Client analysis and interface design of mobile meteorological service in low altitude airspace

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Abstract: Low altitude airspace mobile weather service is based on the short service of meteorological services in China's rapidly developing low altitude navigation industry. Through the analysis of the weather information data acquisition status and the analysis of the main meteorological service software products in the market, it is concluded that professional low altitude weather service software products are needed to meet the demand of low altitude aircraft operation. The software interface design of low altitude airspace mobile meteorological service demand function is analyzed, and the Android technology is used to design and implement the client interface of meteorological services.

1 Introduction

Low altitude airspace is a valuable strategic resource in China. In the development of low altitude airspace resources, how to ensure low altitude flight safety has become an international research hotspot [1]. Accurate and quick acquisition of meteorological information in flight area is an important guarantee for low altitude security flight. In recent years, the comprehensive meteorological observation service in China has made rapid progress. With the deep development, the level of observation automation has been greatly enhanced, the layout of the observation station network is becoming more and more perfect, the quality and efficiency of the observation has been steadily improved, and the comprehensive strength of the meteorological observation service has been in the advanced ranks of the world [2]. At the same time, the demand for meteorological data in China is also increasing, people cannot meet the weather information provided by the weather forecast in TV and hope to obtain the meteorological information from more channels. The development of the mobile Internet and the improvement of the technical level have promoted the rise of the related industries. The companies with meteorological forecast services have developed many clients of meteorological service for the daily needs of the users. However, in the face of various forms and rich content of meteorological service clients, there is no general software product that can meet the needs of general aviation low space airspace mobile meteorological service at present. Therefore, it is necessary to develop software products for low altitude meteorological service requirements for general aviation aircraft, and to further explore the demand for low altitude meteorological services, and the client interface can be developed by Android Studio software at the end [3].

2 Analysis of the client function of meteorological service

At present, the customer service of meteorological services is emerging one after another. It has become the basic function of mobile terminal embeddedness. As far as its functions are concerned, most of the daily life needs are provided, such as location information, real-time temperature, weather condition, range of temperature change, air quality and so on, and forecast the weather and temperature in the next few hours, and give the weather in the next week. Among them, the air quality, comfort, wind, and wind direction of users are carefully divided and presented. The air quality first gives the pollution index, and the next part of the weather software client provides PM10, PM2.5, nitrogen dioxide content, sulphur dioxide content, ozone content, carbon monoxide content, and other monitoring values. Comfort provides information such as air humidity, body temperature and UV index. Wind and wind direction provide two parameters of wind size and wind direction for people's reference. Some of the software also provided 45 days of long-term forecasts and provided more detailed guidance on clothing, sunscreen, car washing, fishing, sports, allergy, umbrella, or air conditioning. It can be said that the current weather service client on the market has provided a reasonable proposal for people's daily travel and work life.

At the same time, in the interface design, the client uses a simple interface design idea, which presents the most important monitoring items in the most obvious screen position, reducing the user's operation and adapting to the convenience of the people of different classes.

For the rising general aviation flight, the flight airspace is mostly low space airspace, but the present low altitude airspace meteorological service system has not been completely established. The acquired meteorological data is poor and large, so it is difficult to meet the users' demand for the environment and weather information of small area flight operation environment. Therefore, it is urgent to provide the corresponding meteorological service software. The general software on the market does not integrate the meteorological data required for the flight professionals, and the flight operator can only obtain the related information by means of television forecast and Internet search.

2.1 Poor pertinence of meteorological information

The information provided by software is more focused on the influence of meteorological conditions on personnel, and the impact on aircraft and other systems is difficult to have professional guidance. In addition to the unified management of aircraft operations by the government departments, most of the flight operators can only rely on their flight experience to determine whether they are suitable for flight.

2.2 Large scale of meteorological information

At present, the meteorological forecast obtained from the mainstream Internet software provides large-scale weather forecast information, which can only be provided to the meteorological data in the county or district level, and does not provide the information of the smaller flight area level. Operators often need to visit the
local area in advance or ask the local meteorological department to better judge whether the flight plan needs to be adjusted. All of these have adverse effects on low altitude flight, resulting in waste of time and obstacles to information acquisition.

