11th World Congress on Structural and Multidisciplinary Optimisation
07th -12th, June 2015, Sydney Australia

Level set-based topology optimization for the design of optical hyperlens

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Abstract

We present a topology optimization for the design of hyperlens using level set-based boundary expression. Resolution of conventional lenses is in general constrained by the diffraction limit, which prevents imaging structures smaller than the wavelength of light. To overcome this diffraction limit, novel applications using metamaterials have been proposed, such as superlens [1] and hyperlens [2]. Superlens resolves subwavelength structure by amplifying evanescent waves. However, the one of the limitations is that the working distance is still at near field. On the other hand, hyperlens takes advantage of cylindrical structure to enlarge the image of the subwavelength feature of the objects so that these features are above the diffraction limit at the output of hyperlens.

In this study, we apply a level set-based topology optimization method [3] for the design of hyperlens to enhance its imaging performance. The optimization algorithm uses the adjoint variable method (AVM) for the sensitivity analysis and the finite element method (FEM) for solving the equilibrium and adjoint equations, respectively.

To confirm the validity and utility of the presented topology optimization method, numerical examples are provided to show that the obtained results successfully function as a hyperlens.

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