AERODYNAMIC INVESTIGATION OF A 2D AIRFOIL IN GROUND EFFECT ABOVE WATER USING OPENFOAM

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Based on the OpenFOAM two-phase flow solver, the ground effect of a two-dimensional airfoil above the water surface is studied. The ground effect is intense during the surface taxiing of a seaplane. In order to verify the adaptability of OpenFOAM to this type of problem, the aerodynamic calculation of a simple two-dimensional airfoil above the water surface is investigated. Considering the subsequent need to simultaneously study the two-phase flow of water and gas, the interFoam solver is specifically used to calculate the problem. And both the results of the single-phase and two-phase flow calculation are compared with the experimental data as well. The results show that the ground effect will induce the separation of the airfoil upper wing surface. And also the two-phase flow calculation results of OpenFOAM are different from those of the single-phase flow calculation, but the magnitude of the difference is not very significant in a strong ground effect area close to the water surface.

Introduction

The high-speed taxxing along the surface of amphibious aircraft is a complex process of mechanical phenomena, involving the large-scale high-speed incompressible gas-liquid two-phase flow. To the scope of the author's knowledge, however, research on two-phase flow of amphibious aircraft is quite few. Qu Qiulin of Beihang [1] calculates the problem of the water landing of regional passenger aircraft. Using VOF, 6DOF, and global dynamic grid technology, the ditch landing performance of the upper single wing and high horizontal tail aircraft is studied. Liangjun Qiu [2] of Shanghai Jiaotong University uses the decoupled algorithm to carry out the dynamic simulation of the takeoff process of amphibious aircraft based on commercial software. Besides the complex two-phase flow hydrodynamic computaion, it is also very import to calculate the aerodynamic force accurately using two-phase slover during the taxiing of amphibious aircraft. On this point, this paper will investigate the 2D airfoil gliding on water to reveal the ground effect above the water level using two-phase slover of OpenFOAM.

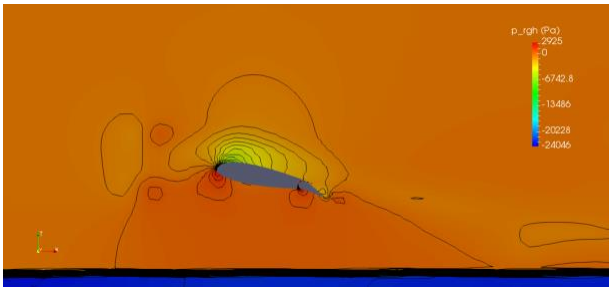

Figure 1: Pressure distribution on a section of the wing and flap

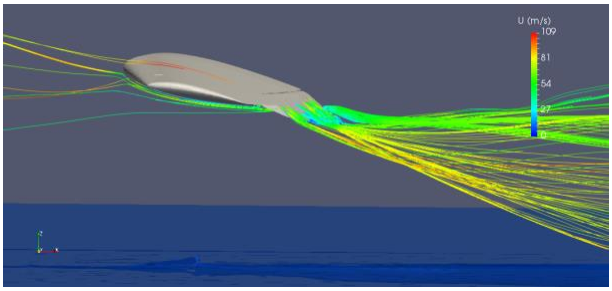

Fig. 2 Streamline passing through flaps at AoA=5 degree

When the angle of attack comes to 5°, there is a small area of separation at the trailing edge of the flap. As shown in Fig. 2, this phenomenon of early occurrence of separation is typical for ground effect. As shown in Figures 1, because of the coexistence of slipstream and ground effect, there is a clear airflow obstruction below the wing, which causes the speed of the airflow above the water surface to slow down and the pressure in the corresponding area to increase.

References

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