



UNIVERSITÀ DEGLI STUDI DI NAPOLI
FEDERICO II

iteePhD
information technology
electrical engineering



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Università degli Studi di Napoli Federico II
PhD program in
Information Technology and Electrical Engineering

PhD Student: Angela Marino

Cycle: XXXV

Training and Research Activities Report

Academic year: 2020-21 - PhD Year: Second

Angela Marino

Tutor: prof. Augusto Aubry

Augusto Aubry

Co-Tutor: Dr Paolo Braca

Date: October 21, 2021

Training and Research Activities Report

PhD program in Information Technology and Electrical Engineering

PhD student:

Cycle: XXXV

1. Information:

- **PhD student:** Angela Marino **PhD Cycle:** XXXV
- **DR number:** 993888
- **Date of birth:** 07/06/1995
- **Master Science degree:** Telecommunication Engineering **University:** University of Naples “Federico II”
- **Scholarship type:** funded by NATO Science and Technology Organization - Centre for Maritime Research and Experimentation
- **Tutor:** Prof. Augusto Aubry
- **Co-tutor:** Dr. Paolo Braca

2. Study and training activities:

Activity	Type ¹	Hours	Credits	Dates	Organizer	Certificate ²
“Patent Searching Best Practices with IEEE Xplore”	Seminar	1	0.2	27/11/2020	Rachel Berrington	N
“How to Get Published with the IEEE”	Seminar	1	0.2	02/12/2020	Rachel Berrington	N
“Subclonal reconstruction of tumor architectures by using machine learning and population genetics”	Seminar	1.5	0.3	11/12/2020	Prof. Michele Ceccarelli	Y
1st International Virtual School on Radar Signal Processing (10 hours of lectures)	Seminar	10	2	22/12/20 - 23/12/20	University of Electronic Science and Technology of China (UESTC)	Y
Submission of the summary of the study “2D Constrained PBR Localization Via Active Radar Designation” at the student contest of The 1st International Virtual School on Radar	Research		6	01/11/2021 - 31/12/2021		

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Signal Processing. Presentation of the contribution at the student contest of The 1st International Virtual School on Radar Signal Processing: 3th classified. Performance assessment of the developed 3D localization techniques exploiting both active and passive sensing systems.						
MSc course – Radiolocalizzazione Terrestre e Satellitare -	Courses	72	9	29/09/2020 – 18/12/2020	Prof. Augusto Aubry-DIETI, UniNA	Y
Advances in Machine Learning for Modelling and Understanding in Earth Sciences – Gustau Camps-Valls	Seminar	1	0.2	27/01/2021	IEEE Geoscience and Remote Sensing South Italy Chapter	N
Finalization of the research activity regarding localization techniques for multiplatform radar systems with deployable nodes.	Research		7	01/01/2021 - 29/02/2021		
Robo Ludens: A game design taxonomy for human-robot interaction, Dr. John Edison Muñoz Cardona	Seminar	1	0.2	05/03/2021	Prof. Silvia Rossi-DIETI, UniNA	Y
Dai mainframe all'IoT: una retrospettiva sull'evoluzione delle architetture di calcolo - prof. Antonino Mazzeo	Seminar	2	0.4	08/03/2021	Prof. Alessandro Cilaro (DIETI, UniNA)	N
Electrical and Computer Engineering (ECE) Seminar:	Seminar	1	0.2	09/03/2021	Asst. Prof. Shiva Abbaszadeh	N

