Multi-Task BCS Inverse Scattering through Minimum-Norm Current Expansion: Motivations, Theory, and Applications

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Abstract

In the last few years, the Bayesian Compressive Sensing (BCS) has emerged as one of the most powerful paradigms to develop robust and efficient inversion methodologies for microwave and optical imaging. The first attempts to exploit BCS methods to time-harmonic microwave imaging problems have included the retrieval of "pixel-shaped" scatterers in 2D transverse-magnetic (TM) or transverse-electric (TE) contrast-source formulations. Approximated (i.e., Born, Rytov) formulations have been considered as well, and the retrieval of metallic targets has been addressed by local-shape-function techniques. Despite these successful applications, current BCS techniques share a common drawback. Indeed, available BCS solvers can manage only real-valued linear problems. Therefore, complex-valued ones must be suitably reformulated by modeling the complex unknowns as purely-real sparse vectors. In this presentation, an innovative and efficient procedure will be introduced still within the CSI probabilistic framework, which is able to reliably retrieve sparse complex current coefficients by enforcing the interrelationships between their real- and imaginary components. Towards this end, a three-step procedure will be discussed which comprises (a) a "minimum-norm" (MN) current expansion computed by means of a singular value decomposition (SVD) starting from the scattering data and used to (b) recast the original CSI problem into two fictitious real-valued ones, comprising either the real or the imaginary parts of the contrast currents, then (c) jointly solved by means of a multi-task Bayesian Compressive Sensing (MT-BCS).approach. Time permitting, a set of representative numerical examples will be also discussed to give some insights on the features, the potentialities, and the limitations of the proposed method also in comparison with state-of-the-art deterministic inversion techniques.

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