A 'VIRTUAL EXPERIMENTS' FRAMEWORK FOR INVERSE SCATTERING

Martina Bevacqua[(1)], Lorenzo Crocco[(2)], Loreto di Donato[(3)], Tommaso Isernia[(1,2)]
(1) DIIES Università Mediterranea di Reggio Calabria, Reggio Calabria, Italy.
(2) Istituto per il Rilevamento Elettromagnetico dell'Ambiente IREA-CNR, Napoli, Italy.
(3) DIEEI, Università degli Studi di Catania, Catania, Italy.

In this communication we review the rationale and the outcomes of a new way of thinking we have recently introduced for solving inverse scattering problems, i.e., the 'virtual experiments' framework.
Such a framework starts from a very simple idea: when combining by means of a linear superposition the fields scattered under different scattering experiments, it is like performing a new scattering experiment wherein the linear superposition of the original incident fields are used instead of the original ones. As there is no need for further experiments, by using different combinations one gives rise to a number of 'virtual' experiments.
Obviously, these new experiments do not carry any new information, as everything is already contained in the original experiments. On the other side, by exploiting the fact that the internal fields are also a combination of the original ones, one can (try to) design the synthetic experiments in such a way that the internal fields (or the contrast sources) obey some specific property or symmetry. Then, such a property or symmetry can be conveniently used in the inversion in order to simplify the solution of the problem, and render it more and more robust against the possible occurrence of false solutions.

In a group of three recent papers [L. Crocco, I. Catapano, L. Di Donato and T. Isernia, *IEEE Trans. Antennas Propag.*, **60**, 2012; M. T. Bevacqua, L. Crocco, L. Di Donato, T. Isernia, *IEEE Trans. Antennas Propag,* accepted for publication in 2015; L. Di Donato, M. Bevacqua, L. Crocco, T. Isernia, *IEEE Trans. Antennas Propag*, submitted], all concerned with the 2D scalar problem, we have exploited the basic idea above in three different ways. In all cases, we have organized the virtual experiments in such a way to enforce some symmetry of the scattered fields around a number of different 'pivot' points. Obviously, this also reflects in some symmetry of contrast sources. In particular:

- In [L. Crocco, I. Catapano, L. Di Donato and T. Isernia, *IEEE Trans. Antennas Propag.*, **60**, 2012, pp.1844-1853], we use a linear approximation for the internal fields which is based on the prolongation of the scattered fields inside the region under test (and up to the pivot point);
- In [M. T. Bevacqua, L. Crocco, L. Di Donato, T. Isernia, *IEEE Trans. Antennas Propag,* accepted for publication in 2015] we use a new approximation of the contrast source, which is able to take into account the circularly symmetric part of the non-radiating sources. Notably, the problem is conveniently reduced to a diagonal system of third degree algebraic equations;
- In [L. Di Donato, M. Bevacqua, L. Crocco, T. Isernia, *IEEE Trans. Antennas Propag*, submitted] we simply enforce a circular symmetry (around the pivot points) of the contrast source by means of a penalty term, so that no approximation is involved.

More details and a comparison will be given at the Conference.