



UNIVERSITÀ DEGLI STUDI DI NAPOLI
FEDERICO II

itee^{PhD}
information technology
electrical engineering



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UNI
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Massimo Rosamilia

Radar Signal Processing

Tutor: Prof. A. De Maio

Cycle: XXXV

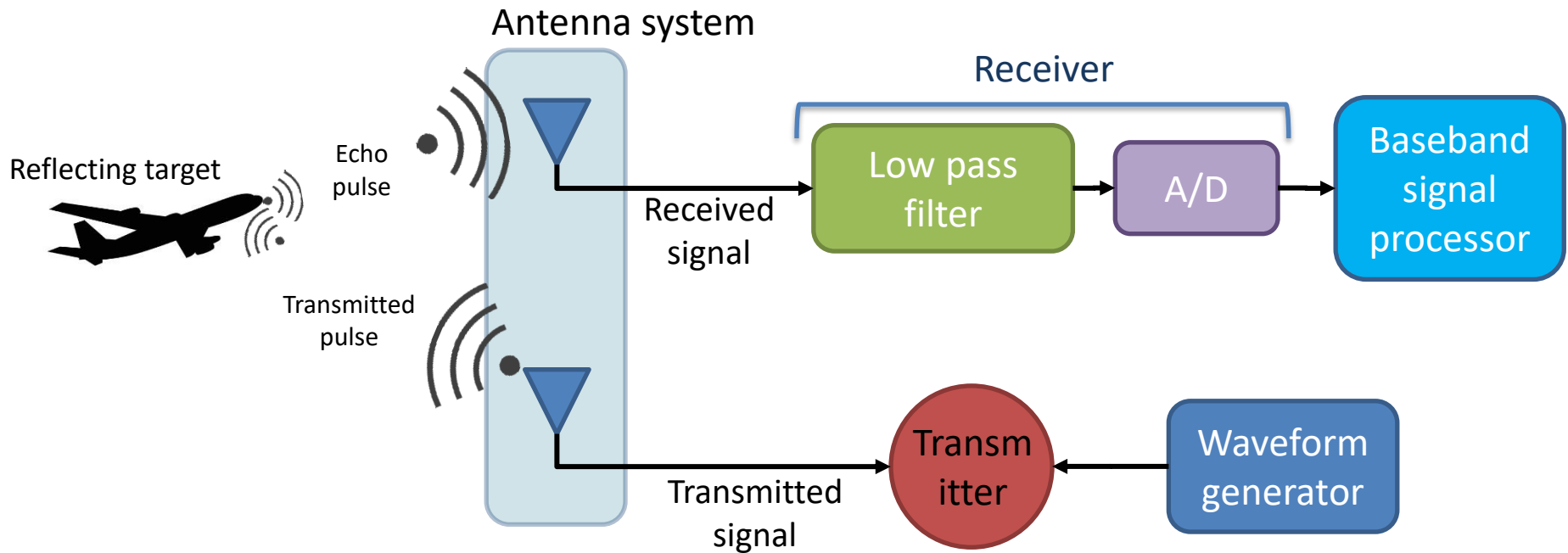
Year: 2

My background

- **Master Science degree:** Computer Engineering at the University of Salerno
- **Research group/laboratory:** Radar Signal Processing and Electronic Defense Research Group (*RSPRG*)
- **PhD start date:** 01/11/2019
- **Scholarship type:** UNINA

Research Field of Interest

Radar Signal Processing



Block diagram of a conventional radar system

Research Field of Interest

Radar Signal Processing

- Detection
- Direction-of-arrival estimation
- Range estimation
- Design of fault-tolerant algorithms

Summary of study activities

Study activities

- Sparse representation and compressed sensing techniques
- Detection, Estimation, and Modulation Theory
- Convex Optimization Theory
- Reconfigurable Intelligent Surfaces

Ad hoc PhD courses / schools

- Cooperative and Non Cooperative Localization Systems
- 1st International Virtual School on Radar Signal Processing

Courses attended borrowed from MSc curricula

- Sistemi Radar
- Radiolocalizzazione Terrestre e Satellitare

Conferences / events attended

- 2020 1st International Virtual School on Radar Signal Processing (1 paper presented)
- 2021 IEEE 8th International Workshop on Metrology for AeroSpace, MetroAeroSpace (2 papers presented)

Summary of study activities

	Courses	Seminars	Research	Tutorship	Total
Bimonth 1	0	3.5	9	0	12.5
Bimonth 2	18	1.3	9	0	28.3
Bimonth 3	3	2.4	9	0	14.4
Bimonth 4	0	1.6	8	0	9.6
Bimonth 5	0	0.8	4	0	4.8
Bimonth 6	0	0	6	0	6
Total	21	9.6	45	0	75.6
Expected	10-20	5 - 10	30-45	0 - 1.6	

Research activity: Overview

- Problem
 - Parameter Estimation for FDA-MIMO Radar
- Objective
 - Joint target angle and incremental range estimation using a FDA-MIMO radar in a background of Gaussian interference with known spectral properties.
 - Fast and accurate target parameters estimation using only a single data snapshot.

