Research of Multi-Information Integration for the Aircraft Ground De-icing Monitoring System Based on GIS and GPRS

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Abstract. Aiming at solving the problem of information dispersed, hysteresis even lost in the process of aircraft ground concentrated de-icing which reduce the efficiency and safety of the aircraft ground de-icing. A multi-information integration system of the whole process of the aircraft ground concentrated de-icing is designed in this paper, which describes the architecture and the function of the information integration system, proposes the hardware structure and implementation of software of the database server and the monitoring terminal. The simulation results show that the system can collect and show the information of the whole process of aircraft ground de-icing properly and provide an efficient monitoring platform for aircraft ground de-icing.

1. Introduction

With the development of China's civil aviation industry, the number of flights at major airport increase rapidly, which is bound to be delayed or cancelled when it encounter snow and cold weather, resulting in huge economic losses even safety accidents. In order to guarantee that flight can function normally, the aircraft must be de-iced in half an hour before taking off. To improve the efficiency of de-icing, management staffs need to know the status of de-icing equipment, de-icing operators and other information so that they can dispatch and command all the de-icing resource according to the actual situation to ensure the de-icing is efficient and reliable. Concentrated de-icing has been adopted by most airports currently, however, it's difficult to achieve the comprehensive arrangement and unified management of de-icing resources because of hysteresis and inefficiency in the transmission of information in the de-icing process so that there are shortcomings such as low efficiency, high operating costs and not full utilization of de-icing resource. To solve this problem, a multi-information integration system of the whole process of the aircraft ground concentrated de-icing is designed in this paper.

2. The overall scheme of multi-information integration system

This paper introduce the design of overall architecture and the data flow of the multi-information integration system of the whole process of the aircraft ground concentrated de-icing.

2.1. The overall architecture design of system

The multi-information integration system of the whole process of the aircraft ground concentrated de-icing consists of ice accretion prediction unit, the database server, monitoring terminals, display terminals and data collection terminal installed in the de-icing equipment parts, which is able to achieve the integration of related system application, data sharing, real-time information display and interaction during the de-icing process and establish a process-oriented information service platform, which help dispatch and command the aircraft concentrated de-icing process to improve the efficiency and safety of de-icing process. The architecture of the system is shown in Fig. 1.

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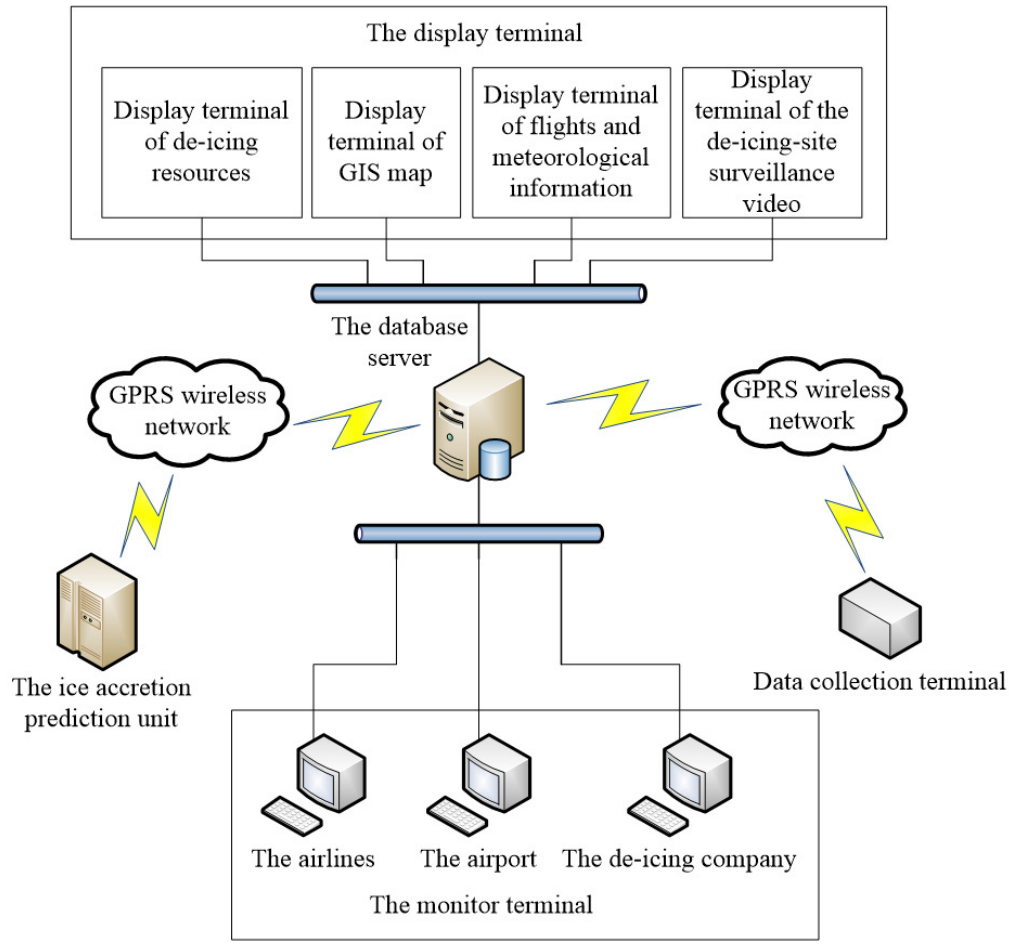


