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Topology Optimization for Heat Conduction Using Generative Design Algorithms

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Abstract

In this article, generative design algorithms are investigated as a strategy for solving two-dimensional steady-state heat conduction topology optimization problems. The motivation for this study is to investigate alternative numerical strategies for the eventual solution of richer three-dimensional multidisciplinary electro-thermal design problems related to functional electrical power systems. The efficient solution of such problems is critical for future power-dense electronics, where the optimal layout of heat sources (e.g., electrical devices) and heat sinks in combination with heat flow control structures and devices is important. Thus, as a first step toward this greater goal, generative algorithms are explored for their possible benefits, which include enabling a broader variety of objective functions, design constraints, and design variables plus separation of the design description from the computational mesh. Specifically, a new design method based the Space Colonization Algorithm is investigated. The generative algorithm is implemented using two distinct techniques. The first method is to use the generative algorithm to produce a starting topology for the SIMP Method; this will be referred to here as the Hybrid Approach. The second technique is to use the generative algorithm to produce topologies that can be meshed directly and evaluated with a finite element solver; this will be referred to here as the Generative Design Approach. A two-dimensional case study is used to compare the effectiveness of the SIMP, Hybrid, and Generative Design approaches. These initial studies involve a homogeneously heated square design domain where the thermal compliance design objective and computational cost are assessed.

Keywords: Topology Optimization, Generative Algorithms, Conduction.