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RECENT TRENDS IN TOPOLOGY OPTIMIZATION

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SHINJI NISHIWAKI* AND TAKAYUKI YAMADA†

* Department of mechanical Engineering and Science, Kyoto University
C3, Kyotodaigaku-katsura, Nishikyoku, Kyoto, 615-8540, Japan
E-mail shinji@prec.kyoto-u.ac.jp and http://www.osdel.me.kyoto-u.ac.jp/english/members/index.html

†Department of mechanical Engineering and Science, Kyoto University
C3, Kyotodaigaku-katsura, Nishikyoku, Kyoto, 615-8540, Japan
E-mail takayuki@me.kyoto-u.ac.jp
and http://www.osdel.me.kyoto-u.ac.jp/english/members/index.html

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ABSTRACT

Topology optimization[1],[2] is the most flexible type of structural optimization method that allows topological changes in addition to changes in shape, and has a potential to provide the optimal configurations with markedly higher performance and to implement them new structural function. Topology optimization is widely used in many industries.

Typical and well-known topology optimization methods include homogenized design methods [3] and Solid Isotropic Material with Penalization (SIMP) [4] method. Various new topology optimization methods such as the level-set based method [5], [6], [7] have been recently proposed.

These methods have been applied to a variety of physics problems such as structural mechanics, acoustics, thermal diffusion, fluid mechanics, thermal-fluid mechanics and electromagnetics. This has also been applied to structural designs of materials such as structural, electromagnetic, and acoustic meta-materials.

Topology optimization originally used the finite element method for the numerical analysis targeting the structural design problems. The finite element method have been widely applied to other physics problems. However, different types of numerical analysis methods such as the lattice Boltzmann method and the particle methods have been recently applied to designs concerning fluid mechanics and thermal-fluid mechanics. The use of such numerical methods have great advantages such as potentials to deal with the extremely large scale problems and the free boundary problems. The many applications of the isogeometric analysis method have also been reported.

From the viewpoints of optimization schemes, topology optimization originally used the optimality criteria methods for efficiently obtaining the structural configurations targeting the maximum stiffness. Later, the convex approaches such as the Method of Moving Asymptotes MMA have been applied for solving the wide range design problems. Recently, the schemes

that use the differential equations such as the Hamilton-Jacobi equation and the reaction-diffusion equation have been proposed as a new trend.
As explained above, the developments of topology optimization are prominent since it has been first proposed in 1988, and we can expect the wide range of further developments that are related to the theory, implementation schemes, optimization schemes, applications of variety of numerical schemes, application to other physics problems, and application to multi-scale problems. In this minisymposium, new trends concerning such current developments in topology optimization and its applications to a variety of physics problems and material design problems are discussed, and their future prospects are investigated.

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