Figure 1. The Architecture of the system.

When the system is running, the personnel of airlines and airport in the monitor terminal provide flight information and weather information for the database server, the ice accretion prediction unit will predict ice accretion according to meteorological information and the data collection terminals will collect information of de-icing equipment including the status and current location of de-icing equipment, temperature and margin of the de-icing fluids and other information, and then the information are sent to the database server through the GPRS wireless network and will be shown on the display terminal of de-icing resources and GIS which shows the current location of de-icing equipment in real-time. The management staff in the monitoring terminal will command de-icing resource according to the above information to ensure the safety and efficiency of de-icing process.

2.2. Data flow of the system

The Multi-Information Integration System of the Whole Process of the Aircraft Ground Concentrated De-icing need to obtain sufficient data and information so that the management staff can arrange de-icing resource reasonable according to the actual situation, and improve the efficiency and safety of de-icing process and ensure the safety and normal operation of flight. The data flow of the system is shown in Fig. 2.

As is shown in Fig. 2, the database server is responsible for the management and maintenance of the data. The database server accepts the real-time data sent by the monitor terminal and send real-time and historical data in the database to the monitor terminal and display terminals at the same time. And the query and display of data is implemented by the monitor terminal and display terminal.

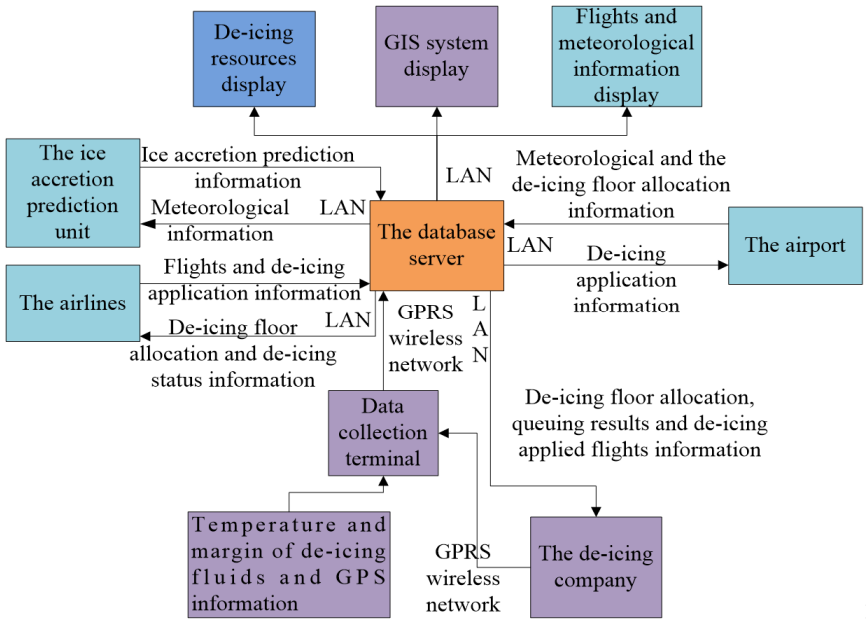


Figure 2. The Data flow of the system.

3. The database design of the system

As the data storage and manipulation part of the whole system, the performance of database will have direct impact on the performance of the whole system when in practical service. In the process of designing the database, the data access and safety should be considered and minimize the storage of redundant data at the same time to ensure the database will perform efficiently.

According to the system requirements, the database should be able to support the following functions:

1. Record various properties of the de-icing equipment, such as the number of device, operators, and the status of device, temperature and margin of de-icing fluids contained in the device and so on;

2. Record various properties of the flight, such as the number of the flight, aircraft type, the de-icing time of the flight, de-icing status of the flight and so on;

3. Facilitate the command and dispatch work of management staff, make sure they can check the information mentioned above in real-time, provide a reference for their command and control.

According to the requirements mentioned above, the E-R diagram of database is designed as it is shown in Fig. 3.

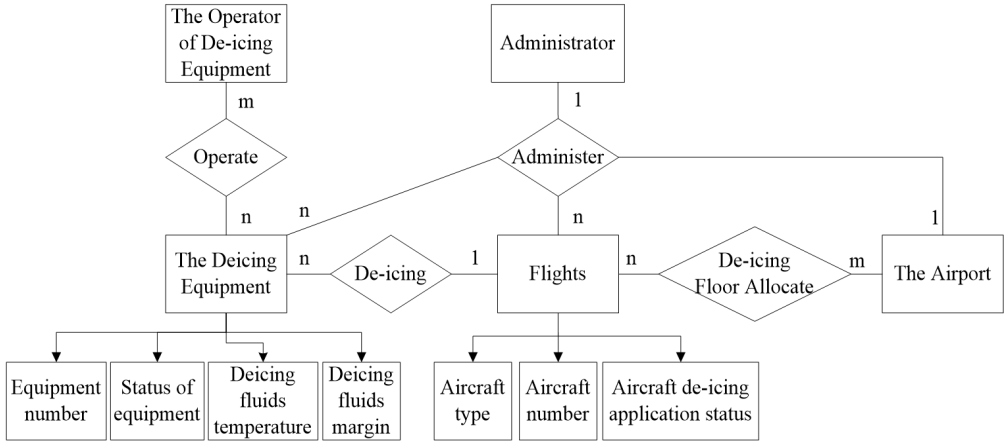


Figure 3. The E-R diagram of database.

The data table and the relationship between them can be abstracted according to the system database E-R diagram, which is shown in Fig. 4.