These factors will cause the users to not get the detailed flight weather information, in serious cases, there may be a flight accident, resulting in certain property loss or personnel injury. Therefore, in order to ensure flight safety, the corresponding low altitude airspace weather information service is needed to ensure flight safety.

3 Conditions of meteorological service industry

In different industries, the degree of meteorological services is different.

3.1 Military application

In terms of military applications, military aircraft are used in battlefield conditions and applied to field operations. The vast territory of our country has a complex natural environment. From plateau, mountain, hilly to plain, from land to sea, from air to ground [4], the meteorological environment is changeable and complex, and the meteorological application under the condition of low altitude airspace operations is very extensive, for example, the super low altitude penetration and strike of fighter planes, the transportation and fire support of various helicopters etc. Different fighters undertake different tasks of low altitude operations. At the same time, various kinds of meteorological support systems are needed to carry out meteorological support, such as Fengyun series meteorological satellite, mobile meteorological support vehicles, sounding balloons, meteorological unmanned aerial vehicles and so on. The professional weather support team will provide first-hand weather information for the use of combat personnel.

3.2 Civil application

Compared with military protection, the low altitude airspace meteorological service is relatively backward. At present, the main purpose of China's aviation meteorological service is to provide accurate meteorological information for the transport airport, airspace, high altitude flight and so on. The application of meteorological information in the field of low altitude flight is less. The main reason for this phenomenon is that our country has not yet provided the weather information service which is consistent with the demand of low altitude flying users and the characteristics of low altitude flying weather, which leads to the existence of many security risks in our low altitude flight and a large number of economic losses [5].

In the study of the impact of meteorological information on low altitude flight security, Shelton and others have studied the synchronous enhanced vision system for the environment simulation and flight test performance evaluation of the next generation of the next generation aircraft for the low visual environment with the combination of the NASA safe flight project [6]. Weitz points out that the flight trajectory is directly related to the friendliness of the environment, and studies the uncertainty decision and visualisation technology for the 4D trajectory prediction for the air traffic system [7]. The Feng Dengchao team explored the image matching method of the low altitude airspace flight view and the safe warning aerial map under the complex weather environment, and used the airborne positioning system of the aircraft to collect the information of the aircraft position, and compared the information of the special aerial map obstacle with the low altitude warning. The integrated application technology of remote sensing, geographic information system, and satellite navigation system is used to complete the visual matching of flight view and aerial map, so as to realise the early warning of low altitude flight risk [8, 9]. Sermis and others have described the evaluation method of aircraft flight hazard based on adverse weather avoidance [10]. In 2015, NASA launched a low altitude airspace development program based on adaptive configuration, adaptive optimisation, adaptive protection mechanism, and planned to complete the security environment test of cooperative and non-

cooperative UAVs flying in the urban area in 2018 [11]. Gao Bing analysed the influence of visibility, air pressure, wind, and other weather conditions on the aircrafts [12]. Feng Dengchao and others studied the effects of climate, topography, and aircraft on low altitude flight safety [13]. The results of these studies have filled the blank of the low altitude airspace meteorological service and promoted the development of meteorological service, which laid a good foundation for the further research.

At present, China is in the period of rapid development of civil aircraft, and the opening level of low altitude airspace has been continuously enhanced, and general aviation has been developing steadily. By the end of 2015, there were >300 general airports in our country, >2000 general aircraft, and 735 thousand hours flying hours for general aircraft, with an average annual growth rate of 20%. In recent years, China's UAV is showing explosive growth. In 2016, the sales volume of UAV reached 390 thousand, with an annual growth rate of more than 60%. It is estimated that by 2020, China's general airport will reach >500, and the number of general aircraft will exceed 5000, with an annual flight capacity of 2 million hours. The number of UAV will reach >3 million, and 95% will be civilian light and small UAVs [14].

