



Prof. Andrea Massa, University of Trento, Italy
Inverse Problems in Electromagnetics - Challenges and New Frontiers

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Abstract:

Inverse problems arise when formulating and addressing many synthesis and sensing applications in modern electromagnetic engineering. Indeed, the objective of antenna design, microwave imaging, and radar remote sensing can be seen as that of retrieving a physical quantity (the shape of the radiating system, the dielectric profile of a device under test, the reflectivity of an area) starting from (either measured or “desired”) electromagnetic field data. Nevertheless, the solution of the well-known theoretical features (including ill-posedness, non-uniqueness, ill-conditioning, etc.) of electromagnetic inverse problems still represents a major challenge from the practical viewpoint. Indeed, developing and implementing robust, fast, effective, and general-purpose techniques able to solve arbitrary electromagnetic inverse problem still represent a holy grail from the academic and industrial viewpoint. Accordingly, several ad-hoc solutions (i.e., effective only for specific application domains) have been developed in the recent years.

In this framework, one of the most important research frontiers is the development of inversion techniques which enable the exploitation of both the information coming from the electromagnetic data and of that which is provided by prior knowledge of the scenario, application, or device of interest. Indeed, exploiting *a-priori* information to regularize the problem formulation is known to be a key asset to reduce the drawbacks of inversion processes (i.e., the its ill-posedness). However, properly introducing prior knowledge within an inversion technique is an extremely complex task, and suitable solutions are available only for specific classes of scenarios (e.g., comprising sparseness regularization terms). The aim of this talk is to provide a broad review of the current trends and objectives in the development of innovative inversion methodologies and algorithms. Towards this end, after a review of the literature on the topic, different classes of methodologies aimed at combining prior and acquired information (possibly in an iterative fashion) will be discussed, and guidelines on how to apply the arising strategies to different domains will be provided, along with numerical/experimental results. The open challenges and future trends of the research in this area will be discussed as well.

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Prof. Massa received the “laurea” degree in Electronic Engineering from the University of Genoa, Genoa, Italy, in 1992 and Ph.D. degree in EECS from the same university in 1996. From 1997 to 1999, he was an Assistant Professor of Electromagnetic Fields at the Department of Biophysical and Electronic Engineering (University of Genoa). From 2001 to 2004, he was an Associate Professor at the University of Trento. Since 2005, he has been a Full Professor of Electromagnetic Fields at the University of Trento, where he currently teaches electromagnetic fields, inverse scattering techniques, antennas and wireless communications, wireless services and devices, and optimization techniques.

At present, Prof. Massa is the director of the ELEDIA Research Center with a staff of more than 30 researchers located in the headquarter at the University of Trento and in the offshore labs (ELEDIA@L2S within the L2S-CentraleSupélec (Paris), ELEDIA@UniNAGA at the University of Nagasaki). Moreover, he is Adjunct Professor at Penn State University (USA) and holder of a Senior DIGITEO Chair developed in co-operation between the Laboratoire des Signaux et Systèmes in Gif-sur-Yvette and the Department "Imagerie et Simulation for the Contrôle" of CEA LIST in Saclay (France) from December 2014, and he has been Visiting Professor at the Missouri University of Science and Technology (USA), the Nagasaki University (Japan), the University of Paris Sud (France), the Kumamoto University (Japan), and the National University of Singapore (Singapore).

Prof. Massa serves as Associate Editor of the "IEEE Transaction on Antennas and Propagation" and Associate Editor of the "International Journal of Microwave and Wireless Technologies" and he is member of the Editorial Board of the "Journal of Electromagnetic Waves and Applications", a permanent member of the "PIERS Technical Committee" and of the "EuMW Technical Committee", and a ESoA member. He has been appointed in the Scientific Board of the "Società Italiana di Elettromagnetismo (SIEm)" and elected in the Scientific Board of the Interuniversity National Center for Telecommunications (CNIT). Recently Prof. Massa has been appointed by the National Agency for the Evaluation of the University System and National Research (ANVUR) as a member of the Recognized Expert Evaluation Group (Area 09, 'Industrial and Information Engineering') for the evaluation of the researches at the Italian University and Research Center. Moreover, he has been appointed as the Italian Member of the Management Committee of the COST Action TU1208 "Civil Engineering Applications of Ground Penetrating Radar".

His research activities are mainly concerned with direct and inverse scattering problems, propagation in complex and random media, analysis/synthesis of antenna systems and large arrays, design/applications of WSNs, cross-layer optimization and planning of wireless/RF systems, semantic wireless technologies, material-by-design (metamaterials and reconfigurable-materials), and theory/applications of optimization techniques to engineering problems (telecommunications, medicine, and biology).

Prof. Massa published more than 500 scientific publications among which about 270 on international journals and more than 270 in international conferences where he presented more than 50 invited contributions. He has organized 45 scientific sessions in international conferences and has participated to several technological projects in the European framework (20 EU Projects) as well as at the national and local level with national agencies (75 Projects/Grants).