Design of 3D Track Monitoring Software for UAV's Ground Control Station

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Abstract: The composition and principle of UAV's ground control system software are introduced. The design of the trace monitoring software is discussed. The problem and resolution in the combined debug are showed. Based on the 3D GIS technology of Skyline, the Trace Surveillance and control software of the UAV ground system is designed in 3D map. The software can real-time display position, trace and navigation parameter, send Navigation control command, and query place position and load map. The software is proved effective after some UAV flight test.

1. Introduction

Ground control system (GCS) is an important component of the unmanned aerial vehicle (UAV). It is the command and control center of UAV system, can complete the flight control, the data chain management task, airborne equipment control for UAV, at the same time in the form of digital and graphics provides flight status, reconnaissance image information, and realize the monitoring of the whole system. Foreign GCS of UAV system 6 is to develop in the direction of intelligent, generalization, modularization and series. With the rapid development of computer technology, 3D geographic information system 7, computer graphics and virtual reality technology, and the deepening of the UAV ground system practice, how to make use of the 3D geographic information system for UAV ground system software design has become one of research focuses in UAV ground system.

Skyline software has been one of the 3D GIS software widely applied on the international, has advanced 3D digital display technology. It is widely used in surveying and mapping, digital city, land, water conservancy, and other important fields. The software can quickly fused data, update the database, display 3D geospatial image. Skyline's function is very strong, have open programming interfaces. Both in the network environment and stand-alone applications, function can be customized according to the requirements, and to establish a personalized 3D geographic information system.

This article will use skyline to design UAV ground station track monitoring software with 3D map as the background. This software can real-time display the location and navigation of UAV, send the navigation control instruction, and quickly query region location and load map.

2. The composition and working principle of UAV ground control system software

UAV ground control system is mainly composed of radio ground data Terminal (GDT), data management software, track monitoring software, flight monitoring software, mission monitoring software, as shown in figure 1. Data management software receives telemetry data of GDT downloading via serial port. Through internal transformation, telemetry data were sent to flight monitoring software, track monitoring software and task monitoring software via UDP 4 Ethernet. Flight monitoring software can real-time display of UAV's flight attitude, engine parameters, data link parameters. At the same time flight monitoring software can control aircraft attitude, altitude, and engine speed and data link. Track monitoring software can real-time show the location of the UAV, the flight trace and navigation data, and send the navigation [1] control [2] commands to the

data management software, after the internal conversion to GDT.

Track monitoring software [3] is mainly composed of the map management module, navigation mode selection module, the aircraft position and track display module, navigation data module, district position query and map loading module, etc.

Map management module includes map zoom in and zoom out, iconic drawing. Navigation mode selection is to choose GPS positioning, radio solution positioning, BD positioning or combination positioning. The UAV position display includes a visual display of the UAV icon on the map and text display on the status bar, and displaying a period of flight trajectory. Navigation parameters display includes GPS parameters and BD parameters. Area location query and mapping function reads and displays the location information of a certain region in the database by entering the name of the region, and at the same time adjusts the map centering on the location of the region.

