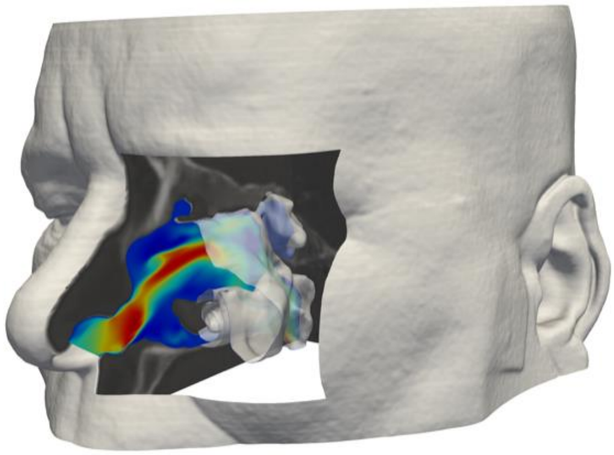
Automated assistance for diagnoses and treatments in rhinology

A key challenge to effectively diagnose and treat pathologies in the field of rhinology is a physics-based evaluation of the human respiration. Nowadays' methods, however, frequently rely solely on the analysis of medical images, visual inspection, or patient surveys. For example, in case of a septoplasty, a method to treat a deviated septum, a surgeon's decision is mainly based on an evaluation of computer tomography (CT) images and more than 40% of the patients are not satisfied after a surgery [1]. Numerical flow simulations can help to evaluate respiration capabilities by analyzing fluid mechanical properties such as the pressure loss, which has to be overcome by the diaphragm to allow for comfortable breathing [2]. Obviously, corresponding workflows can only be applied efficiently in clinical environments if their usage is automated and results are generated fast and accurately.



For more than 3 years, supercomputing resources at RWTH and the Jülich Supercomputing Centre are used to develop methods to accurately analyze the flow and to automate the corresponding simulation pipeline. The pipeline uses CT data as input and provides results of flow simulations as output [3]. The automation incorporates machine learning (ML) into the pipeline that replace otherwise time-consuming manual or semi-manual steps. To accelerate flow simulations, a physics-informed neural network is trained to predict an averaged flow field inside of the nasal cavity for an efficient initialization of the flow field. ML algorithms are further used to optimize nasal cavity shapes with respect to fluid mechanical parameters [4]. Optimized shapes are planned to be used as suggestions for surgical interventions. In this procedure, surgeons need to define the action space in which the ML algorithm is allowed to make changes. Object detection algorithms are trained with CT data and simulation results to support surgeons in this task by localizing and classifying pathologies.

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