Half-a-day on "COMPRESSIVE SENSING IN ELECTROMAGNETICS"

Prof. A. Massa

Abstract

The widely known Shannon/Nyquist theorem relates the number of samples required to reliably retrieve a "signal" to its (spatial and temporal) bandwidth. Such a fundamental criterion yields to both theoretical and experimental constraints in several applications in the fields of inverse scattering, antenna synthesis and measurements, as well as adaptive array control. Indeed, there is a relation between the number of measurements/data (complexity of the acquisition/ processing), the degrees of freedom of the field/signal (temporal/spatial bandwidth), and the retrievable information regarding the phenomena at hand (e.g., dielectric features of an unknown object, presence/position of damages in an array, location of an unknown incoming signal).
The new paradigm of Compressive Sensing (CS) is enabling an overall revision of such concepts by distinguishing the "informative content" of signals from their bandwidth. Indeed, CS theory asserts that one can recover certain signal/phenomena exactly from far fewer measurements than it is indicated by Nyquist sampling rate. To achieve this performance, CS relies on the sparsity/compressibility of the signal at hand, i.e, on the fact that most natural phenomena can be represented by few nonGzero coefficients in suitable expansion bases, and on the use of aperiodic sampling strategies, which can guarantee, under suitable conditions a perfect recovery of the information content of the signal.Some interesting results have already been obtained by exploiting CS techniques to solve problems in nonGuniform array design and analysis, microwave imaging of sparse scatterers, as well as failure detection in large arrays. However, further studies on the exploitation of CS techniques are of interest to investigate the features and potentialities of such an innovative paradigm in many applications of electromagnetics.

References

[1] 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.
[2] 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.
[3] 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.

[4] 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.
[5] 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.
[6] 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.
[7] L. Poli, G. Oliveri, F. Viani, and A. Massa, "MT-BCS-based microwave imaging approach through minimum-norm current expansion," IEEE Trans. Antennas Propag., in press. doi:10.1109/TAP.2013.2265254
[8] G. Oliveri and A. Massa, "Bayesian compressive sampling for pattern synthesis with maximally sparse non-uniform linear arrays," IEEE Trans. Antennas Propag., vol. 59, no. 2, pp. 467-481, Feb. 2011.
[9] G. Oliveri, M. Carlin, and A. Massa, "Complex-weight sparse linear array synthesis by Bayesian Compressive Sampling," IEEE Trans. Antennas Propag., vol. 60, no. 5, pp. 2309-2326, May 2012.
[10] G. Oliveri, P. Rocca, and A. Massa, "Reliable Diagnosis of Large Linear Arrays - A Bayesian Compressive Sensing Approach," IEEE Trans. Antennas Propag., vol. 60, no. 10, pp. 4627-4636, Oct. 2012.
[11] F. Viani, G. Oliveri, and A. Massa, "Compressive sensing pattern matching techniques for synthesizing planar sparse arrays" IEEE Trans. Antennas Propag., in press. doi:10.1109/TAP.2013.2267195
[12] M. Carlin, P. Rocca, G. Oliveri, F. Viani, and A. Massa, "Directions-of-Arrival Estimation through Bayesian Compressive Sensing strategies," IEEE Trans. Antennas Propag., in press.
[13] M. Carlin, P. Rocca, "A Bayesian compressive sensing strategy for direction-of-arrival estimation," 6th European Conference on Antennas Propag. (EuCAP 2012), Prague, Czech Republic, pp. 1508-1509, 26-30 Mar. 2012.
[14] M. Carlin, P. Rocca, G. Oliveri, and A. Massa, "Bayesian compressive sensing as applied to directions-of-arrival estimation in planar arrays", Journal of Electrical and Computer Engineering, Special Issue on "Advances in Radar Technologies", in press.