Beyond NURBS – Efficient CAD-integrated Isogeometric Analysis

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ABSTRACT

The integration of analysis tools in computer aided design (CAD) enables structures to be generated and explored intuitively. To achieve a high degree of interactivity, the use of natural CAD geometric parametrization – for example NURBS – is also desirable at the analysis stage [1]. It is important for this to be done in a computationally efficient manner, to speed up parametric design iterations. However, the analysis of free-form geometries based on NURBS is computationally costly due to the high polynomial degree. Beyond NURBS, modern CAD systems provide other descriptions of free-form geometries, such as discrete meshes or subdivision surfaces. To perform various types of analysis with different geometric descriptions, it is necessary to generalize the process of CAD-integrated isogeometric analysis (IGA) while also increasing the computational speed.

To address this issue, we present a new, efficient, and modular approach for implementing CAD-integrated analysis. It merges the concepts of the adjoint method with algorithmic differentiation to achieve a clean separation between mechanics and geometry [2]. Extracting the NURBS from the mechanics enables more efficient implementation with tighter integration of the analysis tool in a CAD system, which allows extensive interaction with the physical model. The same mechanical formulation can be combined with different geometric descriptions, and vice versa. A feature-rich digital toolbox can be derived from a set of highly optimized mechanical and geometric building blocks.

We present this concept for a range of mechanical element types and geometric parameterizations. The method can be employed for classic structural analysis as well as in form-finding and the constraint-driven design of free-form geometries.

REFERENCES

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