WORKFLOW EXAMPLE FOR NON-PARAMETRIC SENSITIVITY BASED ITERATIVE TOPO AND SHAPE OPTIMIZATION LOOPS

Michael Böhm, Thomas Schützle and Nick Stoppelkamp

FE-DESIGN GmbH, Haid-und-Neu Str. 7, D-76131 Karlsruhe, Germany

michael.boehm@fe-design.de

ABSTRACT

Topology- and Shape- Optimization for fluid problems is currently only available within a small number of specialized CFD solvers with minor industrial impact, in spite of the fact that the underlying theory is well known[6].

For industrial important CFD solvers[1, 2, 7, 3] the research in the field of sensitivity based optimization strategies has just recently started. A commercial implementation of an adjoint sensitivity calculation has recently been released by ANSYS Fluent within the version R14[5], where a parametrization approach can be used to update the geometry. A continuous adjoint implementation in OpenFOAM[8] seems to be a today very usefull approach for fast and effective testing of the applicability of such solutions for industrial optimization tasks.

Based on an example a fully automatic optimization framework will be outlined. The necessary tasks for the industrial users to set up an optimization and the importance of quality and stability of such a framework will be explained. Also explained are the tasks that have to be realized by the framework, such as the movement of points, the regularization[4] of the mesh and the connection to constraints or multiple objective functions. We emphasize the ease and advantage to set up non-parametric [1] optimization tasks and we will show large scale shape optimizations with many design variables as well as many degrees of freedom solved in CAE-environments that are typical for an industrial analyst. The freedom in the design space of the solution is only one of the advantages of non-parametric optimization.

The major disadvantage on the other hand is that the interpretation of the optimization result is not trivial, whereat this task is also not completely solved in all parametrized optimization strategies. Other still challenging tasks are e.g. the implementation of manufacturing constraints.

[1] Optimization parameters are the FE-elements, they are called "non-parameters" because an additional definition of these parameters is not necessary

1. REFERENCES

[1] Ansys Inc. *CFX Manual*, 13.0 edition, 2011.

[2] Ansys Inc. *Fluent Manual*, 13.0 edition, 2011.

[3] CD-Adapco. *Star-CCM+ Manual*, 6.0 edition, 2011.

[4] E.˜Stavropoulou; M. Hojjat; R.˜Wüchner; K.-U.Bletzinger. A mesh regularization approach for surface grids. In *ECCOMASS CFD 2010*, 2010.

[5] Genong Li and Chi-Yang Cheng. Mesh morphing and the adjoint solver in ansys r14. In *ANSYS Conference Boston*, 2011.

[6] Bijan Mohammadi and Olivier Pironneau. Shape optimization in fluid mechanics. *Annual Review of Fluid Mechanics*, 36(1):255–279, 2004.

[7] OpenCFD Ltd. acquired by SGI. *OpenFOAM*, 2.0 edition, 2011.

[8] C.˜Othmer, E.˜de˜Villiers, and H.G. Weller. Implementation of a continuous adjoint for topology optimization of ducted flows. In *18th AIAA Computational Fluid Dynamics Conference*, 2007.