Topology optimization of a thermo-fluid system and an eigenfrequency problem

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Abstract

We propose a novel framework for the two- and three-dimensional topology optimization (TO) of multiphysics system. The proposed design methodology uses a reaction-diffusion equation (RDE) for updating the level-set function based on the topological sensitivity. From the numerical point of view, two key ingredients are highlighted: (i) two different types of dynamic sparse grids (adaptive mesh) are used. More accurately speaking, body-fitted mesh allows the disjoint–reunion of a global mesh whose interfaces can be described by the zero-level-set isosurface. Anisotropic mesh adaptation is highly scalable with respect to the problem size, therefore can accelerate the overall computation; (ii) our framework uses FreeFEM for finite element analysis (FEA) and PETSc for distributed linear algebra. Efficient preconditioner techniques are utilized to solve the large-scale finite element systems. From an engineering standpoint, we construct a complete product development workflow including the pre-processing, TO, B-Rep conversion, and the numerical experiment. The performance of our methodology is demonstrated by showcasing four different optimization problems: natural convection, lift–drag, multi-material design of mean compliance problem and eigenfrequency problem. For comparison and for assessing our various techniques, we benchmark our designs against state-of-the-art works.

References

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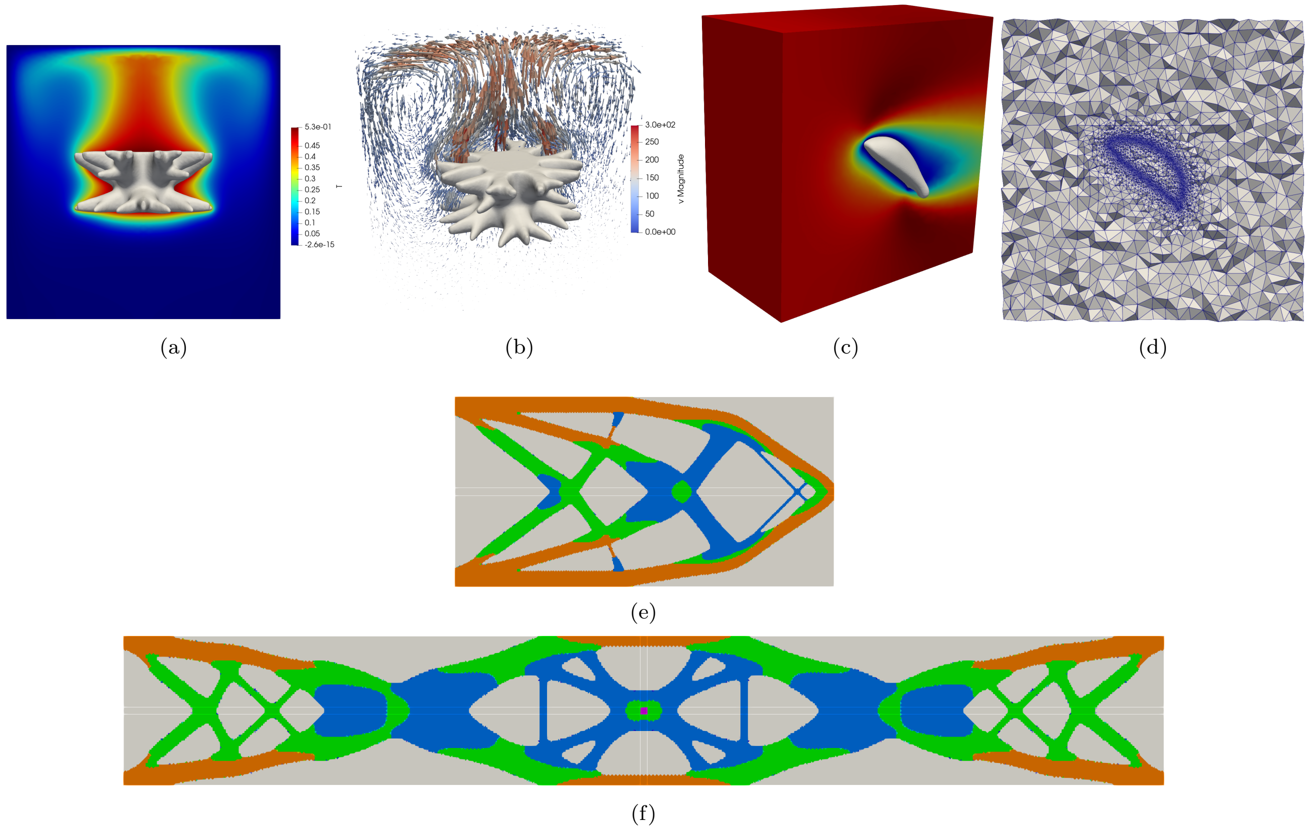

Figure 1: Optimal solutions. (a)–b): natural convection; (c)–d): lift–drag; multi-material design of: (e) mean compliance and (f) eigenfrequency problem.