

# **ESoA Course**



# Compressive Sensing as Applied to Electromagnetics Theory, Techniques, and EM Applications

Trento, Italy, October 25-29, 2021 (online)

#### Abstract

Compressive sensing (CS) is fundamentally interdisciplinary, with interplay between applied/pure mathematics and engineering serving to fertilize new researches opening new frontiers. The impact of CS goes far beyond compression and classical signal processing. Whenever acquiring/inverting data/information is difficult, dangerous, or expensive, CS allows to proceed with much less data/information than previously thought possible. Such a possibility has been rapidly exploited in several and different ranges of practical electromagnetic problems almost always leading to striking results that significantly advance the state-of-the-art.

In view of this, an overview of the latest advances in CS as applied to electromagnetics seems to be useful to highlight current trends also envisaging unknown potentialities in other applicative areas of the electromagnetic scenario.

This course, after reviewing basics and fundamentals of CS, will focus on state-of-the-art and mostly recently introduced CS-based techniques and algorithms, discussing capabilities, limitations, and perspectives in the following topics: Antenna Synthesis and Design, Antenna Measurements, Adaptive Antennas & Antenna Signal Processing, Inverse Scattering and Microwave Imaging. Applicative examples including exercises and speeches regarding specific applications will corroborate the developed concepts.

#### **Course Coordinators**

- Prof. Andrea MASSA, ELEDIA Research Center (ELEDIA@UniTN), University of Trento, Italy; ELEDIA Research Center (ELEDIA@UESTC UESTC), Chengdu, China; ELEDIA Research Center (ELEDIA@TSINGHUA Tsinghua University), Beijing, China
- Prof. Giacomo OLIVERI, ELEDIA Research Center (ELEDIA@UniTN), University of Trento, Italy

### **Course Teachers**

- Prof. Mats GUSTAFSSON, Lund University, Sweden
- Prof. Tommaso ISERNIA, LEMMA Group, Università Mediterranea di Reggio Calabria, Italy
- Dr. Ivan LAHAIE, Centauricorp, USA
- Prof. José MARTINEZ-LORENZO, Northeastern University, USA
- Prof. Andrea MASSA, ELEDIA Research Center (ELEDIA@UniTN), University of Trento, Italy; ELEDIA Research Center (ELEDIA@UESTC UESTC), Chengdu, China; ELEDIA Research Center (ELEDIA@TSINGHUA Tsinghua University), Beijing, China
- Prof. Marco Donald MIGLIORE, ELEDIA Research Center (ELEDIA@UniCAS), Università di Cassino e del Lazio Meridionale, Italy
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- Prof. Paolo ROCCA, ELEDIA Research Center (ELEDIA@UniTN), University of Trento, Italy; ELEDIA Research Center (ELEDIA@XIDIAN Xidian University), China
- Prof. Andrea Francesco MORABITO, LEMMA Group, Università Mediterranea di Reggio Calabria, Italy

### **Course Tutors**

- Dr. Nicola ANSELMI, ELEDIA Research Center (ELEDIA@UniTN), University of Trento, Italy
- Dr. Lorenzo POLI, ELEDIA Research Center (ELEDIA@UniTN), University of Trento, Italy
- Dr. Marco SALUCCI, ELEDIA Research Center (ELEDIA@UniTN), University of Trento, Italy

## Program

MONDAY - October 25th, 2021			CS: INTRODUCTION AND THEORETICAL BASIS
9:15-9:30	A. MASSA/G. OLIVERI	15'	Welcome
9:30-11:00	A. MASSA	90'	CS in a Nutshell: The Idea, and How/Why Can It Work?
11:00-11:15			coffee break
11:15-13:15	G. OLIVERI/P. ROCCA	120'	Compressive Processing, Sparseness, and Incoherence
13:15-14:30			Lunch break
14:30-16:00	T. ISERNIA	90'	Convex relaxations and CS in EM recovery and synthesis problems
16:00-16:15			coffee break
16:15-18.15	M. SALUCCI, L. POLI, N. ANSELMI	120'	SW Exercise: CS basics and applications to small linear problems

TUESDAY - October 26th, 2021			CS IN ANTENNA AND RADAR ENGINEERING
8:30-10:30	G. OLIVERI	120'	Sparse Antenna Design through Compressive Sensing
10:30-10:45			coffee break
10:45-12:45	M. D. MIGLIORE	120'	CS in Antenna Pattern Correction: Theory and Examples
12:45-14:00			Lunch
14.00-16.00	I. LAHAIE	120'	Application of L1 Minimization to radar cross section and ISAR imaging measurements
16:00-16:15			coffee break
16.15-18.15	M. SALUCCI, L. POLI, N. ANSELMI	120'	SW Exercise: Array Design and Pattern Correction through CS

WEDNESDAY	- October 27th, 2021		INVERSE PROBLEMS AND IMAGING WITH CS
8:30-10.30	A. MASSA	120'	CS Imaging in Standard and Transformed Domains
10.30-10.45			coffee break
10.45-12.45	M. GUSTAFSSON	120'	CS-Based NDE/NDT Methodologies and Applications
12.45-14.00			Lunch
14.00-16.00	T. ISERNIA	120'	CS and convex relaxations for shape reconstruction and inverse scattering
16.00-16.15			coffee break
16.15-18.15	M. SALUCCI, L. POLI, N. ANSELMI	120'	SW Exercise: Application of CS in Inverse Scattering

THURSDAY -	October 28th, 2021		COMPRESSIVE SENSING IN ARRAY AND ANTENNA PROCESSING
8:30-10:30	P. ROCCA	120'	Compressive Sensing for Array Processing: Standard and Advanced Strategies for Direction of Arrival Estimation
10.30-10.45			coffee break
10:45-12:45	A. MORABITO	120'	CS for some non linear antenna problems : phaseless diagnostics and power pattern shaped beam synthesis
12.45-14.00			Lunch
14.00-16.00	J. MARTINEZ-LORENZO	120'	Compressive Antennas: Theory and Applications
After 16:00			free time (study/leisure activity)

FRIDAY - October 29th, 2021			FURTHER ISSUES & ADVANCED TOPICS IN CS
9.30-10.30	-	60'	Concluding Remarks and Future Trends
10.30-10.45			coffee break
10.45-12.45	-	120'	Final Exam/Test