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A NEW PROJECTION METHOD FOR NAVIER-STOKES EQUATIONS BY USING RAVIART-THOMAS FINITE ELEMENT

G. Barbi[1], A. Chierici[1], A. Cervone [2], V. Giovacchini[1], S. Manservisi[1] and L. Sirotti[1]

[1] University of Bologna - DIN, Via dei Colli 16, 40136 Bologna (BO), Italy
[2] ENEA FSN-SICNUC-SIN, Via dei Martiri di Monte Sole 4, 40129 Bologna (BO), ITALY
e-mail: giacomo.barbi3@unibo.it

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Computational Fluid Dynamics codes usually adopt velocity-pressure splitting to reduce the computational effort in the solution of the Navier-Stokes equations. In standard projection methods, the finite element approximations show difficulties to find a solution with discrete free-divergence velocity field in all space points. In this work, a new velocity-pressure method for Navier-Stokes equations that projects the velocity field inside the discrete free-divergence velocity space is presented. This algorithm computes the velocity field on the discrete free-divergence space by using Raviart-Thomas finite elements. The projection is obtained by the minimization of the distance, over the discrete free-divergence space, between the auxiliary field and the desired Raviart-Thomas interpolation space. The Raviart-Thomas discretization is based on the quadrilateral and hexahedral finite element space and therefore the divergence mimetic computational approach is used to avoid the well-known degradation of the divergence term convergence. The auxiliary velocity field is obtained by solving the velocity-pressure split system used in the classical ChorinTemam algorithm. The pressure is recovered by the orthogonal space to the projection on the Raviart-Thomas interpolation space. The method is investigated with an explicit and semi-implicit treatment of the pressure terms. The issues on boundary conditions and the errors on the reproducibility of the tangential components are investigated. Several numerical examples are reported to support this new projection method.