ATLANTIS PRESS

Advances in Computer Science Research, volume 83

8th International Conference on Social Network, Communication and Education (SNCE 2018)

Research on Modeling and Simulation of Aircraft Control under Complex weather Conditions

Xiangning Kong[1]*, Ze Yang[1] and Junjie Zhou[1]

[1] Unit95926, Aviation university of air force, Jilin Changchun 130022, China

*yuyangtao312@163.com

*The Corresponding Author

Keywords: Atmospheric turbulence; Atmospheric disturbance; Embedded database; Dynamic simulation

Abstract. During the flight, the aircraft often due to atmospheric turbulence caused by flight bumps, a long time will cause fatigue damage to the aircraft structure. All kinds of low altitude starting phenomenon is the main dangerous weather, which is the main dangerous weather during the takeoff and landing stage. It is very meaningful to simulate the flight of the aircraft in the flight simulator with high fidelity, which is useful for scientific research and training of the pilots. In this paper, all kinds of atmospheric disturbance model and the real time simulation model are established for the flight simulator. Based on the model of various atmospheric disturbances, an aircraft is built through the embedded database and real-time simulation platform, which can be used to simulate the flight simulator. Finally, a numerical simulation method is used to study the dynamic response of a large aircraft through the low altitude and the atmospheric turbulence. Compared with small aircraft, large aircraft scale and small scale wind field scale closely, should not be the aircraft as a particle approximation. Therefore, the dynamic model of wind conditions based on the study of general correction method with three-dimensional turbulent wind effect model. On the basis of the above, a real-time simulation was carried out for the longitudinal change and the lateral change of the large aircraft through the low altitude micro burst flow, and the influence of the delay of the engine on the flight was studied.

Simulation Requirement Analysis

Because the flight simulator is a kind of simulation equipment, which is controlled by the computer, coordinated by the multi system, can be repeated in the air environment, and can be operated ". When a flight simulator is developed, people always ask, "does it fly like a real plane?" Its essence is in the comparison of the simulated and the real aircraft pilot - aircraft control loop performance to a similar degree, about the accuracy of it with one hand and with the simulation model, on the other hand, with the simulation model of coordination is closely related to the operation of, while the latter is for flight simulation part of the machine real-time simulation management system. In this paper, the control simulation of aircraft under complex weather conditions is studied, and the simulation simulator is shown in Fig.1.

The management layer comprises the visual system software, the interface system software, the sound system software, the motion system software, the instrument system software, the control load system software and the corresponding physical effect equipment. The integrated information of the simulation computer generates a visual, auditory, motion and force sensing signal, and the application layer generates the corresponding driving signal. Computer real time simulation mainly consists of two parts of the simulation model and real-time simulation management system. The simulation model for the functional simulation of the performance of the aircraft and aircraft systems, real-time simulation management system is the management of the whole simulation system software, control, display and

monitoring the running state, the important parameters, data recording and so on. Thus real-time simulation management system in flight simulator role: on the one hand the scheduling manager by the scheduling table, public data area and the interface driver and data communication control implementation in the flight simulator system management functions, enable them to coordinate operation, produce high fidelity simulation accuracy, on the other hand for flight simulation machine operation and maintenance personnel to provide the man-machine interactive interface for simulation machine control, debugging, monitoring, and data management, make the flying simulation machine in optimization, safety and ensure the high fidelity of the operating environment.