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Towards Neural Signal Processing and Imaging- Dr. Gordon Wetzstein						
Electrical and Computer Engineering (ECE) Seminar: 6G: A New Frontier for the Design of NOMA- Prof. Zhiguo Ding	Seminar	1	0.2	15/03/2021	Dr. Shuping Dang	N
Antonio Picariello Lectures on Data Science (Lecture 5-14-15-16-17): “At the Nexus of Big Data, Machine Intelligence, and Human Cognition”, “Visual Interaction and Communication in Data Science”, “Big Data and Computational Linguistics”, “Sensoria Health”, “The coming revolution of Data driven Discovery”	Seminar	1	1.5	02/03/2021- 03/03/2021- 10/03/2021- 17/03/2021- 25/03/2021	Prof. Flora Amato (DIETI, UniNA) Prof. Giuseppe Longo (Fisica “Ettore Pancini” - UniNA)	Y
Cooperative and Non Cooperative Localization Systems- Profs. Augusto Aubry, Antonio De Maio Dr. Vincenzo Carotenuto	Course	12	3	22/03/2021 - 09/04/2021	Profs. Augusto Aubry, Antonio De Maio Dr. Vincenzo Carotenuto-DIETI, UniNA	Y
Submission of the conference paper “3D Localization for Multiplatform Radar Networks with Deployable Nodes” to the Signal Processing Symposium SPSympo-2021. Journal submission of the paper A. Aubry, P. Braca, A. De Maio, and A. Marino “Enhanced	Research		9	01/03/2021 - 30/04/2021		

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Target Localization with Deployable Multiplatform Radar Nodes Based on Non-Convex Constrained Least Square Optimization” to the IEEE Transactions on Signal Processing.						
Matrix Analysis for Signal Processing with MATLAB- Profs. Augusto Aubry, Antonio De Maio Dr. Vincenzo Carotenuto	Courses		2		Profs. Augusto Aubry, Antonio De Maio Dr. Vincenzo Carotenuto-DIETI, UniNA	Y
Advanced Topics in Radar Signal Processing, dr. Alfonso Farina	Seminar	8	1.6	18-19-25-26/05/2021	Profs. Augusto Aubry, Antonio De Maio Dr. Vincenzo Carotenuto-DIETI, UniNA	Y
Revision of the conference paper “3D Localization for Multiplatform Radar Networks with Deployable Nodes”, accepted for publication at the Signal Processing Symposium SPSympo-2021. Research activity regarding multitarget tracking algorithms for multiplatform radar systems.	Research	7		01/05/2021 – 30/06/2021		
Submission of the conference paper “Constrained Target Localization for Multiplatform Radar Systems” to the Military Communications Conference MILCOM	Research	6		01/07/2021 – 31/08/2021		

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2021. Study of: Kalman Filter, Extended Kalman Filter, Unscented Kalman Filter, Particle Filter, Nonmaneuver and Coordinate-Uncoupled Maneuver models (White-Noise Acceleration, Wiener-Process Acceleration, Singer and Mean-Adaptive Acceleration model).						
Teoria dell'Informazione, Prof. Marco Lops	Course	48	6	30/09/2020 - 15/01/2021 (exam on 08/10/2021)	Prof. Marco Lops-DIETI, UniNA	Y
Presentation of the contribution "3D Localization for Multiplatform Radar Networks with Deployable Nodes" at the Young Scientist Contest of the Signal Processing Symposium: 1th classified. Work on algorithms regarding the research activity on multitarget tracking for multiplatform radar systems.	Research		7	01/09/2021 - 21/10/2021		

- 1) Courses, Seminar, Doctoral School, Research, Tutorship
- 2) Choose: Y or N

2.1. Study and training activities - credits earned

	Courses	Seminars	Research	Tutorship	Total
Bimonth 1	0	2.7	6	0	8.7
Bimonth 2	9	0.2	7	0	16.2
Bimonth 3	3	2.5	9	0	14.5
Bimonth 4	2	1.6	7	0	10.6
Bimonth 5	0	0	6	0	6
Bimonth 6	6	0	7	0	13

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Total	20	7	42	0	69
Expected	30 - 70	10 - 30	80 - 140	0 - 4.8	

3. Research activity:

Design of localization techniques in Multiplatform radar systems.

