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PARAMETRIC OPTIMIZATION OF LIGHTWEIGHT STRUCTURES

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Much of the worldwide available energy and raw materials is used for the establishment and operation of buildings. The development of resource-saving and energy-efficient constructions is promoted in many areas.
On the one hand side there is a lot of processing regarding structural optimization like form and topology optimization. The progress in the field of modeling and computation of finite element models must be mentioned in this context. One example is the development of lightweight constructions as optimized shell structures, especially fiber reinforced composite structures. On the other hand many innovative materials are being evolved. These include high performance concrete, high-strength steel and fiber composite materials. An important pioneer in the field of material and shape optimization of structures is nature. The application in a technical environment of this knowledge is referred to bionics or biomimetics. In nature one can find a variety of optimized shell structures. These structures often have fiber-reinforced armor plates. Wherein the orientation of the fibers is correlated to the load. The realization of sustainable buildings is only possible through the use of these technical innovations and biological inspirations. Through the use of a common model all aspects can be taken into account. This junction can be realized by a parametric model which includes the geometrical, structural and optimization parameters. The implementation of parametric design methods allows the simultaneously consideration of an extensive number of different but interdependent parameters. It is also possible to expand the number of variants by the use of a continuous cycle for model generation and analysis. While the principles of evolutionary optimization can be applied Appropriate interfaces between the individual models are necessary for this purpose.
In addition to the criteria mentioned above the integration of adaptive and smart characteristics is one of the main topics to increase the efficiency of lightweight fiber reinforced shell structures. Especially in relation to the vibration and deformation behavior the usage of smart sensors and actuators is essential. The presented method allows an early stage integration of smart materials in fiber composite structures. The fiber orientation can be investigated in this case by conventional and smart fibers taking account into different smart materials. The integrated sensors need to be positioned in specific and characteristic areas of the structure. The generated variants will be analyzed and optimized by the mentioned evolutionary algorithm. The process of optimization terminated if the given fitness criteria is reached.

The presented algorithm can be described as forward-looking because of the parametric design and the possible connection of computer-controlled production methods.

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