

Ph.D. in Information and Communication Technologies – ICT

Ph.D. Course:

“PhD Course: “Wideband and Robust Sensor Array Processing. Part I and Part II”

Edition 2019 (30 hours, 6 credits)

Class Objectives

Part I: Duration: 15 h (3 CFU); broad review of theory and state of the art techniques for array processing in telecommunications, acoustics and remote sensing that pinpoint the statistical modeling issues.

Part II: Duration: 15 h (3 CFU); focus on recent issues in detection, statistical modeling and algorithm performance analysis”

Language: English. Italian only if all participants have Italian as mother tongue.

Recommended for PhD tracks in: Telecommunications, Remote sensing, Electromagnetic Fields, Audio and Multimedia.

The idea of this PhD Course stems from the converging paths of telecommunications, remote sensing and aerial acoustics toward the use of wide- and ultra-wideband (larger than an octave) signals, received by a sensor array, made up of antennas, microphones, hydrophones, etc....

However, the models commonly adopted in open literature are extremely simplified and neglect relevant application issues, such as sensor non-ideality and mis-calibration, the continuous change of propagation and signal models with frequency, the presence of echoes and reverberation that impair the consistency of Maximum Likelihood parametric estimators, their suboptimal subspace approximations and MIMO transmission models.

Some scientific contributions, though dispersed into several disciplines, can be used to build a unitary framework and derive improved and innovative solutions for real world telecommunication, remote sensing, that can be generalized to pattern analysis in photographic and SAR images.

Syllabus

The course focuses on the following themes:

Part I:

- 1) Background on basic narrowband array models and related classical approaches for parametric source localization and adaptive beamforming.
- 2) Statistical perturbation of signal models and related statistics because of finite sample errors, array mis-modeling or channel estimation errors (e.g., in MIMO communications) and consequent application issues¹.
- 3) Robust signal analysis.
- 4) Compressive sensing concepts for beamforming and detection
- 5) Wide band array basic models: frequency channelization and binning, time difference of arrivals, spatial focusing and steering. Specific wide-band array geometries.

- 6) Wideband array model mismatches. Robust ML wideband beamforming and parametric direction finding with non-conventional, though near-optimal statistics (WAVES, ML-STBF, matched field and Laguerre expansions).

Part II:

- 1) The source detection problem.
- 2) Large-array, low sample environments.
- 3) Wide-band model and estimator consistency issues.
- 4) Sensor array like models for linear pattern estimation in images.

Class Schedule

The course will be held **from 17 June to 19 July 2019** in the of the DIET department, Via Eudossiana 18, 00184 Rome, Italy, with the following schedule:

Monday	14:30-17:30	DIET 09 room or seminar room at the second floor of DIET Dpt.
Friday	10:30-13:30	seminar room at the second floor of DIET Dpt.

Final Examination

Discussion of a scientific paper related to the course.

Learning and teaching support materials

Class slides.

Teacher

Prof. Elio D. Di Claudio, is a Full Professor of Electrical Engineering with Sapienza, DIET Dpt. University of Rome. His scientific interests include a variety of topics in the areas of signal and image processing, parallel algorithms and machines for DSP and machine learning. Prof. Elio D. Di Claudio is the author of several state of the art approaches for wideband beamforming and spatial localization with sensor arrays and the generalization of these models to image processing and pattern matching.