MULTI-GPU TOPOLOGY OPTIMIZATION OF CONTINUUM STRUCTURES UNDER UNCERTAIN LOADING

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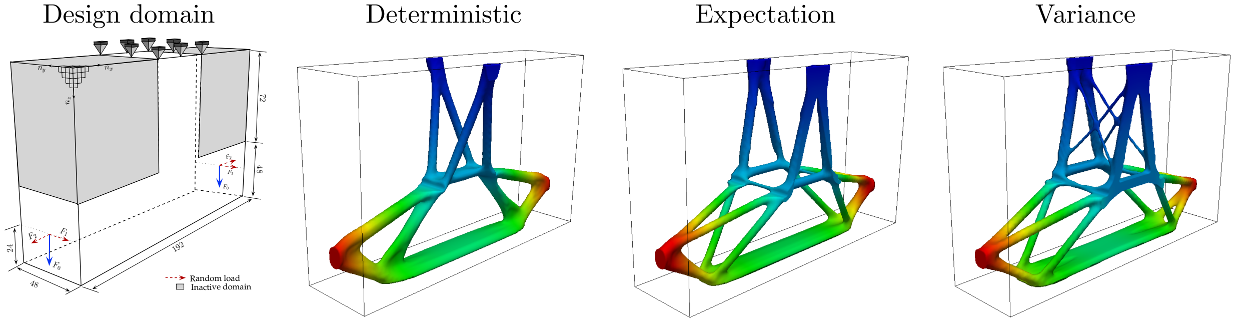
Abstract. Multi-GPU is used for addressing the robust topology optimization of continuum structures under uncertain loading. A well-suited strategy to make use of the massive parallel capabilities of these architectures is mandatory. The strategy exploits data locality and minimizes both memory consumption and data transfers. Besides, different granularities are used to maximize the GPU performance.

1. Introduction

Robust topology optimization of continuum structures is a compute-intensive task. This is mainly due to the use of uncertainty propagation methods to estimate the statistical metrics within the topology optimization process. Such a computational problem is exacerbated in terms of memory consumption and processing time for relatively large problems, as are the 3D finite element models. This work aims to alleviate these constraints using a well-suited strategy for multi Graphics Processing Unit (GPU) computing. Coarse-grained computing is used to concurrently evaluate the independent simulation models arising from an sparse grid stochastic collocation method. These simulation models are calculated by the different GPUs using a master-worker pattern approach. A fine-grained matrix-free Preconditioned Conjugate Gradient (PCG) solver is then used for the resolution of the simulation model in each GPU. The matrix-free approach permits to reduce the memory requirements obviating the assembly process of finite element models and to exploit data locality performing well-balanced parallel calculations. The proposal is evaluated using 3D topology optimization problems, as shown in Figure 1, achieving significant speedups compared to the classically used CPU implementation.

Design domain | Deterministic | Expectation | Variance



(a) (b) (c) (d)

Figure 1. (a) Configuration problem, (b) optimized deterministic design, and robust optimized designs for (c) minimal expectation and (d) minimal expectation and variance.