On the Seamless Integration of Topology Optimization and Additive Manufacturing

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ABSTRACT

The advancement in additive manufacturing technologies over the last two decades have made the success of numerical design optimization methods such as topology optimization ever so relevant. The unparallelled design freedom made possible by topology optimization can now be manufactured, paving the way for a multitude of technological novelties across scales, covering a multitude of problems ranging from the design of new materials, through medical applications, to large-scale structures such as aircrafts and bridges.

This talk will focus on state-of-the-art methodologies within the field of topology optimization. Here, the main limiting factor in the application of topology optimization to engineering design problems, concerns the computational complexity and time to solution. With the recent advancements in computer hardware, this bottleneck can be significantly reduced by leveraging novel matrix-free multigrid methods utilizing GPU platforms [1] or by wrapping efficient high-performance computing optimization codes in simpler languages such as Python. Thereby allowing for easy access to fast and efficient topology optimization.

It will be shown how such frameworks can be tailored for problems within biomechanics. As example, we will demonstrate how topology optimization and additive manufacturing can be used to design patient specific implants, specifically the design and in-silico testing of spinal fusion cage implants [2].

Extensions of the topology optimization method to include dynamics, multiphysics and transient analysis, will be presented and exemplified by the design of component for hearing systems. The inclusion of time-dependent modelling within the optimization process is then shown to allow for integrated structural design and additive manufacturing process optimization for fibre reinforced composites.

REFERENCES

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