In actual flight operations, the application of general aviation in various industries is biased towards low altitude airspace. The airplane usually has only a simple flight system and related flight auxiliary equipment at low altitude. It is difficult to obtain professional meteorological information, such as agricultural plant protection, electric power patrol, ocean monitoring, border patrol and so on. At the same time, the variation of meteorological elements in the low altitude airspace of flight space is severe, low cloud, thunderstorm, low air wind shear, cloud shelter, low visibility, terrain bump and ice accumulation will cause serious threat to low altitude flight security. Low altitude meteorological service system or technical equipment is relatively weak in developed countries, with a single means of meteorological services and a lack of specialised meteorological products [15].

The characteristics of integrated low altitude flight and low altitude weather, among which low altitude flight features include high air density, high speed pressure, large collision probability, wide range of range of activities, visual flight, task emergency and so on. The characteristics of low altitude weather include: wind shear and lower impact airflow, large temperature and humidity gradient, strong convection development, more influence of local back wind wave and topographic wave, low visibility factor, large probability of low cloud and cloud cover mountain, thick and low height of supercooled water drop layer [16]. Therefore, the failure to get the low altitude weather information in time or the lack of the low altitude weather information not only increases the flight cost, but also affects the flight efficiency, which has become an obstacle to the development of general aviation low altitude applications.

4 Current solutions

At present, there are two ways to obtain meteorological data before low altitude operation for large civil aircraft. First, it belongs to the aircraft of the government department. The advantage is that the government departments can obtain the meteorological data from the relevant departments through the professional channels. The shortcomings of the government departments are that the number of the special aircraft used by the government departments is small. It is necessary to cooperate with various departments, and it is difficult to carry out the related activities at any time. Second, the company's aircraft, the advantages of the use of more flexible, more quantity and can carry out low altitude operation, the shortcomings of the meteorological support vehicles or convenient meteorological support equipment need to be deployed in the field, some working environment is difficult to work, and also need professional meteorological service support.

While some enterprises, groups, or individuals with small or micro aircraft and the qualification of flight operations, the low altitude operations of the aircraft often rely on the experience of the team's flight and the collection of meteorological information. For personal flight enthusiasts, there is a lack of professional access to
meteorological information, which increases the probability of flight accidents.

Users at different levels are faced with the problem of acquiring meteorological data for low altitude airspace flight. In the process of obtaining the meteorological information related to a certain place, every operation should re-obtain the relevant meteorological information through various channels, and the quality of the acquired meteorological information is difficult to guarantee. More than one time to obtain single guarantee. The problem is whether it can obtain the historical meteorological data in the area to compare the related time, and whether it can obtain the auxiliary information of the flight guidance experience under different weather conditions. The whole meteorological information is scattered and there is no reliable integrated channel to integrate the relevant information.

Therefore, the demand for the meteorological information in the low altitude operation of civil aircraft needs more professional integration channels, that is, to provide low altitude weather service software and provide technical support for low altitude operation. It enables the aircraft operators to understand the meteorological information in the flight-related areas in a timely manner, and provide more professional flight suggestions for the flight area, and ultimately improve the safety of the operations. It not only meets the needs of professionals for meteorological data in low altitude airspace flight operations, but also provides guidance for amateur flight enthusiasts. The software can provide a view of the historical weather data and other functions to facilitate the prediction of weather conditions, and can also transfer the related flight meteorological data to the database, so as to facilitate analysis and summary and later view. Low altitude airspace meteorological service client relies on national network power strategy, “Internet plus” action plan, intelligent terminals, and mobile Internet business platform as the basis. Business application and platform mode become the key point of competitiveness. Since the behaviour of mobile Internet users has new features such as Forever online, fragmented, and socialised, and modern information technology tends to be intelligent, the environment, conditions, tasks, and requirements of the meteorological service have changed [17]. All these provide convenient conditions for the development of low altitude airspace meteorological service client. Here, the meteorological service client lays particular emphasis on providing the weather information forecast in the low altitude area and providing the operator with the meteorological information service for the flight operation.

