A Modified Matching Pursuit Algorithm for Two-Dimensional Electromagnetic Imaging

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Greedy compressed sensing (CS) algorithms such as orthogonal matching pursuits OMP (A. J. Tropp and A. C. Gilbert, *IEEE Trans. Inf. Theory*, 53, 4655-4666, 2007) and compressive sampling matching pursuits (CoSaMP) (D. Needell and J. A. Tropp, *Appl. Comput. Harmon. Anal.*, 26, 301-321, 2009) have been developed to efficiently reconstruct signals from (noisy) measurements. These algorithms work under the assumption that the signal is sufficiently sparse in a given domain and the system matrix representing the relation between the signal and the measurements obeys the restricted isometric property (RIP) (E. J. Candes and T. Tao, *IEEE Trans. Inf. Theory,* 51, 4203-4215, 2005). Even though these algorithms have gained popularity in the areas of image and signal processing, their application to electromagnetic (EM) inverse scattering problems has been very limited. This stems from the fact that the EM scattering matrix, which is obtained by sampling the background medium Green function between measurement locations and the investigation domain, does not satisfy the RIP. Recently an OMP-based algorithm has been used for two-dimensional (2D) EM imaging of closely-spaced point-like objects (R. V. Senyuva, et al., *IEEE Antennas Wireless Propag. Lett.*, 15, 1179-1182, 2016). Unfortunately, the accuracy of this scheme significantly deteriorates when the SNR of the measurements is lower than 30dB. Additionally, the orthogonalization procedure of the OMP makes it highly unlikely for two adjacent columns of the scattering matrix to be “selected” and consequently scatterers of large size or connected geometry might not be accurately reconstructed.

In this work, for the first time, a CoSaMP algorithm is used for solving the 2D EM inverse scattering problem to reconstruct the sparse dielectric permittivity profile of an unknown investigation domain. The algorithm is operated as follows: (i) The CoSaMP algorithm is used for recovering the currents, which are induced in the investigation domain upon excitation from every individual transmitter, from the (noisy) scattered fields measured away from the investigation domain. For the CoSAMP algorithm to work and to reduce effect of noise on the reconstruction, the scattering matrix is damped by adding a constant parameter to its diagonal entries. (ii) The recovered currents are “radiated” to compute the total fields induced in the investigation domain. (iii) The dielectric permittivity profile is reconstructed by solving a least squares problem involving the currents [computed at step (i)] and the total fields [computed at step (iii)].

Numerical results, which demonstrate the proposed scheme’s accuracy and applicability, will be presented.