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A Comparison Between Deterministic and Stochastic Inversions of Phaseless Data for Microwave Imaging

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The development of microwave imaging techniques and their application are strongly related to the possibility to realize fast and cheap measurement systems. On the contrary, the phase acquisition usually requires complex and expensive apparatus and it turns out to be critical especially at high frequencies. Moreover, holographic and interferometric methods, often used in optical applications [1], are usually characterized by a high computational burden because of the time-consuming data post-processing. Consequently, the study of efficient algorithms for the reconstruction from amplitude-only data is necessary in several applications. Toward this end, different strategies have been proposed. A two step method has been proposed in [2], where firstly a phase-retrieval problem is solved and then (i.e., at the second step) a standard inversion is performed. Alternatively, single step approaches have been investigated. In such cases, customized algorithms have been developed to directly process amplitude-only data [3]. In this paper, the two step strategy presented in [4] is considered. Such an approach is aimed at solving an inverse source problem at the first step to retrieve the distribution of the incident field in the investigation domain [4]. Then, such an information is exploited at the second step in order to recast the phaseless inversion problem to the minimization of a suitable multi-resolution cost function with phaseless data. Because of the non-dfferentiability of the functional, the optimization is carried out by means of a gradient-free stochastic optimizer [5]. Alternatively, a new formulation is proposed where a differentiable cost function is defined thus allowing the exploitation of a conjugate gradient minimization [6]. The results of a comparative analysis between deterministic and stochastic two-step approaches are presented and discussed in order to point out the potentialities and the limitations of the two strategies in terms of reconstruction accuracy, robustness, and computational efficiency. Moreover, some comparisons with full-data approaches are performed, as well.

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