A volume integral method in inverse scattering

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We discuss the problem of finding the index of refraction for the two-dimensional scattering of electromagnetic waves in an inhomogeneous medium with fixed frequencies. This type of problem arises in numerous areas of interest including geophysics, technology, medicine and nondestructive testing. The problem is difficult to solve since it is nonlinear and ill-posed (the solution-if it exists at all-does not depend on the data). Many methods were suggested in the literature and can be broadly divided into two classes: Optimization and iterative methods. Most work was done for TM wave illuminations whereas much less was reported for the most complicated TE case. The TE incident field is complicated compared to the TM case because of the strong nonlinearity and singularity of the kernel of the integral equation. We have considered both polarization cases in the past using the dual space optimization and simplified Newton iterative methods. Our methods were based on finite elements; but this involves a discretization of the two-dimensional space, which is a heavy numerical task, especially for high wave numbers and it is impossible to discretized to infinity so one has either to couple the finite element with boundary element using artificial boundaries or select a cut-off at some arbitrary distance from the obstacle and implement there the Sommerfeld radiation condition.

In this work we present a method based on the dual space method of Colton and Monk where exact integral equations (derived from Maxwell equations) are used. The radiation conditions will be satisfied and a Nystrom integration can be easily implemented, with much fewer cost than the finite element method, to solve the resulted Lippmann-Schwinger type integral equation. We consider both the TM and the TE polarizations. Several numerical examples will be discussed and the results will be compared to those of other existing methods