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Image Registration Using Optimal Control of a Linear Hyperbolic Transport Equation

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Image registration is crucial in many imaging applications such as medical imaging or computer vision. The goal of finding a suitable transformation between two images poses similar restrictions and requirements on the set of admissible transformations as shape optimization problems. In the scope of this talk, we build on an approach that models image registration as an optimization problem that is constrained by a linear hyperbolic transport equation. We use a higher-order discontinuous Galerkin finite element method for discretization and motivate the numerical upwind scheme and its limitations from the continuous weak space-time formulation of the transport equation. Moreover, we build on recent theoretical results to model the optimization problem. To discuss the potential of the proposed algorithm, we apply it to patient specific brain mesh generation from magnetic resonance images (MRI). This can be a time consuming task and require manual corrections, e.g., for meshing the ventricular system or defining subdomains. The idea is to use the registration of an input MRI to a respective target in order to obtain a new mesh from a high-quality template mesh.

Authors: ZAPF, Bastian (Expert Analytics AS); HAUBNER, Johannes (University of Graz); BAUMGÄRTNER, Lukas (Humboldt University of Berlin); SCHMIDT, Stephan (University of Trier)

Presenter: HAUBNER, Johannes (University of Graz)

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