A ROBUST AND SIMPLE LOW-MACH NUMBER SOLVER FOR FLAPPING-WING SIMULATIONS

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Abstract

In the current study, a very simple preconditioned Navier-Stokes solver based on Roe type numerical fluxes is developed to investigate the unsteady aerodynamics around the flapping wings. A modified Osher-Chakravarthy (MOC) upwind finite-volume scheme is used for space discrete. To evaluate unsteady accuracy, a dual-time stepping strategy including the second-order Euler implicit method and diagonal dominant alternating direction implicit scheme (DDADI) are selected for the physical time and pseudo time stepping implements.
In the test cases, a three-dimensional cavity flow calculation will be performed for numerical validation. Then, simulations will be carried out on a NACA0012 wing oscillating in heave motion. The Preliminary results as the attached plot demonstrate numerical predictions of aerodynamic thrust coefficients compared with measured data are in good agreement. Validation of the current code demonstrates its robustness and accuracy. Quantitative and understanding simulations at different phases of heavy motion will be studied. The mechanisms determining of the lift, drag and propulsive efficiency of the flapping flight will be the main objectives to tackle with in the further works.

Keyword：Navier－Stokes equations; unsteady preconditioned compressible flow code, biological aerodynamics, flapping wing, propulsive efficiency.