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A NEW LEVEL SET BASED METHOD FOR TOPOLOGY OPTIMIZATION

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Topology optimization has become a very popular field during the last decade, tempting thousands of scholars to dive into this discipline with a diversity of tools, among which level set based method is the celebrated one. In this paper we introduce a new level set based method, which achieves higher order accuracy, for topology optimization.

Conventional level set-based methods have the merit of accomplishing topology and shape optimization instantaneously and averting the catch of checkboard problem. Besides, it provides distinct interfaces and smooth boundaries which play a pivotal role particularly for designs. Nonetheless, there are two conspicuous defects residing in conventional level set based methods, encumbering the implementation of level set method. (1) It is not able to create new holes; (2) Only the first order accuracy has been achieved.

We employ the topological sensitivities in dealing with the first flaw of conventional level set method for topoloty optimization. Topological sensitivities are embeded in the Hamilton-Jacobi equation, which decides the update of level set function. Topological sensitivities facilitate the process of nucleation of holes.

For the sake of higher accuracy, trapezoidal method is also incorporated in the update scheme of level set method. Based on the conventional level set equation, the ultimate numerical update scheme is derived as follow:

$$\Phi_{n+1} = \Phi_n - \frac{\Delta t}{2}(v_n \left|\nabla\Phi^{n+1} + \nabla\Phi^n\right|) - \omega g,$$

where Φ_n is the level set function in the n^{th} iteration, $\boldsymbol{v_n} = \boldsymbol{v} \cdot (\nabla\Phi / |\nabla\Phi|)$ is the normal velocity, t is the pseudo-time, ω is a positive parameter for balancing the influence of topological sensitivities, and g denotes topological sensitivities.

Then Let us take a look at a numerical example. Consider an elastic material with a Young's modulus of E=1 and a Poisson's ratio of $\nu = 0.3$. The load is applied vertically in the upper left corner and the supports sit at the lower left and right corners. The design domain is

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discretized with a mesh of 120×20. Finally, it takes 66 iterations and achieves a compliance of 84.82.

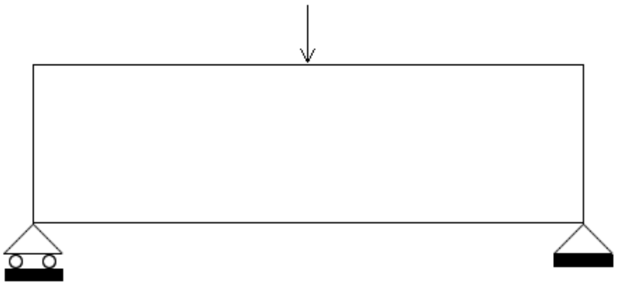

Figure 1. Design domain of the structure

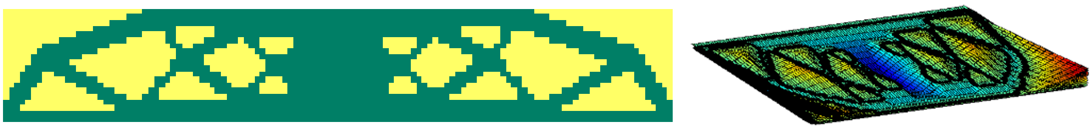

Figure 2. Zero level set contours and level set surface (120×20) of optimal structure

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