

SoftFEM: the Soft Finite Element Method

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Keywords: *Finite element method, heuristic optimisation, soft computing, solid mechanics, SoftFEM*

The finite element method (FEM) has arguably reached full maturity both in academy and industry. However, it remains computationally intensive and cumbersome when used as a part of a design optimisation pipeline. In particular, currently used optimisation schemes leveraging FEM still require the choice of dedicated optimisation algorithms for a specific design problem, and a “black box” approach to FEM-based optimisation remains elusive. To this end, we propose here an integrated finite element-soft computing method, the Soft Finite Element Method (SoftFEM). SoftFEM essentially integrates a finite element solver within a soft-computing-based metaheuristic search wrapper. To bypass the limitations in search capabilities of the usual optimisation techniques, a hybrid self adaptive search technique, the Multiple Offspring Sampling (MOS) [1], is used to combine two metaheuristics methods: a population-based differential evolution method [2] and a local search optimiser [3]. Doing so, SoftFEM is able to optimise geometry changes and mechanistic measures based on geometry constraints and material properties inputs. The formulation is presented in detail and its flexibility is illustrated with three representative solid mechanics problems. These experimental results show MOS as the most versatile search algorithm for SoftFEM compared with any of its components. A new method for the identification of non-fully determined parameters is also proposed.

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