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STRUCTURAL OPTIMIZATION BASED ON THE PARTICLE SWARM GLOBAL OPTIMIZATION METHOD

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ABSTRACT

A swarm of birds or insects or a school of fish searches for food, protection, or resources in a very typical manner. If a member of the swarm discovers a desirable path to go, the rest of the swarm will follow quickly. 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. Even human beings show a tendency to behave in this way as they learn from their own experience, their immediate neighbours and the ideal performers in the society.

The Particle Swarm Method of Global Optimization (PSO) mimics the behaviour described above. It 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.

Every individual of the swarm is considered as a particle that has a position and a velocity in the multidimensional space. These particles “fly” through hyperspace and remember the best position that they have seen. The members of the swarm move towards ‘fitter’ regions (represented by better solutions) by communicating good positions to each other and adjusting their own position and velocity based on these good positions. The position and velocity are updated at each iteration, until the global optimum is achieved.

The PSO method has been applied successfully in mathematical models in the past. In the present work, the method is applied in real-world structural engineering optimization problems where the aim is to find the optimum design of a structure under specific loads [1]. The structure considered is a 3D steel frame, the objective function is the weight of the structure, while the constraints refer to restrictions in the maximum values of stresses and displacements, as described by the design codes [2]. The constraints are checked by performing Finite Element analysis for every candidate optimum design.

The effect of the different setting parameters and the functionality of the algorithm are investigated. The results show the ability of the proposed methodology to find good optimal solutions for structural optimization tasks.

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