

Reconstruction of 3D Distributed Parameter Functions with Discontinuities

U. Ascher

Dept. Computer Science, University of BC, ascher@cs.ubc.ca

We consider inverse problems of shape recovery from noisy boundary data, where the forward problem involves the inversion of elliptic PDEs. Such problems arise frequently in applications such as electrical impedance tomography, DC resistivity, data inversion of Maxwell's equations (governing electromagnetic phenomena), muscle activation localization through surface measurements, and so on.

The piecewise constant solution, a scaling and translation of a characteristic function, is hard to work with because its jump discontinuities, where all the information really is, move significantly at each iteration of a direct algorithm. Thus, an iterative solution method better described in terms of a smoother level set function. We have recently proposed a fast and robust dynamic regularization method for this purpose. A regularization is provided by the assumption of piecewise constancy, and no Hamilton Jacobi equations need be solved.

For problems of moderate size in two spatial variables, direct linear algebra methods have been found to be rather effective. For larger problems, however, especially in three spatial variables, iterative methods of linear algebra are required. Perhaps contrary to initial intuition, the iterative methods are particularly useful for the inverse rather than the forward linear systems. Preconditioned CG is investigated, both as a solver and as a regularization source. The efficacy of the obtained method is demonstrated on examples from applications.