Projection-Based Topology Design Optimization with Discrete Object Projections

†*Seung-Hyun Ha[1]

[1]Department of Ocean Engineering, Korea Maritime and Ocean University, South Korea

*Presenting author: shha@kmou.ac.kr

†Corresponding author: shha@kmou.ac.kr

Abstract

Topology optimization is a well-known computational method that selectively distributes materials in the design domain. In this research, projection-based topology optimization method is applied in accordance with discrete object projection method. In the conventional topology optimization method, design materials can be located anywhere in the design domain, but this free-form approach used to result in some numerical issues such as checkerboard pattern, hinge connection, and mesh dependency. Heaviside projection method [1][2] is one of the remedy for this numerical instability, in which the minimum length scale is controlled for projected materials, and manufacturability is greatly improved. By introducing additional length scale parameters, discrete objects are naturally introduced during the optimization without any overlaps between adjacent objects [3][4]. Furthermore, super-elliptical parameterization is developed in the discrete object projection method, which allows various inclusion shapes such as ellipses, super-rectangles, and even asteroids [5]. Then, the developed method is applied for structural design problems as well as material design problems combined with homogenization method, and this work can be used for optimizing the material property of composite materials with non-overlapping discrete objects such as fibers or particles.

Keywords: **Topology optimization, Discrete object projection, Heaviside projection method, Homogenization method**

Acknowledgement

This work was supported by National Research Foundation of Korea (NRF) grant funded by the Korea government(MSIT) (No. NRF-2015R1C1A1A01051797).

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