Shape optimization and fluid-structure interaction with automated process integration

Z. Horváth[1]

[1]Széchenyi István University, Győr, Hungary, horvathz@sze.hu

In this paper we present our methods with automated process integration of industrial solvers and research codes of our university within the frame of the project "Simulation and Optimization". We deal with two areas of industrial applications: the shape optimization of Diesel engine intake ports and a fluid-structure interaction for virtual wind tunnel application.
Our method for the shape optimization (see also [1]) is an iterative process of black-box coupled state-of-the-art industrial commercial codes and in-house research codes forming the following automated steps in loop:

1. modeling of the product with some parametric CAD tool (e.g. Pro/Engineer – Creo),
2. analysis of the model, typically done with a CFD software (e.g. HyperMesh for mesh generation and Ansys Fluent),
3. decision on and modification of the CAD model for the next iteration by an optimization code (e.g. LGO, or research codes with evalutionary algorithms – see [2] for the special difficulty the optimization has to face, namely the limited number of objective evaluations due to 3D CFD simulations in each step).

In the second part of the talk we present another software process of ours for the virtual execution of fluid-structure interaction testing usually done in wind-tunnels (see [4]), which is the coupling of the following tools using industrial standard input and output structures:

- Parmod (Parallel Modeller): our in-house software framework for providing easily accessible modern CFD algorithms running on many-core systems including GPGPUs (see [3]), producing several Teraflops computational performance on cheap hardware,
- NX NASTRAN: the capabilities of this FEA software is achieved by our set of DMAP (Direct Matrix Abstraction Programming) modifications to NX NASTRAN.

Finally, we present the outline of the recently started research on simulation and optimization of hybrid and electric vehicles.

References

[1] Z. Horváth, T. Morauszki, K. Tóth, *CAD-based optimization and applications in automotive engineering*. In: B. Zupanic, R. Karba, S. Blazic (eds.), Proceedings of the 6th EUROSIM Congress on Modelling and Simulation. Ljubljana, Slovenia, September 9-13, 2007, pp. 9-16. ISBN:978-3-901608-32-2

[2] J.D. Pintér, Z. Horváth, *Integrated experimental design and nonlinear optimization to handle computationally expensive models under resource constraints*. Journal of Global Optimization 53:(1) pp. 51-75, 2012.

[3] M. Liebmann, C.C. Douglas, G. Haase, Z. Horváth, *Large Scale Simulations of the Euler Equations on GPU Clusters*. Proceedings of Ninth International Symposium on Distributed Computing and Applications to Business, Engineering and Science (DCABES), pp.50-54, 2010.

[4] Z. Horváth, T.A. Kocsis, G. Takács, L. Komzsik, *Development of a virtual wind tunnel: Tools and Methods of Competitive Engineering*. In: I Horváth, A Albers, M Behrendt, Z Rusák (eds.), Proceedings of the Ninth International Symposium on Tools and Methods of Competitive Engineering - TMCE 2012, May 7-11, 2012, Karlsruhe, pp. 1147-1156. ISBN/EAN 978-90-5155-081-8