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Topology Optimization using the Discrete Element Method.

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Structural Topology optimization is attracting increasing attention as a complement to additive manufacturing techniques. The optimization algorithms usually employ continuum-based Finite Element analyses, but some important materials and processes are better described by discrete models, for example granular materials, powder-based 3D printing, or structural collapse. To address these phenomena we have adapted the established framework of Topology optimization to address systems modelled with the Discrete Element Method.

Our method discretizes the design domain for a classical topology optimization problem into a system of mechanically interacting particles; that may for example model the fracture mechanics of a beam, or the powder rheology inside a mill. A modified SIMP topology optimization algorithm can then drive the system towards optimal performance, defined for example in terms of minimising damage, or maximising system energy.

The immediate benefits of this new approach include the easy and simple incorporation of geometric and mechanical non-linearity as a production of inter particle interactions, optimizing dynamic phenomena such as impacts and progressive failure, and the optimization of discontinuous, continuum, or combined media.

The methods efficacy has been shown in our initial paper proving the concept in applications to simple beam problems. But the work remains to fully develop the technique and realise the goal to tackle the kinds of problems that rely on discrete behaviors that have traditionally impeded adoption of topology optimization.

REFERENCES

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