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OpenLSTO: An Open-Source Code for Level Set Method Based Topology Optimization with Applications on Multiscale Structural Design

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The rapid advance of additive manufacturing offers freedom to engineering design owing to its capability to develop structures with unprecedented level of complexities, length scales, and material compositions. To leverage these new design freedoms that were not easily accessible with traditional manufacturing technologies, topology optimization, which places material within a prescribed design domain in a rigorously mathematical manner, has been widely recognized as an ideal design tool. Several topology optimization approaches have been developed in the past decades. Level set topology optimization has a unique advantage of producing design solutions with smooth boundaries and no fictious intermediate density material thereby enabling a directly manufacturable solution suitable for additive manufacturing. However, the lack of level set topology optimization tool limits engineers and researchers to easily explore and exploit the method.

This presentation will introduce a recently released open source code software for level set topology optimization (OpenLSTO). This is based on a series of studies and developments in our research group over the last 15 years e.g. [1-2]. It is composed of two C++ based modules that can handle a wide range of structural topology optimization problems. One of the modules is M2DO_FEA, which can be executed individually to perform finite element analysis, but the real power of the suite lies in the coupling with the level set method module, i.e. M2DO_LSM, to perform topology optimization. A key feature of the C++ modules is that each has been designed to perform a distinct functionality as much as possible and leverages the advantages of the class-inheritance structure. This makes OpenLSTO an ideal platform for prototyping new numerical methods such as discretization schemes, governing equation sets, mesh perturbation algorithms, adaptive mesh refinement schemes, parallelization. Apart from its capabilities on structural scale topology optimization that is available in the current version, the presentation will focus on novel features, including multiscale analysis and design optimization, to be added in the next version through several examples, including simultaneously structural and material topology optimization.

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