHF speech signal to process the uplink and downlink voice, parses it into text, and then judge the ground to air call intention combined with semantic analysis.

- When the system calculates and concludes that there is a conflict between the instructions in specific scenarios and the operation situation, or readback error, or a conflict between the aircraft operation and surface operation, a corresponding acousto-optic alarm will be generated.

Runway intrusion alarm---Runway-holding position alarm

- Every aircraft crossing through the runway-holding position of key taxiway crossings (it can be extended to monitor vehicles in the future, but only all types of aircraft are monitored at this stage), generate movement trend information and line crossing signals in real time; combined with the control intention information from the tower (The tower Electronic Flight Strip and voice-to-text data), it can be determined whether the crossing behavior has a permit issued for the aircraft, and enhance the runway intrusion alarm function.
- If an aircraft is detected to cross the hold line without the controller's clearance, the alert will be sent to the tower Electronic Flight Strip through the extended application of the Eurocontrol ADEXP format.
- If an aircraft's speed is found to conflict with the instruction and the runway situation, cross line trend alert will be generated.



Figure 5 Hold line video detection

Readback error warning

- The two-way voice recognition technology for all seats of the tower voice, combined with the scene, can automatically determine the intention of the voice command, can find out errors between the controller and the pilot's readback, and remind the tower controller by an alarm. Since the dialogue is converted into text, the readback error text will be highlighted;

Round taxi alarm

➤ The round taxi of Hongqiao Airport allows aircrafts of the C category and below to enter the round taxi process. The electronic strips that allow entering the round taxi are marked with green background in the system. The photoelectric system calculates the wingspan according to the video to make the final judgment and verification. If the aircraft with an abnormal wingspan tends to enter the round taxi, an alarm message will be shown on the system.



Figure 6 Aircraft wingspan detection

2.2.7. The recording and replaying module

➤ The recording and replaying module is responsible for real-time recording of the surface, so that it can be replayed and queried when an abnormal event occurs. The recorded content is mainly divided into two categories, one is the log data, including various data input of the program and the intermediate processing process of the program, and the other is scene data, including the screen recording of the client interface and the external surface camera video, VHF voice, etc.

3. SUMMARY AND OUTLOOK

3.1 The intelligent surface security assistant system based on voice and photoelectric intelligent assistance introduced in this paper utilizes the multi-source surveillance data fused by A-SMGCS, combines voice and photoelectric technologies to supplement the surveillance blind spots existing in A-SMGCS, and establishes a unified scene of the tower Electronic Flight Strip and voice command. The system is in addition to the traditional control and command operation system based on A-SMGCS and the tower Electronic Flight Strip, which provides auxiliary surface operation monitoring supplements and alarm function enhancement applications to improve the alarming accuracy in specific (runway intrusion) scenarios.

3.2 The relevant planning of CAAC has made it clear that the Tower ATM Automation System (Integrated Tower) will be promoted and applied in the new towers in the future. Based on the tower control business as the mainline, the system covers the whole process of the tower control operation. The Advanced Surface Movement Guidance Control System (A-SMGCS), Electronic Flight Strip (EFS), Departure Clearance Delivery (DCL), Digital Automated Terminal Information Dissemination (ATIS/D-ATIS), Control Integrated Information Display System, and other tower information systems are deeply and organically integrated in the system. This system will provide differentiated, efficient, and integrated interface display information for various control work positions to support the airport tower control operation.

3.3 CAAC will continue to study the auxiliary applications based on voice and photoelectric technologies in the airport tower control operation. At the same time, it is expected that the continuous update of AI voice recognition technology will improve the system scene judgment at a higher level; in the later stage, infrared technology and millimeter wave radar technology on the fusion application will be studied.

4. ACTION BY THE MEETING

4.1 The meeting is invited to:

- a) note the information contained in this paper; and
- b) discuss any relevant matter as appropriate