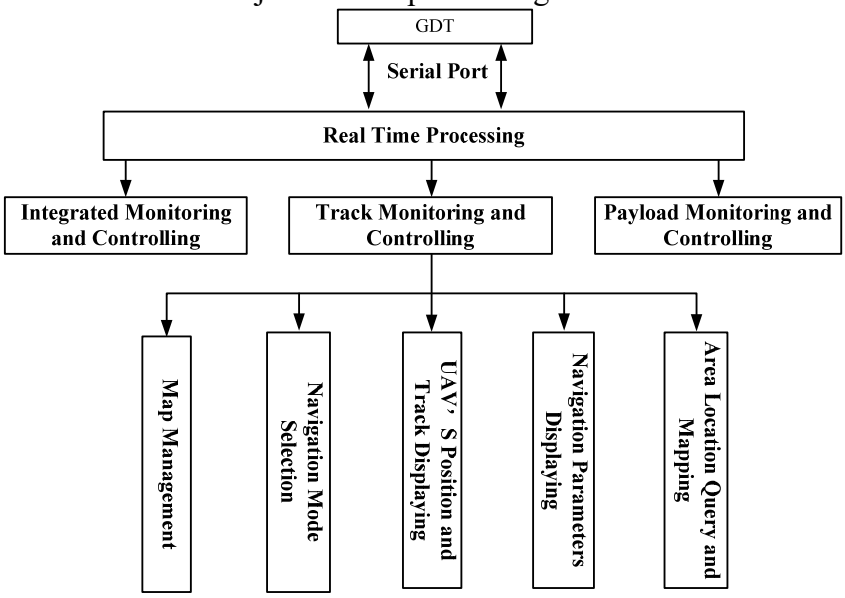

Figure 1. The Software Structure Chart of UAV Ground Controlling System

3. Design and Implementation of Track Monitoring Software

3.1 Send and Receive Data

The external interface of the track monitoring software is the Ethernet interface, and the network communication protocol is UDP broadcast. Windows Sockets is a network programming interface for Microsoft Windows, it is an extension from Berkeley Sockets. Windows Sockets inherits the main features of Berkeley Sockets and makes important extensions to it. These extensions mainly provide some asynchronous functions and add a network event asynchronous selection mechanism that conforms to the Windows message-driven feature. These extensions help application developers create software that conforms to the Windows programming model, making it possible to develop high-performance network programs under Windows. The key to implementing Windows network programming with Windows Sockets is that it provides message-based asynchronous access to network events. This system uses Windows Sockets version 2.0, initializes the UDP broadcast in the program initialization function, and receives the telemetry data in the WindowProc() message processing function. Use the Send to () function to send control commands.

3.2 Map Interface Management

Skyline [5] software uses TerraBuilder to fuse a large amount of image, elevation and vector data to create a 3D model [4] with precise coordinates Terrain Database; Then use the modeling tools in TerraExplorer Pro to model the files built on the TerraBulder. Create a 3D model through a series of processes such as texture capture, modeling, image processing, and mapping. TerraExplorer Pro fuses 3D model data and terrain data into a 3D simulation of the final file *.FLY file. Using the VC++7.0 development language and Skyline's ActiveX control, the 3D map is applied to the track

monitoring software through secondary development.

The track monitoring software created a single document application for CFormView using the VC++7.0 programming environment. Load Skyline's TE 3D Window control on the main dialog of the window view. Load the 3D map database in the initialization function OnInitialUpdate () of the window view and display it. The specific implementation is as follows:

```
HRESULT hr = CoCreateInstance (CLSID_TerraExplorer, NULL, CLSCTX_INPROC_SERVER, __uuidof (ITerraExplorer5), (void**)&TE);// Create 3D maps
BOOL bAdvised = AfxConnectionAdvise (TE, __uuidof (_ITerraExplorerEvents5), TE_Events->GetInterface (&IID_IUnknown), TRUE, &m_dwCookie); // Connect TE event
CStdioFile MapFile ("3DMap.nxs", CFile::modeRead);
CString str;
MapFile.ReadString(str);
sscanf(str, "%s", FilePathOf3DMap);
MapFile.Close (); //Read the 3D map path
TE->Load ((_bstr_t) FilePathOf3DMap); // Transfer to the 3D map and display
```

3.3 UAV Position and Track displaying

In order to monitor the position of the aircraft on the map in real time, a combination of graphics and text is used to display the aircraft position information. The text information of the aircraft position, latitude, longitude and altitude are displayed on the status bar. Instantly take out the position information of the aircraft and convert it to screen coordinates, displaying dynamic aircraft icons on the map according to the heading.

During the flight, sometimes the manipulator needs to know the true trajectory of the aircraft for a period of time, and the track display function is designed for this situation. The aircraft's flight path display function is realized by drawing the real-time position of the aircraft and then connecting the two points by using the line drawing function. The track display process is shown in Figure 2.

