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Mathematical and numerical studies of an inverse eigenvalue problem on computing guided modes in optical fibers

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This work discusses studies, in both theoretical and numerical aspects, of two inverse eigenvalue problems. The numerical part is based on two efficient Algorithms for determining (reconstructing) accurately the best approximation of the exact refractive-index (for an optical fiber having a circular cross section and a graded-index profile), allowing a better transmission of a given information. Mathematically, the objective of this work leads to the resolution of two inverse eigenvalue problems that required the knowledge of a prescribed finite set of eigen data (of the direct problem) and the wavenumber in vacuum (the frequency). The corresponding direct problem consists of computing guided modes that propagate, under weak guidance assumptions, in the considered optical fiber. We use two iterative basic schemes to tackle these inverse problems, the first one: without any regularization and the second: with a regularization method. For the first inverse problem, we concentrate our attention to use a special fast and rapidly convergent Algorithm for solving a convex constraint optimization problem using Lagrange multipliers. Examples and several numerical illustrations, related to the considered inverse eigenvalue problem, show the robustness and the higher efficiency obtained by our suggested approach that converges geometrically and linearly to the exact refractive-index. For the second inverse problem, an original iterative method (based on Tikhonov regularization and assisted by L-curve method and relative errors calculation) has been exhibited and developed for the computation of the regularized (unique) solution of a discrete convex unconstrained minimization problem. Thanks to a novel described optimization Algorithm, we have led to very satisfactory and promising results where it was obviously found that the reconstructed function is very close to the true function. Furthermore, the results of numerical experiments confirm the reliability of the proposed technique.This work makes a significant contribution to the field and helps to inspire some additional interest and stimulate further research into this topic.

Biography

Hayat Rezgui is a Doctor of Sciences (in Mathematics). She currently works at the Department of Mathematics, École Normale Supérieure de Kouba (Algiers, Algeria) as a University lecturer/researcher. She does research in mathematical Physics, optical fibers, multi-resolution analysis, wavelets and image processing. She has several publications (in renowned journals) and conference papers. She participated in many international conferences, meetings and events.

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