

Almost- C^1 splines

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Isogeometric Analysis generalizes classical finite element analysis and intends to integrate it with the field of Computer-Aided Design. A central problem in achieving this objective is the reconstruction of analysis-suitable models from Computer-Aided Design models, which is in general a non-trivial and time-consuming task. This talk will present new spline constructions [1, 2] that enable model reconstruction, as well as simulation of high-order PDEs on the reconstructed models. The proposed *almost- C^1 splines* [2] are finite piecewise-biquadratic splines on fully unstructured quadrilateral meshes (i.e., without restrictions on placements or number of extraordinary vertices). This is the lowest-degree unstructured spline construction that can be used to solve fourth-order problems on surfaces of arbitrary topology.

The definition of almost- C^1 splines builds upon the one from [1], and leads to splines that are C^1 smooth almost everywhere – that is, at all vertices and across most edges, and in addition almost (i.e. approximately) C^1 smooth across all other edges. Moreover, the proposed refinement scheme yields a C^1 smooth limit surface. The spline basis described has no parametric singularities, has several B-spline-like properties (e.g., partition of unity, non-negativity, local support), and can be implemented using Bézier-extraction. Numerical tests suggest that the basis is well-conditioned and exhibits optimal approximation behaviour.

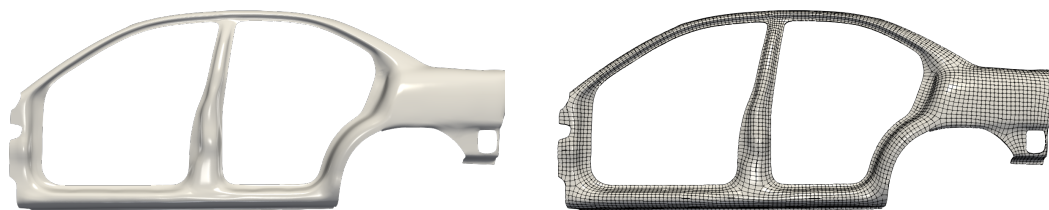


Figure 1: Example of an analysis-suitable model of a Dodge Neon reconstructed using almost- C^1 splines. The left figure shows the spline surface, the underlying Bézier mesh is shown on the right.

Joint work with: Thomas Takacs (Johann Radon Institute for Computational and Applied Mathematics)

References

- [1] D. Toshniwal. Quadratic splines on quad-tri meshes: Construction and an application to simulations on watertight reconstructions of trimmed surfaces. *Computer Methods in Applied Mechanics and Engineering*, 388:114174, 2022.
- [2] T. Takacs and D. Toshniwal. Almost- C^1 splines: Biquadratic splines on unstructured quadrilateral meshes and their application to fourth order problems. *arXiv preprint*, arXiv:2201.11491, 2022.