Popular science summary of the PhD thesis

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Title of the PhD thesis	Emerging methods for Topology Optimisation
PhD school/Department	Civil and Mechanical Engineering

Science summary

* Please give a short popular summary in Danish or English (approximately half a page) suited for the publication of the title, main content, results and innovations of the PhD thesis also including prospective utilizations hereof. The summary should be written for the general public interested in science and technology. Before the thesis defence, the summary is sent to DTU's Office for Communication and Media and to the media *Ingeniøren*:

This Ph.D.-thesis serves as a comprehensive contribution towards assessing the question of how emerging technologies in computer sciences, and especially computer graphics, can be utilised to improve or extend the capabilities of topology optimisation applications. Topology optimisation is a powerful tool for designing complex engineering structures by determining the best balance between maximising structural performance and minimising resource usage in an automated manner. The main research objectives are concerned with developing optimisation procedures capable of solving large-scale design problems at low computational costs.

Artificial intelligence-based applications aimed at reducing the computational cost of topology optimisation are becoming increasingly more established as a research field. The existing literature does, however, consist of a significant fraction of works presenting methodologies based on erroneous assumptions about the capabilities of current artificial intelligence technology. Paired with an overall tendency to present incomplete model validation and misinterpretations of results, this motivated a critical and thorough literature review, providing recommendations for best practises when working with such technologies.

One of the main observations from this review was that the select works promoting applications with sufficient generalisation abilities, are aimed at solving specific sub-tasks within the optimisation procedure, that can be reduced to an image processing or pattern generation problem. Especially, the application of a neural network for translating a theoretically optimal design to a realised structure suitable for manufacturing was fundamental to the subsequent work presented in this thesis. It is found that there are other more promising and understandable techniques established within computer graphics disciplines, than can substitute the neural network without significant loss in efficiency.

To this end, a solution framework based on a particular form of noise functions, typically utilised for texture synthesis and pattern generation in computer graphics, for obtaining the manufacturable designs. Efforts are aimed at investigating the flexibility of the core noise function concept and discussing potential use-cases within structural design. The proposed solution framework is analysed and tested in comparison to other existing methodologies, to contextualise its good-quality quantifiable performance in terms of its inherent characteristics in contrast to the alternative approaches.

The thesis, as such, culminates in an extensive collection of analysis and recommendations for interdisciplinary applications for topology optimisation. These contributions are accommodated by a detailed description of the development of a specific framework, building on computer graphics techniques. Initial tests have revealed great potential for achieving efficient design automation for complex structures, and a comprehensive discussion of its future potential is presented to promote further interdisciplinary research avenues.

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