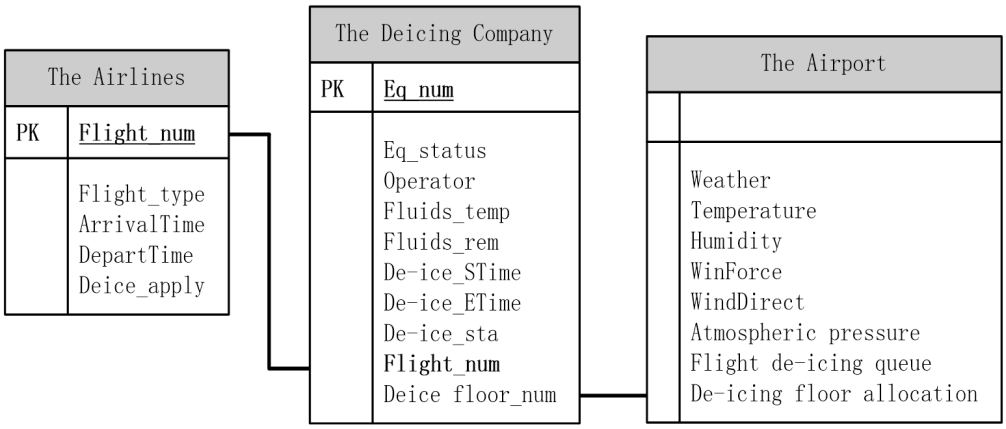


Figure 4. The table of database.

The meaning of the character in Fig. 4 is shown in Table 1.

Table 1. The meaning of the character in database table.

Character	Meaning	Character	Meaning
Flight_num	The number of flight	De-ice_ETime	End time of de-icing
Flight_type	The type of flight	De-ice_sta	Status of de-icing
ArrivalTime	Arrival time of flight	Deice flloor_num	The number of deice floor
DepartTime	Depart time of flight	Weather	The weather of environment
Deice_apply	Apply for de-icing	Temperature	The temperatureof environment
Eq_num	The number of deicing equipment	Humidity	The humidity of environment
Eq_status	The status of deicing equipment	Winforce	The force of wind
Operator	The operator of deicing equipment	WindDirect	The direct of wind
Fluids_temp	The temperature of deicing fluids	Atmospheric pressure	The atmospheric pressure
Fluids_rem	The margin of deicing fluids	Flight de-icing queue	The queuing result of flights which apply for deicing
De-ice_STime	Start time of de-icing	De-icing floor allocation	The allocation result of deicing floor

4. The software development of the monitor terminal

The monitoring terminal is the core part for the management staff to monitor and control the whole process of the aircraft concentrated de-icing which convert every link of the de-icing process into the concrete data and graphics displayed on the screen. The main function of the monitoring terminal is to satisfy the requirements of querying and monitoring of the information of the de-icing resource claimed by different users such as de-icing companies, airlines and airports. According to the request of the system, the monitoring terminal is developed in Client / Server mode in which the tasks are completed by the client and server respectively. The most typical application of this model is the database technology. The database server in the Client / Server mode database system is huge and abstract, however, the client can own a small database for the user's request, if the client's database is

able to meet the data request, it will give the result directly to the user, and otherwise it will invoke the server to handle the request. When users invoke the resources of server, the clients sent request to the server, and analyse the results sent back by the server and then display the result to users. The system using the Client / Server mode has very strong function of representing the data and can achieve complex data acquisition, data processing and realistic data real-time monitoring. The software flow chart of the monitor terminal is shown in Fig. 5.