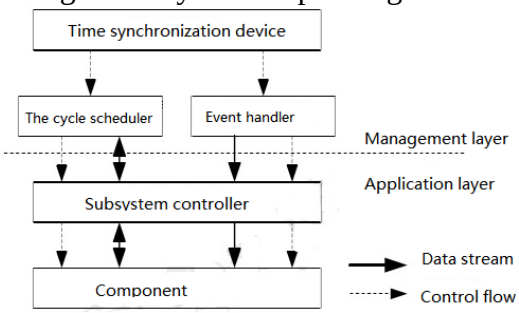

Figure 1. The simulation simulator

Aircraft Modeling Data Structure

The simulation process of information storage and management of flight simulation database is the basis of simulation. It separates the large and complex data from the simulation program, which can give full play to the efficiency of the simulation project and the ability to solve the problem. In the process of modeling data, we need to consider the problem of data storage and access, structure and database system of real time flight simulation system. The data access model can be embedded into the dynamic model of the software. Aircraft modeling database structure as shown in Fig.2. Its main function:

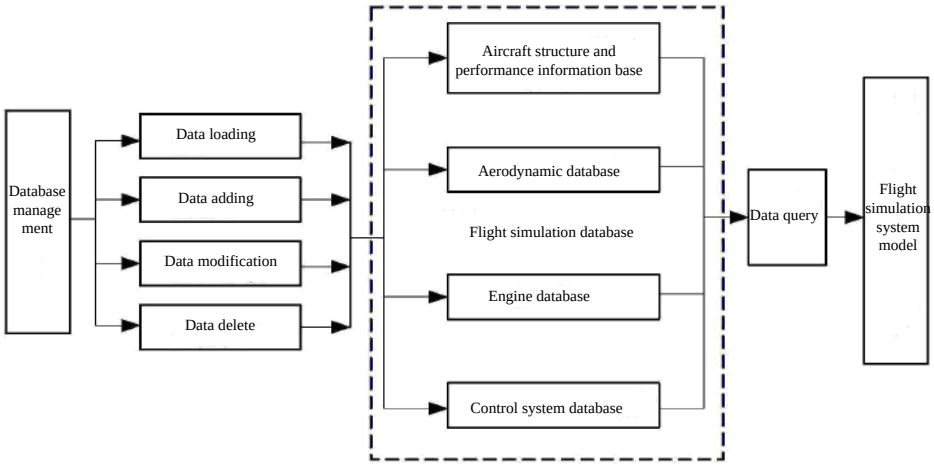

Figure 2. Aircraft modeling database structure

Load modeling data;
The latest data modeling, including data to add, delete and repair;
Real time query model data.

Flight Simulation Database

This study according to the flight simulation modeling of the specifications and requirements of flight simulator, based on Modeling of aircraft data, a real-time flight simulation model design and implementation can be used for flight simulator, running on a PC, with some reconstruction, including the aerodynamic force and moment model, engine model, control system model and the model of atmospheric environment. Aerodynamic and moment of time step model in real time simulation of aerodynamic and moment calculation. The relationship between the input and output models is shown in Fig.3. In each of the database access operation module, the corresponding data in the database is calculated, according to the real-time flight status, call interpolation algorithm, the calculation of each coefficient. Through the final dimension and matrix transformation, the equations of motion for the aerodynamic force and moment are obtained. Distributed object technology is a technology that can be used to speed up simulation by decomposing a large model into a simulation sub model distributed in different space. This is a tightly coupled distributed simulation technology. On the other hand, it can also be distributed through the distribution of the computer on the network processing, which is loosely coupled simulation. This simulation method breaks through the traditional, closed, self-contained simulation model.

