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# Isogeometric Analysis for Compressible Flow Problems

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The EU-funded MOTOR project [1] is developing modelling, simulation and optimization tools that enable integrated design workflows for aircraft engines, water turbines, ship propellers, and rotary twin-screw compressors. Next to giving a very brief overview of the project, we will present an isogeometric analysis framework for simulating compressible fluid flows and describe its HPC implementation in the open-source software G+Smo [2].

The framework is designed with heterogeneous hardware platforms in mind. The overall design philosophy is to associate individual compute devices like multi-core CPUs and many-core GPUs with individual patches of the multi-patch parameterization. The parameterization pre-processing tool that has been developed for screw-compressor geometries ensures that each single patch provides sufficient computational work to use the device to full capacity. Preliminary dynamic load-balancing capabilities are realized by locally enhancing the multiplicity of knots to create $C^{-1}$ continuous grid lines and breaking patches up along them.

Modern meta-programming techniques are adopted to combine different hardware-optimized linear algebra back-ends like ArrayFire, Blaze, Eigen, and VexCL with the fluid dynamics expression-template library FDBB [3]. This enables us to implement the core components of the flow solver as hardware independent compute kernels, which get just-in-time compiled and thereby optimized for each individual patch at run time.

Mathematically, the flow solver is based on a generalization of the Algebraic Flux Correction paradigm [4], to higher-order B-Spline basis functions and adopts strong stability preserving explicit Runge-Kutta time-integration schemes for advancing the solution forward in time.

## REFERENCES

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