Computational Steering: Interactive Design-through-Analysis for Simulation Sciences

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Computational steering has seen regular incarnations in the Computational Science and Engineering (CSE) domain with every leap forward in computing and visualization technologies. While often associated with the ability to interact with large-scale simulations running on high-performance compute (HPC) clusters, this poster will introduce a novel computational steering approach: *interactive design-through-analysis (DTA) through visual demonstration.*

The DTA paradigm means the seamless integration of computer-aided design and (simulation-based) analysis tools so that scientists, engineers & researchers can go back and forth between product design, analysis, and optimization. While coined already in the late 70's [1], the DTA paradigm got new impetus with the advent of Isogeometric Analysis (IgA) [2], which emerged from the vision of bridging the gap between CAD and CAE by resorting to a common mathematical framework – Non-Uniform Rational B-Splines (NURBS) – for modeling geometries and representing solution fields to PDE models.

The proposed approach's novelty consists in replacing traditional simulation-based (isogeometric) analysis that often hinders rapid design-through-analysis workflows due to its high computational costs with our recently developed IgANets [3], which is the embedding of physics-informed machine learning as proposed in [4] into the IgA paradigm. More precisely, we train parameterized deep neural networks to predict solution coefficients of B-Spline/NURBS representations in a compute-intensive offline stage. Problem configurations and geometries are encoded as B-Spline/NURBS objects and passed to the network as inputs, to provide a mechanism for user interaction. Evaluation of IgANets is instantaneous, thereby enabling interactive DTA feedback loops.

Note to organizers We plan to complement the poster with an interactive demonstration of our approach. We anticipate to have a VR-prototype ready by the time of the conference which we intend to bring to the poster session. In addition, we aim to present the demonstrator on a tablet or laptop to demonstrate multi-user interaction. We would therefore appreciate if the organizers can provide access to power and internet if this abstract gets accepted.

References

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