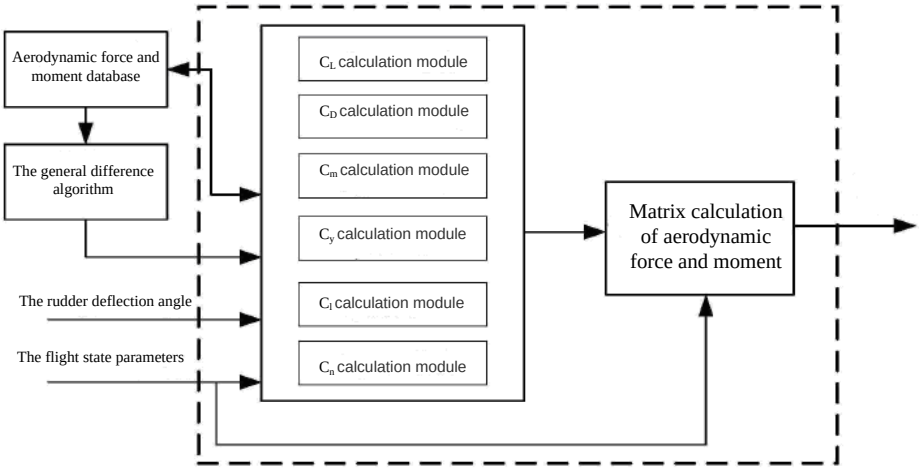

Figure 3. Flight simulation input and output model

Numerical Simulation of Atmospheric Turbulence

Flight tip vortex effects to the lift coefficient decreases, resistance coefficient increases, lift to drag ratio decreases sharply, the stall angle of attack decreases. Correctly reflect the aircraft wing flow field around the basic information, and to reveal the variations in these performance parameters of aircraft control the extent of the impact of performance is used numerical method for aerodynamic characteristics of the aircraft and the manipulation of analysis based. In the influence of wingtip vortex numerical computing, along with the change of eddy current range, intensity, machine interference flow distribution will also change, need repeated calculation for the flow around the new changes, numerical simulation process calculation workload is huge. In this chapter, based on the thorough study of Western Europe and the United States to solve the low speed viscous flow N-S equation, a set of method based on improved SIMPLE numerical model is proposed to solve the N-S equation. This

method takes into account the viscous effect of the flow field in the flight process, and has a high numerical model to solve the velocity. The results of numerical simulation of the flow field are obtained. Reasonable and accurate prediction of wingtip spoiler affected zone is to give the accurate control of response judgment premise. Domestic and foreign scholars from the 90's of the last century, began to carry out a lot of research on the flow field prediction method of the wing spoiler, draw many conclusions have guiding significance.

Generation and Propagation of Atmospheric Turbulence

This research can be used for the generation and expansion of 3D atmospheric turbulence flow field in aircraft flight simulation. Direct generate three-dimensional turbulent flow field and von Carmen model in the space domain, avoiding a different problem, and then based on the three-dimensional Fourier transform to the time domain space turbulent flow field. In the frequency domain, the turbulent flow field is divided into $M1 \times M2 \times M3$ grid point. Because of the transformation from frequency domain to time domain, the time domain and frequency domain sampling frequency and sampling frequency meet the following relations according to the basic principle of Fourier transformation:

$$\Delta f_i = \frac{f_i}{M_i} \tag{1}$$

In this paper, the spatial distance is non dimensional, the space generated by the turbulent field is non dimensional, and then the scale of the turbulent flow is solved by the inverse process.

$$\hat{f} = f_i L_i \tag{2}$$

Conclusion

This paper presents a system which can be used for real time simulation of atmospheric turbulence conditions for flight simulators. A real time simulation method is then carried out to ensure the dynamic flight height intensity and the size of the turbulence field. We can guarantee the effective expansion of the space turbulence to a large range of continuous turbulent field. Through this model and real time simulation, we simulate the dynamic modeling of aircraft in a variety of complex atmospheric disturbance problems.

References

[1] Tao Bo, combat behavior modeling technology of [J]. of national defense science and Technology University, 2002: 1.
[2] Fu Qiang. Key technologies of virtual prototype system design platform [D]. Nanjing: Master Thesis of Nanjing University of Science and Technology, 2005: 14-18.
[3] LIBOHU. Integrated Manufacturing System Technology for Complex Product [J]. Aeronautical Manufacturing Technology, 2002, (12): 17-20.
[4] Liang Yizhi, Zhang Weishi, Kang Xiaoyu, et al. Review of simulation model reuse method [J]. computer simulation, 2008, 25 (8): 1-5.