Research activity: Overview

- Intended contribution
 - Design of a signal processing architecture able to jointly estimate target angle and incremental range
 - Devise of several adaptive and computationally efficient estimators.
 - Illustrate the effectiveness of the devised estimators (in both white and colored interference scenario) to reliably estimate the unknown target parameters.

Research activity: Overview

- Problem
 - Reconfigurable Intelligent Surfaces for N-LOS Radar Surveillance
- Objective
 - Use of RIS technology to extend the coverage of a standard radar system whereby the direct LOS from a prospective target is missing
 - Development of new sensing mode via the formation of an artificial and favorable propagation environment established via the modulation of RIS parameters

Research activity: Overview

- Intended contribution
 - Radar equation laid down accounting for the artificially induced two-way and double-hop channel as well as the effects of the reflecting surface
 - Expressions for SNR and SCR (both for surface and volume clutter)
 - Discussion on the data acquisition procedure for N-LOS operation together with the resolution issues in the range, angle, and Doppler domains.
 - A numerical analysis in terms of SNR, detection performance, and SNR loss with respect to a LOS monostatic geometry

Research activity: Overview

- Problem
 - Structured Covariance Matrix Estimation with Missing Data via Expectation-Maximization Algorithm
- Objective
 - Provide a general method to obtain a more robust estimate of the noise covariance matrix in the presence of missing data...
 - ...possibly exploiting some a-priori knowledge about the operating environment

Research activity: Overview

- Intended contribution
 - Theoretical results capitalized for some specific structural covariance models with reference to two radar applications: adaptive beamforming and detection of the number of sources.
 - Study of the convergence properties for the resulting iterative procedure according to B-stationarity as well as the computation of the rate of convergence
 - Extensive numerical results to show the effectiveness of the bespoke strategies to handle missing-data scenarios

Research activity: Overview

- Problem
 - Adaptive Radar Detection in the Presence of Missing-Data
- Objective
 - Design of adaptive detection architectures, based on GLRT criterion, capable of operating in the presence of missing-data
 - Joint ML estimation of the complex target echo parameter and the interference covariance matrix in a scenario with missing-data

Research activity: Overview

- Intended contribution
 - Performance evaluation of the devised detectors in terms of probability of detection (PD) versus the signal-to-interference-plus-noise (SINR)
 - Validation of the proposed decision strategies also on measured data, collected in a controlled environment using an inexpensive four-channel receiver.

Products

Journal papers

[J2]	L. Lan, M. Rosamilia, A. Aubry, A. De Maio, and G. Liao, " <i>Single-Snapshot Angle and Incremental Range Estimation for FDA-MIMO Radar</i> ," in IEEE Transactions on Aerospace and Electronic Systems, IEEE TAES, published, 2021.
[J3]	A. Aubry, A. De Maio, and M. Rosamilia, " <i>Reconfigurable Intelligent Surfaces for N-LOS Radar Surveillance</i> ," in IEEE Transactions on Vehicular Technology, IEEE TVT, published, 2021.
[J4]	A. Aubry, A. De Maio, S. Marano, and M. Rosamilia, " <i>Structured Covariance Matrix Estimation with Missing-(complex) Data for Radar Applications via Expectation-Maximization</i> ," in IEEE Transactions on Signal Processing, IEEE TSP, published, 2021.
[J5]	A. Aubry, V. Carotenuto, A. De Maio, M. Rosamilia, and S. Marano, " <i>Adaptive Radar Detection in the Presence of Missing-Data</i> ," in IEEE Transactions on Aerospace and Electronic Systems, IEEE TAES, submitted.

Products

Conference papers

[C2]	M. Rosamilia, A. Aubry, V. Carotenuto, and A. De Maio, " <i>Experimental Analysis of Structured Covariance Estimators with Missing data</i> ," 2021 IEEE 8th International Workshop on Metrology for AeroSpace, MetroAeroSpace, published, 2021
[C3]	A. Aubry, A. De Maio, and M. Rosamilia, " <i>RIS-Aided Radar Sensing in N-LOS Environment</i> ," 2021 IEEE 8th International Workshop on Metrology for AeroSpace, MetroAeroSpace, published, 2021.
[C4]	M. Rosamilia, L. Lan, A. Aubry, A. De Maio, J. Xu, and G. Liao, " <i>Adaptive Monopulse Based Estimation in FDA-MIMO radar</i> ", 2021 CIE International Conference on Radar (Radar 2021), submitted.

Products

I ranked second in the Student Contest of the 1st International Virtual School on Radar Signal Processing, in 2020, with the contribution “Simultaneous Radar Detection and Constrained Target Angle Estimation via Dinkelbach Algorithm”.

Next Year

Research activities

- Adaptive radar detection with a polarimetric Frequency Diverse Array Multiple-Input Multiple-Output (FDA-MIMO) radar.
- RCS measurements of drones (experiment).

Research periods abroad

- From February to April in Netherlands Organisation for Applied Scientific Research (TNO), Delft, Netherlands.

Draft topic or title of the thesis

- Design of advanced algorithms for radar detection and target parameters estimation

Thanks!