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Level set based topology optimization for optical cloaks containing a large scattering object

Garuda Fujii[1], Hayato Watanabe[2], Takayuki Yamada[3], Tsuyoshi Ueta[4], Mamoru Mizuno[1]

[1]Akita Prefectural University, Akita, Japan, garuda_fujii@akita-pu.ac.jp
[2]Nagoya University, Nagoya, Japan
[3]Kyoto University, Kyoto, Japan
[4]The Jikei University School of Medicine, Tokyo, Japan

Abstract

Optical cloaks [1, 2, 3] have been received much attention as one of the most interesting and remarkable topics in the field of optical engineering. Topology optimizations are effective methods for the design of the cloaks with high performance. The optimal designs of optical cloaks for a wavelength-scale object are demonstrated in the previous studies [4, 5, 6]. A next step for the realization of optical cloaks is to enlarge the size of a scattering object that can be rendered invisible by optical cloaks. This paper newly presents the design of optical cloaks for a large scattering object whose typical scale is larger than the wavelength of incident light. A topology optimization method based on the level set expression [7] of dielectric structures is used to optimize configurations of optical cloaks. Several optimal configurations with various geometrical complexities are demonstrated by adjusting a regularization parameter. A finite element method is used for light scattering analyses, the computation of adjoint fields, and updating level set functions. Level set functions are defined on grid points of grids to express dielectric structures. Dielectric boundaries are interpreted as lines on the iso-surface of the level set functions.

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