Density filters for topology optimization based on the geometric and harmonic means

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Abstract

In the ground structure approach for topology optimization, some restriction method is needed to avoid mesh dependent solutions and enforce a length scale on the optimized structure. This talk presents new restriction methods in the form of four different density filters to be used within a relaxation/penalization method like SIMP. The first two are based on the geometric mean, while the last two are based on the harmonic mean. The filters have been analyzed and numerically compared with six other filters from the literature. The obtained results indicate that the new filters are successful in generating almost black and white solutions with competitive objective function values after a competitive number of iterations.

Moreover, and perhaps more important, it is demonstrated that on some problems several of the considered ten filters generate different final solutions with close to equal objective values but with quite different topologies and/or geometries! In such cases, an extensive "filter tool box" would provide the user with several different optimized solutions, each corresponding to a (hopefully) clever suggestion of how the real structure should be designed. Since there are almost always some aspects which are not properly considered by the optimization model, like manufacturing aspects, it is clearly a benefit for the user to have several clever suggestions to choose between for the further processing.

It turns out that each of the four suggested new filters generates, on at least one test problem, a final solution with topology and/or geometry not obtained by any of the other nine filters. Together with the apparent ability to produce almost black and white solutions with competitive objective function values, this should make the new filters interesting candidates for any filter tool box in topology optimization.