Solving the inverse problem of finding the incident field on a high aperture lens for a desired field at the focus of the lens using evolutionary algorithms

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Obtaining a desired field in the focal plane of a high aperture lens is of much interest in applications such as particles trapping and imaging. The forward problem of finding the field at the focus of a high aperture lens for an arbitrary polarized incident wave is routine and was first discussed by Richards and Wolf [1]. The inverse problem of finding the polarization of the incident field on a high aperture lens for a desired focused field, however, is an inverse Fredholm problem of the first kind with a singular kernel and is an ill-posed problem [2,3]. Due to the difficult nature of this problem, we have no choice but to use heuristic and meta heuristic algorithms, among them evolutionary algorithms, which have proven very efficient in finding solutions to complex problems.

In this paper, we develop and utilize an evolutionary algorithm based on evolutionary strategies [4,5,6]. We tailor this algorithm for solving the specific inverse problem of finding the polarization of the incident field on a high aperture lens for generating a desired focused field. In order to overcome the time-consuming nature of the current problem, we apply a single chromosome strategy and for its nonlinearity, we use certain properties of genetic algorithm operators. The simulated experiences show the computational efficiency of the proposed algorithm in solving the discussed inverse problem.

Key words: Inverse problem, focused field, evolutionary algorithm