Computational Fluid Dynamic-Rigid Body Dynamic(CFD-RBD) Technique and Application in Lifting Body Vehicle Aerodynamic Model

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The goal of this work is focus on a multidisciplinary computational study undertaken to compute the flight trajectories and simultaneously predict the unsteady free flight aerodynamics of plane-symmetric hypersonic vehicle configuration with the use of an advanced structured unsteady Navier-Stokes coupled with Rigid Body Dynamic computational technique. The numerical investigation fullfilled for perfact gas using three dimensional unsteady compressible Navier-Stokes equation and the six-degree-freedom(6-DOF) body dynamics are computed at each repetition of a flow solver.The method verification is carried out by simultaneous prediction of trajectory and free-flight aerodynamics of HBS and Finner standard configuration. The shock wave of the flow structure and distribution of the pressure of the plane-symmetric hypersonic vehicle configuration are obtained,which go with the multi-degree body motion. The trajectory of translation and attitude motions are obtained.It has been found that the pitch angle has a different affect on the roll motion. With increasing pitch angle, rolling moment slope coefficient decrease, which lead to increasing the oscillation amplitude of the rolling motion. The moment of the inertia and the initial location of the vehicle has great affect on the motion. This work lay the foundations of multidisciplinary CFD-RBD computations for complex guided hypersonic vehicle with maneuvers using control surfaces. The application of CFD-RBD numerical techniques can reduce the number of costly experiments by helping engineers quickly estimate the dynamic characteristics of the preliminary design.

Keywords: Hypersonic, CFD-RBD, Computational method, Lifting body, Aerodynamic model