6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 – 15 June 2018, Glasgow, UK

NUMERICAL SIMULATION OF SOUND SCATTERING USING IMMERSED BOUNDARY METHOD FOR COMPRESSIBLE FLOWS

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Key Words: *Acoustic Scattering, Non-linear Euler Equations, Immersed Boundary Method*

An aim of this work is to develop a method for numerical simulation of sound scattering over solid bodies described by the immersed boundary conditions (IBC) approach.

The mathematical model is based on the nonlinear Euler equations for compressible flows. Within the IBC approach, the Brinkman penalization method [1] is applied, to provide the required boundary condition on solid-fluid interface. The no-penetration boundary condition for velocity is imposed by adding the penalty terms in the momentum and energy equations which have non-zero values inside the streamlined obstacles. As all the IBC algorithms, the present method is free from the necessity to generate body-fitted computational meshes what could be very time-consuming especially in a case of moving obstacles or obstacles of complex geometry.

As known, the Brinkman penalization method for compressible flows can lead to wrong results for wave-solid interaction simulations because of a possible unphysical-wave transmission into the obstacle. This problem was first mentioned in [2] and solved by using the additional term into the continuity equation to provide the isothermal boundary condition. In the work presented, this idea has been implemented and extended to the adiabatic boundary condition. The developed method has been verified on canonical test cases – acoustic scattering on a cylinder and a sphere.

The method is implemented in the in-house code NOISEtte for simulation of CFD and CAA problems on unstructured meshes. The numerical algorithm is based on the higher-accuracy EBR (Edge-Based Reconstruction) scheme [3] and second-order implicit Newton-based method for the time integration.

The work is supported by the Russian Science Foundation (Project 16-11-10350).

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