Multi-objective Structural Optimization based on the Particle Swarm Optimization Method

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ABSTRACT

The Particle Swarm Optimization (PSO) Method [1] mimics the behaviour of a swarm of birds or insects or a school of fish that searches for food, protection, or resources. Every member of the swarm searches for the best in its locality, learns from its own experience, as well as from the others, typically from the best performer among them. The PSO method represents population based optimization heuristics for searching in high-dimensional spaces. It is an instance of a successful application of the philosophy of bounded rationality and decentralized decision-making to solve global optimization problems. It has been applied successfully in mathematical models in the past and recently it has also been applied to structural optimization problems [2].

In multi-objective optimization, a set of non-dominated solutions is usually produced instead of a single recommended solution. According to the concept of non-dominance, a solution to a multi-objective problem is non-dominated, or Pareto optimal, if no objective can be improved without worsening at least one other objective.

The recent success of the PSO algorithm as a single-objective optimizer has motivated researchers to extend the use of the technique also to multi-objective optimization problems. Although various methods have been proposed lately for dealing with multi-objective optimization problems with PSO [3], the method has not been applied to multi-objective constrained structural optimization problems. In the present work, PSO is applied in real-world structural engineering optimization problems where the aim is to find the optimum design of a structure under specific loads, under conflicting design criteria. The structure considered is a 3D truss tower, the objective functions are the weight of the structure and a characteristic nodal displacement both to be minimized, while the constraints refer to restrictions in the maximum values of stresses. The constraints are checked by performing a Finite Element analysis for every candidate optimum design.

References

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