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Corresponding author: Shuanghou DENG
e-mail of corresponding author: shuanghoudeng@nuaa.edu.cn
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Title

A Numerical Virtual Flight Platform Development and its Application on High Maneuverability Flight Vehicles

Authors

Hongyu QIAO [1], Shuanghou DENG [1], Fan QIN [1], Tianhang XIAO [1]*

** Corresponding author*
[1] Nanjing University of Aeronautics and Astronautics, 210016 Nanjing, P.R. China, shuanghoudeng@nuaa.edu.cn

Abstract

Increasingly, the importance of air supremacy is triggering aircrafts owning high agility and maneuverability. When the aircraft is flying at a large angle of attack, the complex aerodynamic problems such as flow separation and hysteresis effect will cause unsteady and nonlinear changes in the aerodynamic and kinematic parameters of the aircraft, and there will be multidisciplinary coupling phenomena such as aerodynamic, kinematic, elastic and control, which may lead to the non-command self-excited motion of the aircraft and seriously threaten the flight safety. Therefore, it is of great significance to develop the aerodynamic-kinematic-control coupling numerical simulation technology of aircraft and give full consideration to the unsteady aerodynamic characteristics and multidisciplinary coupling problems. It can not only study the aerodynamic and kinematic changes of aircraft under the action of the control system, but also evaluate the performance of the control system under the action of unsteady aerodynamic forces, so as to provide a reference for the design of aircraft.

In the present study, a numerical virtual flight platform is developed and applied on high maneuverability flight vehicles. Initially, unsteady flow numerical simulation method and dynamic nested mesh technique are established for high maneuvering aircraft, and the accuracy of the calculation method is verified by steady and unsteady examples. Secondly, the flight mechanics equation and its solution are established using small disturbance theory. The six-degree-of-freedom motion equation of the aircraft is linearized. The dynamic derivative of the aircraft is obtained by the forced pitch oscillation method, and the control model of the aircraft system is established. Subsequently, the design method of flight control system is introduced. Finally, the loose coupling method is used to construct the numerical virtual flight simulation technology and software platform of aerodynamic-kinematic-control coupling, and the reliability of the coupling method is verified. At the same time, the attitude angle response characteristics of aircraft under different types of PID controllers will be compared.

With the developed numerical virtual flight platform, several cases such as missile and jet fighter will be employed for the sake of evaluating the feasibility, accuracy and efficiency of the VF platform.

References

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