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Synergistic Exploitation of 'Divide and Conquer' Strategies for Inverse Scattering Problems

M. Benedetti[1], D. Franceschini[1], M. Lambert[2], D. Lesselier[2] and A. Massa[1]

[1]Dept. Information and Communication Techn., University of Trento,
Via Sommarive 14, 38050 Trento, Italy
[2]Dpt. Recherche en Electromagntisme - Lab. Signaux Systmes (CNRS-SUPELEC-UPS 11),
Supelec, 3, rue Joliot-Curie, 91192 Gif-sur-Yvette cedex, France

Generally speaking, inverse scattering problems are characterized by a high complexity in terms of both the mathematical model and computational costs. As a matter of fact, ill-posedness and nonlinearity are very difficult issues to be carefully addressed in order to allow faithful reconstructions. Moreover, in order to obtain a suitable representation of the scenario under test, customized strategies [1][2] and efficient optimization methodologies [3][4] are needed. In such a framework, recent developments reported in literature suggest splitting the original problem in a series of successive sub-problems according to the general strategy of 'divide and conquer'. Then, each partial solution is profitably used as initialization for solving the successive problem, which turns out to be more and more close to the original one even though characterized by a reduced complexity because of the information on its solution acquired at the previous steps. In such a framework, two different guidelines have been taken into account. The former improves at each step the resolution accuracy in a subset of the whole investigation domain by considering a more detailed multiresolution description of the unknown scatterer profile [5][6]. On the other hand, an alternative strategy is that of acquiring at each step of an iterative process some information on the problem solution thus composing a sort of puzzle whose final "shape" fits the description of the scatterer under test [7].

As far as the so-called multiresolution strategies are concerned, a non-negligible problem is that of defining a criterion for identifying the number of regions-of-interest (RoIs) where the synthetic zooming takes place. Towards this end, various solutions have been proposed based on image processing techniques [8]. In such a contribution, such an issue is addressed by considering a shape-based representation of the scatterer. At each step of the multistep process, the RoIs defined at the previous step are processed through a level set method [1] in order to better estimate the support of the RoIs at the successive steps. Then, according to the standard IMSA, different levels of resolution are allocated in the investigation domain (i.e., higher in the RoIs defined at the current step and with a decreasing order in those estimated at previous steps) and a pixel-based reconstruction is carried out through a suitable optimization strategy [4].

A selected set of preliminary numerical results carried out in noiseless as well as noisy scenarios gives some indications on current limitations and potentialities of the proposed approach.

REFERENCES

1. A. Litman et *al.*, "Reconstruction of a two-dimensional binary obstacle by controlled evolution of a level-set," *Inverse Problems*, vol. 14, pp. 685706, 1998.
2. R. Ferraye et *al.*, "Reconstruction of complex and m ultiple shape object contours using a level set method," *J. Electromagn. Waves Applic.*, vol. 17, pp. 153-181, 2003.
3. A. Massa et *al.*, "Parallel GA-based approach for microwave imaging applications," *IEEE Trans. Antennas Propagat.*, vol. 53, pp. 3118-3127, 2005.
4. M. Donelli *al.*, "Computational approach based on a particle swarm optimizer for microwave imaging of two-dimensional dielectric scatterers," *IEEE Trans. Microwave Theory Techn.*, vol. 53, pp. 1761-1776, 2005.

5. S. Caorsi et *al.*, "A new methodology based on an iterative multiscaling for microwave imaging," *IEEE Trans. Microwave Theory Techn.*, vol. 51, pp. 1162-1173, 2003.
6. A. Baussard et *al.*, "Adaptive multiscale reconstruction of buried objects," *Inverse Problems*, vol. 20, pp. S1-S15, 2004.
7. O. Bucci et *al.*, "Intelligence and strategy in the solution of nonlinear inverse scattering problems," *Proc. URSI EMTS 2004*, pp. 694-696, 2004.
8. S. Caorsi et *al.*, "Detection, location, and imaging of multiple scatterers by means of the iterative multiscaling method," *IEEE Trans. Microwave Theory Techn.*, vol. 52, pp. 1217-1228, 2004.