Automated Shape Optimization using a multigrid method and Estimation of Distribution Algorithms

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ABSTRACT

The shape optimization problem has been largely tackled by different optimization methods [1]. Most of them require expertise and/or initialization from the user, by instance, inserting initial holes in the structure, defining the percentage of material to be removed, or an initial structure which contour is parametrized and evolved by the optimization process. In contrast, our proposal considers a completely blind knowledge about the final design, neither any kind of user given initialization. The main idea is to sample completely random structures, then the best of them are used to train a probability distribution, which is, then, used to sample new candidate solutions.

This work considers two grids for representing the possible solutions. In the first and coarse mesh, the optimization algorithm sets values T_i on the nodes, which are randomly picked from a continuous interval, the interval in the first iteration is [0,1], in the subsequent iterations the interval is automatically computed by the optimization algorithm. These random values are used to define a Poisson problem, which solution is approximated by using the Finite Element Method (FEM). The second and finest mesh is used for solving the structural problem. By using the solution of the first mesh we compute $T(x,y)$ on the centres of the elements of the finest mesh, if the $T(x,y)$ value is less than a given threshold (0.5 in all cases), then the corresponding element is not present, otherwise it is present. In this way we automatically remove elements. The optimization problem is defined as minimizing the structure weight without exceeding a maximum given Von Mises stress and maximum given displacements. The method does not require special parameters, and the quantity of material that is removed is only constrained by the maximum stress and displacements. Additionally, forcing regions with material or holes in any part of the structure is straight forward. The results are competitive with state of the art algorithms. We present several experiments and comparisons with results from up-to-date literature.

REFERENCES

[1] Martin Philip Bendsøe and Ole Sigmund, *Topology Optimization: Theory, Methods and Applications*, Springer 2004.