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Numerical Modeling of the Moving Body in the Stratified Medium

L. Beneš[1], J. Fürst[1], Ph. Fraunie[2]

ABSTRACT

The contribution deals with the numerical simulation of 2D and 3D un-stationary, viscous incompressible flows with stratifications. The mathematical model is based on the Boussinesq approximation. The pressure and density perturbations are considered as difference to the reference flow field, fulfilling hydrostatic balance. The obstacle is modeled using penalty method. The numerical solution is achieved using the artificial compressibility method in dual time. The derivative with respect to the physical time t is discretized by the second order BDF formula whereas the dual time stepping is done using an explicit Runge-Kutta method. Two different numerical schemes was used for the spatial semidiscretiaztion.

• WENO scheme: the discretization in space dimensions are achieved by standard fourth order differences for viscous terms and by the following high order flux-splitting method. The inviscid flux is divided onto two parts, the convective flux and pressure flux . The high order weighted ENO scheme (WENO5) is chosen as the interpolation method. This interpolation is applied separately for convective and pressure terms. Resulting scheme posses high order of accuracy in space and second order of accuracy in time.

• AUSM scheme: in the second scheme, for spatial discretization of the inviscid fluxes, the finite volume AUSM scheme was used. Quantities on the left/right hand side of the face are computed using MUSCL reconstruction with Hemker-Koren limiter. The scheme is stabilized by the pressure diffusion. Viscous fluxes are discretized in central way on dual mesh.

• **Numerical results:** the flows in 2D or 3D towing tank were modeled and generation of internal waves is studied. The obstacle is either a cylinder or a strip and in the time $t = 0$ the obstacle starts moving with a given velocity. Various level of the stratification was modeled. The degree of the stratification is changed by the changing of the gravity constant for the Richardson numbers $Ri \in < 0, 100 >$. Both numerical methods were compared. In the case of the strip also comparison with the laboratory experiment is presented.

[1]Dept. of Technical Mathematics
Faculty of Mechanical Engineering, CTU in Prague
Karlovo nam. 13, Prague 2
121 35 Czech republic
`benes@marian.fsik.cvut.cz, Jiri.Furst@fs.cvut.cz`

[2]LSEET/CNRS
Université du Sud Toulon Var
BP 20136, F83957, La Garde, France
`fraunie@lseet.univ-tln.fr`