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A CHIMERA METHOD WITH A DISCONTINUOUS GALERKIN DISCRETISATION FOR THE NAVIER-STOKES EQUATIONS

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The Chimera method [1] is a special technique for grid generation. It needs at least two different grids: a grid for the simulated body and another grid, in which normally the body grid is embedded. The first one, the chimera grid, is usually body-fitted while the second one, the background grid, is often a simple rectangular grid. Advantages of the method are that the two grids are easier to create compared to a single grid for the corresponding problem and that the method is suitable for fluid problems with a motion of a body or relative motions between two bodies.

In this paper the Chimera method is used within a CFD solver based on the Discontinuous Galerkin (DG) method. The DG method combines ideas from the Finite Element method and the Finite Volume method. The method uses a high-order polynomial basis function inside the cell to approximate the flow solution as it is common in Finite Elements. As the solution is discontinuous across cell faces, a Riemann solver, which is typically used in Finite Volume discretisations, is needed for the definition of a unique flux between two cells. The aim of the work is to assess the usage of the Chimera method inside the DG method for the Navier-Stokes equations. Hence, the chimera method is limited to the static case, with no relative motion between the grids. The following features are part of every chimera method and are covered here:

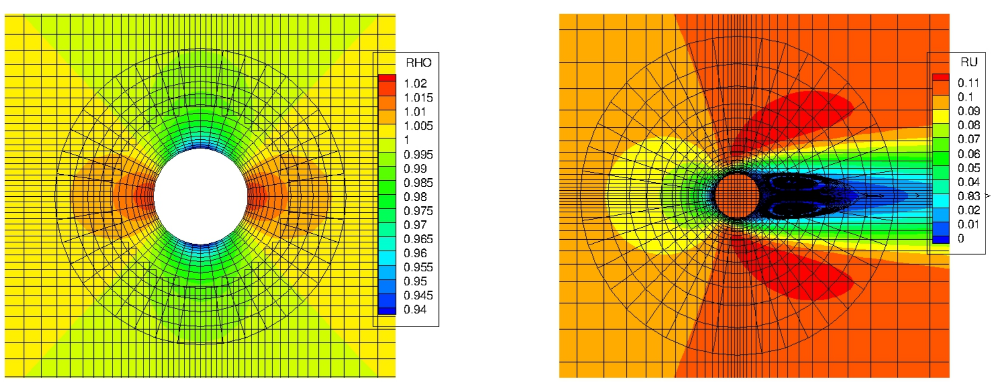
- The hole cutting algorithm: The cells in the background grid, which lie inside the body, must be excluded from the calculation.
- The interpolation between the two grids: The solution has to be transfered from the background grid to the chimera grid and the other way round. This is done with a discrete projection.
- The adaption of the temporal discretisation: In explicit temporal discretisation this can be easily done by suppressing the update of the interpolated cells and the hole

	chimera grid	single grid	Sen et al.
c_d	1.5096	1.5095	1.5093
separation bubble length	2.257	2.259	2.247
separation angle	53.40	53.39	53.61

Table 1: Comparison between simulation with chimera grid and a single grid with reference computations of Sen et al..

cells. Implicit discretistation is employed here for steady problems with a Euler Backward discretisation. The nonlinear problem is then solved with a Newton-GMRES algorithm. Interpolated cells in the linear matrix of the GMRES algorithm are again suppressed by exchanging their entries with a unit matrix and zeroing their right hand side.

The Chimera algorithm is tested with two two-dimensional simulations: a cylinder simulated with the Euler equations and a laminar cylinder with Re=40. Results are presented in figure 1(a) for the Euler case and in figure 1(b) for the laminar case. Both cases have a steady solution and are solved with the implicit Newton-GMRES algorithm using P3 quad elements. For the laminar case a comparison with a simulation using a single grid was performed and compared concerning the separation bubble length, the separation angle and the drag coefficient with reference computations [2] in table 1. The difference between the two methods are negligible and only small deviations to the reference computations are present.



(a) (b)

Figure 1: a) Density distribution of the Euler simulation, b) x-Momentum with the separation bubble of the Navier-Stokes simulation.

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