

Topology Design Optimization for Structures by Adaptive Growth Method

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The paper suggests an innovative design methodology of structural topology optimization by utilizing the optimality of branch systems in nature – so called as the adaptive growth method. The method bases on such essential characteristics of branch systems in nature that branches can grow by adapting themselves automatically to the growth environments in order to achieve better global performances, such as the maximal absorbance of nutrition or sunlight in plants and intelligent blood distribution of a vascular system in animal body. Thus, it can be expected that optimal topologies of engineering structures and systems can be generated by utilizing the generation method based on the growth mechanism of branch systems in nature. The layout design of cooling channel in a heat transfer system is studied as an application. If the so-called nutrient density in the generation process of branch system is referred to the temperature in a heat transfer system, the distribution of branches is responsible to the distribution of cooling channels. Because branch system can grow adaptively corresponding to the nutrition distribution in order to absorb the nutrition to the maximal extent, the cooling channel can be constructed adaptively by the control of the temperature so as to make it possible to achieve comparative uniform temperature distribution of the whole heat transfer system. Having the similar optimality of branch systems in nature, the constructed cooling channel can be designed flexibly under any complex thermal boundary conditions within any shapes of perfusion volumes to be cooled and can achieve good cooling performance. The design problems of both the conductive cooling channel and the convective cooling channel are studied, and the layouts of two-dimensional and three-dimensional cooling channels are illustrated.

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