Air Traffic Control

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Abstract—With the increasing demand for air transportation, all parties involved in the air transportation system have increased their efforts to make the system more efficient without sacrificing safety. This paper presents a new system based on information integration, the Air Traffic Control Command Monitoring System (ATCCMS), which integrates all kinds of fundamental information such as radar information, flight plans, voice communication, and weather conditions into a comprehensive information platform. In this paper, the context of voice communication is analyzed with speech recognition technology and is correlated with radar data and expert knowledge to determine whether any potential danger will emerge from the controller's instructions. Simulation experiments show that the safety level of air transportation systems will be effectively improved by the use of the information integration technique. The prototype of ATCCMS is under test run in North China Regional Air Traffic Management Bureau of CAAC.

I. INTRODUCTION

To provide separation service for civil flights is the primary task of air traffic control. Aviation safety is the basis of expediting air traffic flow and improving the profitability of civil aviation transportation. Along with the rapid increase in air traffic flow in China in recent, air traffic controllers workloads have been so greatly.

Increased that man-made mistakes that threaten flight safety frequently happen. Although technical innovations in communication, navigation and surveillance have progressed and on-board safety devices, such as the Traffic Alert and Conflict Avoidance System (TCAS), have been gradually perfected, one problem that remains is to develop an efficient auxiliary automated system for air traffic controllers, which will act as an intelligent supervisor with the functions of monitoring daily air traffic control operations, alerting human controllers to possible man-made errors and ultimately ensuring flight safety.

As described in , information integration, the driving force of this decade of IT (information technology) spending, is a technological approach that combines core elements from data management systems, content management systems, data warehouses, and other enterprise applications into a common platform. Based on the information integration technique this paper presents a new system for air traffic control, the air traffic command monitoring system (ATCCMS), which can reduce the controller's man-made errors and ensure flight safety. Some key components of ATCCMS are discussed in following sections.

The paper is organized as follows. Section II introduces the safety problems in air traffic control. Section III presents the design objective of ATCCMS. Section IV and section V present the function architecture and logic architecture of ATCCMS, respectively. Section VI presents analysis and experiments on key components of ATCCMS. Section VII gives the conclusions of this paper and comments on future work.

II. SAFETY PROBLEMS IN AIR TRAFFIC CONTROL (ATC)

During busy aviation activity, the concentration and stress of human controllers are so heavy that their mistakes are an important source of danger to flight safety. Most mistakes are related to the controller's speech instructions .

At present, TCAS has become the standard device for current civil aviation aircraft, which can effectively provide the pilot with potential conflicts and advice in order to avoid collision. For the controllers, there are several sets of new air control systems and aided-command systems to choose from, such as the AutoTrac system of Raytheon, the international airspace management system of Hughes, the EUROCAT of Thomson-CSF, the ASTEC system of Lockheed-Martin, and the CTAS of NASA . Most of these systems comply with the CNS/ATM standard of ICAO , and have common characteristics such as wide-screen high-differentiability-rate controller workstation, friendly graphical user interface (GUI), and functions such as radar data processing (RDP), flight data processing (FDP), automatic dependent surveillance (ADS), and conflict detection and alerting. For flight safety, however, the following flaws exist in these systems: (1) speech instructions are not recognized as an important data source so that controllers' behavior cannot be monitored, and hence alerts for the danger resulting from false instructions can not be given in advance; (2) high-level flow management is not combined with conflict avoidance.

The process of ensuring ATC safety may be regard as the one that ensures the basal information to be transmitted quickly and to be processed efficiently so as to provide good decision-making information. There are two ways to improve ATC safety.

One is to upgrade the unit technique in the air traffic control system, such as the radar and controller workstation. This requires great investment and a long time period, and cannot improve monitoring of the controller's voice communication.

The other is to use integration technology, which includes two steps. The first step is information integration. With computer networks and relation databases, all kinds of basal information in air transportation system can be shared by controllers, and dynamic information of aircraft and the condition of controllers and pilots can be acquired in real time and stored in the global database. Integrated information about flight safety is extracted, and false instructions and potential dangers are detected using model analysis, on-line analysis & processing, or artificial intelligence, so that alerts and advice are given to controllers

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in time. The second step is system-integration on the basis of information integration. In this step, the optimal schedule of flow within a whole country or regional area is introduced, and flight safety is ensured at a higher level. Thus profitability can be improved. In information integration, the investment is comparatively small. But it is difficult to deal with many kinds of information (including speech information and radar information etc.)

III. Design Objective Of ATCCMS

For safety critical system, the ATCCMS integrates all current ATC information and efficiently deals with basal data including speech information, radar information, and flight plan information so as to monitor actual operation, and to provide ATC departments with good decision-making information.

According to the practice of air transportation systems in China, the design objective of ATCCMS is established as follows.

- Accurately identifying the controller's instructions so as to extract command information.
- Realizing the correlation of command information, radar data and flight plan data.
- Efficiently detecting flight conflict based on radar track information and potential conflict based on control instructions (i.e., pseudo-conflict). The response time of the system is less than two seconds
- Efficient conflict alerting (the percentage of false alerting and missed alerting are less than 5%).
- Providing referenced advice for exceptional cases.
- Efficiently managing basal data (including relation mode and multidimensional mode).
- Recording and analyzing global flight status data and command information.
- Providing comprehensive information query and on-line analysis & processing of flow information.
- Having openness, expansibility and good communication capability

IV. Conclusions

Integrates radar information, flight plan information, speech information of control instructions, and weather information into a common platform. Its function architecture and logic architecture were discussed in this paper. It can ensure reliable safety through monitoring the whole process of controller's instruction.

In ATCCMS, multi-item unit techniques are used, such as speech recognition and its post-processing, flight conflict detection and alerting, and short-term flow management. These units monitor the different parts of the ATC command process, and support and reinforce each other by information integration. The simulation results show that the information integration technique is more effective than simply improving unit technique, and it can be a new promising method for solving the control and optimization problem of a large, complex system. ATCCMS can present, besides system safety, an information environment for air traffic control automation and the national flow management system of China.

However, the speech recognition component of ATCCMS currently relies on a Verbex voice recognition card, which is only supported by DOS drivers and is not supported by the Windows platform. Verbex also required users to train for up to one hour before using the program. While this ensured higher accuracy rates, the training period was inconvenient and required considerable time and effort in maintaining user's voice profiles. At the same time, the ability to use dynamic call signs and complex multi-instruction messages are strongly desired by air traffic controllers. It became clear that the Verbex system needed to be updated.

The direction for future work is to develop a new speech recognition system that can work well with Windows-based applications and support large complex grammar files. The grammar files could be easily modified to allow for multiple pronunciations of a single word or phrase. Most importantly, for the new system, user's training time should be eliminated and allow users with discrete accents to readily use the application.

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