Interactive Aerodynamic Design via Reduced Order Modeling

Markus Mrosek[‡,*], Carsten Othmer[‡] and Rolf Radespiel[*]

[‡]Volkswagen AG, Group Research, Letterbox 1777, 38436 Wolfsburg, Germany

[*] Technische Universität Braunschweig, Hermann-Blenk-Str. 37, 38108 Braunschweig, Germany

ABSTRACT

Aerodynamic optimization of the exterior vehicle shape is challenging due to the demand for esthetic designs - iterative loops between aerodynamicists and stylists are the consequence. As of today, this sequential process is inefficient since the aerodynamic evaluation of a vehicle design using Computational Fluid Dynamics (CFD) takes up to several days.

This talk presents an interactive aerodynamic design process which allows real-time computations of aerodynamic coefficients and flow fields within the design space of a parameterized vehicle [1]. To that end, we leverage methods of Reduced Order Modeling (ROM) and machine learning. Based on sampled CFD data, the dimension of the solution space is reduced via Proper Orthogonal Decomposition (POD). To predict the flow field at unseen parameter combinations, the POD base coefficients are interpolated using Kriging [2]. For the visualization of the ROM, we demonstrate a Paraview plugin that allows interactive evaluation.

We present a Volkswagen Jetta test case with 6 parameters to assess the accuracy of the predictions both qualitatively and quantitatively. The developed process allows for aerodynamicists and stylists to interactively find the best compromise between esthetic design and optimal aerodynamics.

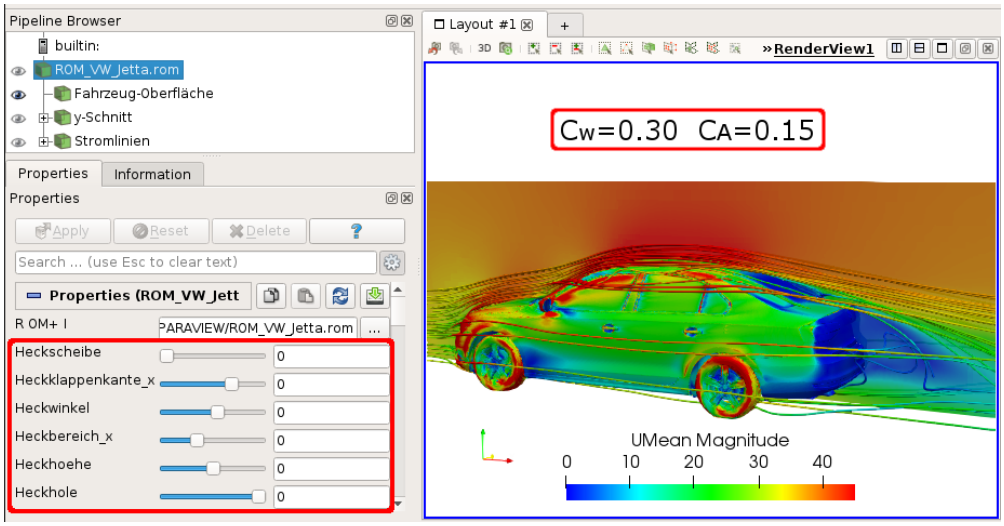

Figure: Visualization of the Volkswagen Jetta ROM: geometry variations via sliders (left box) and predicted aerodynamic coefficients (right box).

REFERENCES

[1] Bertram A., Othmer C. and Zimmermann R., *Towards Real-time Vehicle Aerodynamic Design via Multi-fidelity Data-driven Reduced Order Modeling*, In 2018 AIAA/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, Reston, VA, USA, 2018.

[2] Forrester, A., Sóbester, A., and Keane, A., *Engineering design via surrogate modelling: A practical guide*, Wiley, Hoboken, N.J., 2008.