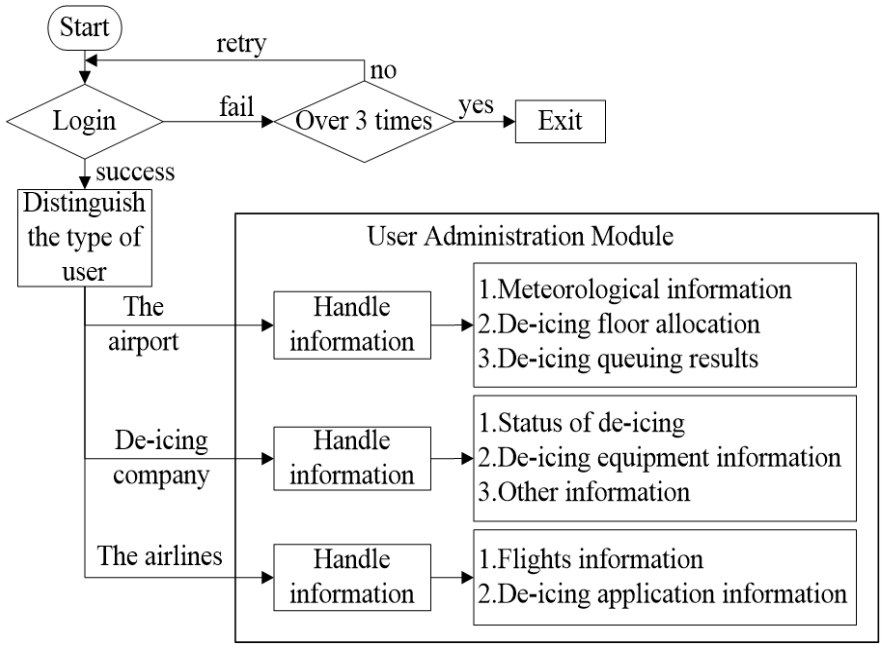
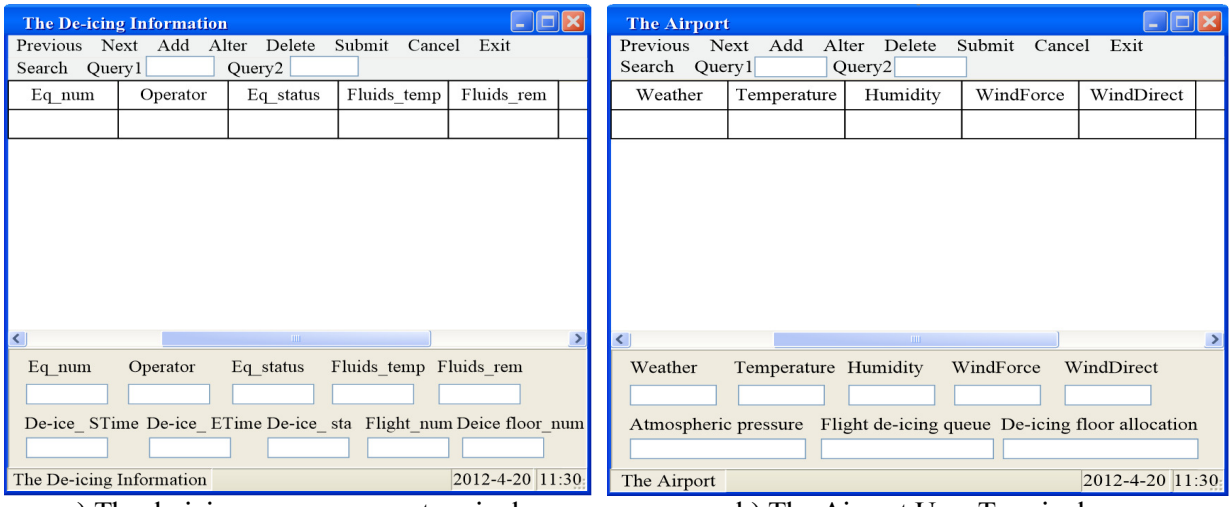


Figure 5. The software flow chart of the monitor terminal.

5. Running of the Monitor Terminal Software

The running effect of the monitor terminal software is shown in Fig. 6



a) The de-icing company user terminal b) The Airport User Terminal

Figure 6. The Running Effect of the Monitor Terminal Software.

6. Summary

A multi-information integration system of the whole process of the aircraft ground concentrated de-icing is designed in this paper, the design of critical component of the system such as the ice accretion prediction unit, the database server, monitoring terminals, display terminals and data collection terminal installed in the de-icing equipment parts is also proposed in this paper. The system proposed in this paper can achieve multi-source information monitoring and processing and help the de-icing management staff achieve reasonable and fully utilized of de-icing resources, improve the efficiency of aircraft ground de-icing and guarantee the safety of aircraft concentrated de-icing at the same time.

Acknowledgments

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