5 Interface design

The client interface is designed according to the functional requirements of the meteorological customer service side. The interface design holds the simple interface layout and divides into five modules, such as the meteorological information of the takeoff point, the weather information of landing point, the weather information of the flying area, the flight guidance, the historical meteorological weather data and so on.

Flight accidents are easy to occur at the take-off point and landing point. The flight safety of take-off and landing stage is ensured by extracting meteorological information from relevant locations. The meteorological information of take-off point and landing point includes six indexes: position, wind direction, wind speed, temperature, humidity, and barometric pressure [18], as shown in Fig. 1.

The meteorological information module of the flight area includes the meteorological conditions in the low altitude operation range of the aircraft. In areas with a smaller operating area, the flight area may coincide with the meteorological information at the take-off point and landing point. The information of the flight area includes typical weather information (weather, wind direction, wind speed, temperature, humidity, air pressure etc.) and the information of obstacles that affect the weather conditions, the terrain and the seasonal characteristics of the climate in the region.

The professional flight guidance module refers to the guidance of the flight area provided by the backstage and provides guidance to the flight operator as a flight reference through the system analysis of meteorological conditions. At the same time, it can provide warning hints, as shown in Fig. 2.

Historical meteorological data are meteorological information in a certain period of time in the region. The history information will display the simultaneous historical weather data according to the flight time and are displayed on the screen TextView, and can be uploaded to the server database as needed in the case of network. Historical meteorological data provide a basis for operators to speculate on the meteorological conditions in the flight operation period through these historical data, as shown in Fig. 3.

6 Application case

Users can get the required low altitude meteorological information before the aircraft operates at low altitude through the low altitude airspace weather service client. The following operation steps can be used when applying the client:
First, users need to open the main client interface to fill in the information of aircraft take-off point and landing point location.

Second, users need to enter the historical meteorological information interface, fill in the flight operation time section, and click the query button. The client will read the completed information and retrieve the relevant information from the database, then display it on the client interface. Among them, the low altitude airspace meteorological service client can basically determine the flight operation range according to the take-off point and landing point, and the weather information, terrain and obstacle information and the seasonal characteristics of the flight operation area can be displayed in time through the background program. At the same time, according to the location information and the date of the work, the expert guidance area is displayed in the expert guidance area, the suggestion of whether to meet the low altitude operation conditions of the aircraft and the possible danger, as shown in Fig. 4. In the case, the meteorological data meet the conditions of flight operation, the terrain environment is gentle hills and no artificial obstacles, and the seasonal characteristics of the area are also suitable for flying. The advice given by experts is that meteorological conditions meet all flight indicators.

In the take-off and landing area, the main interface automatically calls the meteorological information of the database take-off point and landing point, and updates it under the network environment, as shown in Fig. 5. The case shows the meteorological information of take-off point and landing point. It can be concluded from the analysis that the meteorological conditions of take-off point and landing point have little impact on flight operations.

Third, users can get the meteorological data in the selected time section of the region at the historical meteorological information interface, as shown in Fig. 6. The case shows that the weather conditions are relatively good in this historical period, and it has little effect on the aircraft's low altitude operation. Aircraft operators can judge whether the prediction is accurate based on data. It also combines monitoring and forecasting data, expert advice and operator judgment in three aspects. The case shows that the client's business needs and interface design are tightly around the low altitude safe flight operation, and provide the corresponding meteorological service information for the low altitude operation of the aircraft.

7 Conclusion

Under the background of rapid development of general aviation industry, the low altitude airspace meteorological service has led the development and application of low altitude meteorological
service products at the same time. Low altitude airspace meteorological service has become an important part of ensuring low altitude safe flight environment. This paper analyses the problems encountered in the current low altitude airspace operation and some methods to solve the problem at present, and designs the client interface for the demand for the existing low altitude flight operation. At the same time, the interface is reserved for the professional meteorological service to provide information. In view of the current low altitude meteorological service system has not been completely established, information needs to be obtained from multiple channels. It can only provide low space airspace meteorological services for the areas with perfect ground monitoring sites.

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9 References
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