JOURNAL OF INTEGRAL EQUATIONS
AND APPLICATIONS
Volume 19, Number 3, Fall 2007

AN EVOLUTIONARY NEWTON METHOD FOR SHAPE RECONSTRUCTION

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ABSTRACT. We consider the problem to reconstruct the location and shape of an *unknown number of sound-soft obstacles* from the far field pattern of scattered acoustic waves. First, the *point source method* is used to generate an estimate for the area where the obstacles are located. In its simplest form the point source method will provide the convex hull of the set of obstacles. Then, we investigate a novel evolutionary Newton algorithm which integrates the Newton scheme with elements of an evolutionary approach. The *Newton method* is an efficient local method to find obstacles if the number, approximate location and shape of all obstacles is known. Without this knowledge the method quickly runs into local minima or diverges. The *evolutionary algorithm* is capable of finding the number of obstacles, their location and shape. However, in its typical form the algorithm is not appropriate for inverse scattering problems due to the expensive evaluation of the forward scattering map. Evolutionary algorithms usually use a large number of target function evaluations on a population of solutions and converge slowly. We will employ principles of both algorithms to formulate a novel *evolutionary Newton scheme* which does combine the strength of both evolutionary methods and the Newton scheme and does avoid their particular limitations. This shows that a combination of statistical and deterministical reconstruction methods can be used to significantly extend the range of the algorithms of both areas. In our last part we illustrate the feasibility of the scheme by numerical examples.

1. Introduction. Shape reconstruction problems are important basic problems for many applied sciences, for example in nondestructive testing, medical imaging and geophysical exploration. The mathematical area of inverse scattering problems investigates the reconstruction of the location and shape of objects from the knowledge of the Cauchy values or far field pattern, respectively, of scattered acoustic or electromagnetic waves. For a description of the state-of-the-art of inverse scattering theory we refer to [**1**] and the survey article [**16**].

Received by the editors on November 19, 2006, and in revised form on May 23, 2007.

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