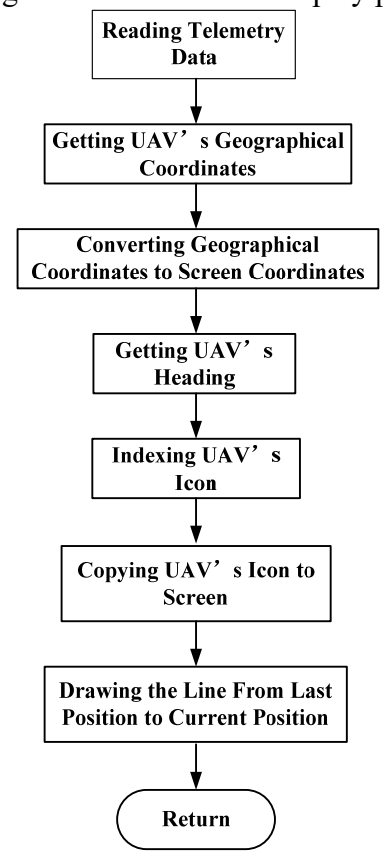

Figure 2. The Flow Chart of Track Displaying

3.4 Area Location Query and Mapping

Users will complete the flight missions in different areas. Each time they need to query the geographical location information of the area and call up the map of the area, according to this demand, the location of the quick query area (latitude and longitude) is designed in the track monitoring software, and the function of centering the map with the geographical location of the area.

By entering the name of the area to be queried in the regional location query interface, clicking the Query button will list all the geographical location information containing the name of the area in the list, and click on the desired geographic location information to call up the area as the center. Point map. Here we use the Access database and SQL query statements for fuzzy queries.

4. Problems and treatments in the joint test

We use the combination of Skyline and VC++ 7.0 to develop the UAV ground station track monitoring software. The software interface is shown in Figure 3.

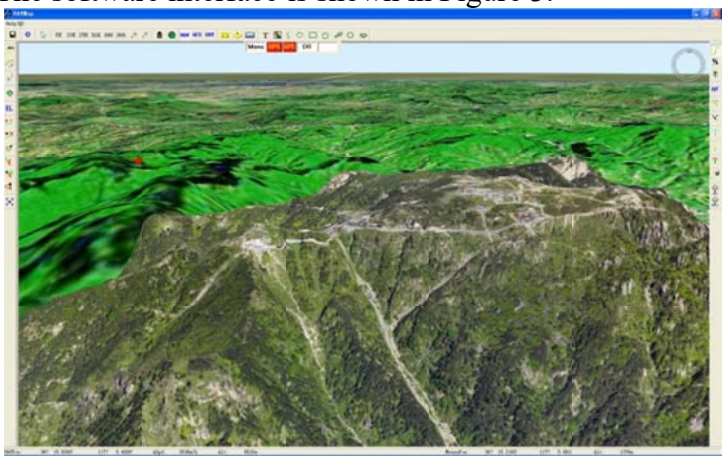

Figure 3. The Software Interface of Track Monitoring

4.1 Message-based Windows system timer error problem

The ground station software runs under the Windows platform. The software uses a message-based Windows timer for data transmission timing control and performs timing processing in the OnTimer message processing function. In the joint debugging, it was found that the ground station software was somewhat confusing for the measurement and control of the aircraft. Finally, the search was found to be due to the lower priority of the timer message and the large error of the message-based timer. We have adopted a third-party NI company's Windows-based multimedia timer to ensure timing accuracy and real-time performance, and the problem is solved.

4.2 Fault alarm optimization problem

In the process of monitoring the aircraft by the ground station software, GPS and GLONASS will not be located. Although this situation occurs, the ground personnel can analyze it and perform necessary operations and processing, but the response speed will be slower. Processing, track monitoring software adds GPS, GLONASS fault warning lights, if it is normal, it displays green light, once it fails, it turns red light alarm.

5. Conclusion

In this paper, Skyline was used to design the track monitoring software for UAV's ground control station on the 3D's map. The solution to the problem in the test is given, and the flight test results verify that the software has a friendly user interface, easy operation, and provides a three-dimensional visual operation platform for operators.

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