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Stochastic topology optimization in high-performance computing clusters using adaptive mesh refinement algorithms

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Robust topology optimization of large scale continuum structures is a computational challenge by itself. This is due to the use of large Finite Element (FE) models and uncertainty propagation methods. The former aims to address the ever-increasing complexity on more and more realistic models, whereas the latter is required to estimate the statistical metrics of the formulation. The computational burden of the problem is addressed by using a sparse grid stochastic collocation method to calculate the statistical metrics and an adaptive mesh refinement approach to efficiently solve the stochastic collocation nodes. Parallel computation on distributed memory systems is used to calculate the stochastic nodes partitioned using a domain decomposition method. Such partitioned problems are solved using an adaptive mesh refinement approach, which focuses the computational effort on the spatial regions surrounding the boundary of the structural design. A dynamical parallel repartitioning strategy is used to balance the workload of the computational processes involved on the computation of each stochastic node. A level-set based algorithm, driven by the topological derivative function, is used to address the topology optimization problem.The method is evaluated in terms of performance and scalability using several numerical benchmarks and real-world applications.

REFERENCES

[1] J. Baiges, J. Martínez-Frutos, D. Herrero-Pérez, F. Otero and A. Ferrer. Stochastic topology optimization in high-performance computing clusters using adaptive mesh refinement algorithms.