Guidelines for Student Reports

WAVELET-BASED COMPRESSIVE SENSING IMAGING OF 2D NON-SPARSE SCATTERERS

M. Hannan

Abstract

The application of Compressive Sensing (CS) techniques are becoming more and more popular in microwave imaging, thanks to their ability to mitigate the theoretical and practical difficulties arising in the associated inverse problem, while properly complying with several common applicative requirements (e.g., reduced computational costs, high spatial resolution, and robustness to the noise). A key requirement to be satisfied for employing CS methods in inverse scattering problems is that the unknowns (e.g., the contrast function or the equivalent current) are sparse with respect to their expansion basis either in the spatial domain or in a transformed one. Indeed, it is worthwhile pointing out that sparseness is not an absolute concept, but a relative one and the relation is with or versus a basis. A scatterer can be sparse with respect to a basis and not sparse versus another one. In this framework this project activity aims to investigate the use of different Wavelet Functions (e.g., Daubechies, Morlet, Coiflet, Spline...) for microwave imaging of non-sparse scatterers, that are large with respect to the investigated domain and with a contrast profile that show some similarities with the used wavelet functions.

Reference Bibliography: Compressive Sensing [1]; Compressive Sensing and Inverse Scattering [2]-[9]; Inverse Scattering [10].

[1] A. Massa, P. Rocca, and G. Oliveri, "Compressive Sensing in Electromagnetics - A Review," IEEE Antennas and Propagation Magazine, pp. 224-238, vol. 57, no. 1, Feb. 2015.

[2] G. Oliveri, N. Anselmi, and A. Massa, "Compressive sensing imaging of non-sparse 2D scatterers by a total-variation approach within the Born approximation," IEEE Trans. Antennas Propag., vol. 62, no. 10, pp. 5157-5170, Oct. 2014.

[3] L. Poli, G. Oliveri, and A. Massa, "Imaging sparse metallic cylinders through a Local Shape Function Bayesian Compressive Sensing approach," Journal of Optical Society of America A, vol. 30, no. 6, pp. 1261-1272, 2013.

[4] F. Viani, L. Poli, G. Oliveri, F. Robol, and A. Massa, "Sparse scatterers imaging through approximated multitask compressive sensing strategies," Microwave Opt. Technol. Lett., vol. 55, no. 7, pp. 1553-1558, Jul. 2013.

[5] L. Poli, G. Oliveri, P. Rocca, and A. Massa, "Bayesian compressive sensing approaches for the reconstruction of two-dimensional sparse scatterers under TE illumination," IEEE Trans. Geosci. Remote Sensing, vol. 51, no. 5, pp. 2920-2936, May 2013.

[6] L. Poli, G. Oliveri, and A. Massa, "Microwave imaging within the first-order Born approximation by means of the contrast-field Bayesian compressive sensing," IEEE Trans. Antennas Propag., vol. 60, no. 6, pp. 2865-2879, Jun. 2012.

[7] G. Oliveri, P. Rocca, and A. Massa, "A bayesian compressive sampling-based inversion for imaging sparse scatterers," IEEE Trans. Geosci. Remote Sensing, vol. 49, no. 10, pp. 3993-4006, Oct. 2011.
[8] G. Oliveri, L. Poli, P. Rocca, and A. Massa, "Bayesian compressive optical imaging within the Rytov approximation," Optics Letters, vol. 37, no. 10, pp. 1760-1762, 2012.
[9] L. Poli, G. Oliveri, F. Viani, and A. Massa, "MT-BCS-based microwave imaging approach through minimum-norm current expansion," IEEE Trans. Antennas Propag., vol. 61, no. 9, pp. 4722-4732, Sep. 2013.
[10] T. Moriyama, G. Oliveri, M. Salucci, and T. Takenaka, "A multi-scaling forward-backward time-stepping method for microwave imaging," IEICE Electronics Express, vol. 11, no. 16, pp. 1-12, Aug. 2014.

This report is submitted in partial fulfillment of the degree of the course "ACM".
Supervisors: Prof. Andrea Massa, Dr. Nicola Anselmi.