TOPIC

Multiplatform radar networks (MPRNs) allow to enlarge the surveillance area, to improve data reliability and accuracy, to enhance the fault tolerance, and to improve the data utilization of the system. As in multistatic systems, MPRN configuration can exploit spatial diversity, improving target detectability (in particular against low-observable and stealth targets) and endowing better resistance to electronic countermeasures, such as focused jamming. In addition, these surveillance infrastructures may boost their sensing capabilities via geometric diversity which refers to the possibility to optimize dynamically the number and the locations of the individual platforms. Hence, the use of low-cost receiving units, possibly expendable and heterogeneous, is of particular interest. Furthermore, small Unmanned Aerial Vehicles (UAVs) can be equipped with such simple receiver units, forming an intelligent network with enhanced performance and robustness.

The research carried out focused on a novel approach for 3D localization in multiplatform systems with a single transmitter and multiple receivers.

METHODOLOGY

Angular constraints are forced on the target position to capitalize on the information embedded into the characteristics of the active node radiation pattern, formulating the localization as a constrained Least Squares (LS) problem. The resulting non-convex optimization problem is efficiently handled invoking the Karush-Kuhn-Tucker (KKT) optimality conditions. The determination of the optimal solution of the aforementioned problem is handled with the design of a smart rooting method based on bisection algorithm in order to determine all the solutions of non-linear equations.

RESULTS

A novel 3D target localization strategy for Cooperating Radio Frequency sensor Nodes (C-RFNs), composed of a master transmit-receive node and multiple receive sensors, is derived. The overall target localization process demands a computational complexity proportional to the squared number of receive units, since the solution is determined in quasi-closed-form. The performance of the proposed algorithm is analyzed in terms of Root Mean Square Error (RMSE), proving that the devised technique achieves a significant accuracy gain over the counterparts, especially for weak target returns.

Possible future research includes:

- Experimental validation of the proposed algorithm on measured data;
- Extension of the developed framework to a C-RFN comprising multiple transmitters;
- Cognitive approach to optimally compute the UAV-receivers' trajectories to enhance the overall performance and optimally react to environmental changes or to the target trajectories.

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4. Research products

[J1] A. Aubry, P. Braca, A. De Maio, and A. Marino, "2D PBR Complying with Constraints Forced by Active Radar Measurements", *IEEE Transactions on Aerospace & Electronic Systems, IEEE TAES*, Published, 2021.

[J2] A. Aubry, P. Braca, A. De Maio, A. Marino, "Enhanced Target Localization with Deployable Multiplatform Radar Nodes Based on Non-Convex Constrained Least Squares Optimization", *IEEE Transactions on Signal Processing, IEEE TSP*, Under revision (RQ), 2021.

[C1] A. Marino, A. Aubry, A. De Maio, and P. Braca, "3D Localization for Multiplatform Radar Networks with Deployable Nodes", *Signal Processing Symposium*, Published, 2021.

[C2] A. Marino, A. Aubry, A. De Maio, P. Braca, and D. Gaglione, "Constrained Target Localization for Multiplatform Radar Systems", *Military Communications Conference MILCOM 2021*, Accepted, 2021.

5. Conferences and seminars attended

- Student Contest of the 1st International Virtual School on Radar Signal Processing University of Electronic Science and Technology of China (UESTC), 22-23 December 2020. 1 paper presented. Ranked Third to the Student Contest.
- Signal Processing Symposium (SPSymo) 2021, 21-23 September 2020, Lodz, Poland. 1 paper presented. Received the Young Scientist Contest Award (First Prize).

6. Periods abroad and/or in international research institutions

01.07.2021 – present

Centre for Maritime Research & Experimentation NATO, La Spezia

Supervisor: Dr. Paolo Braca.

I have studied several filtering algorithms such as Kalman Filter, Extended Kalman Filter, Unscented Kalman Filter, Particle Filter, and different target motion models, i.e., Nonmaneuver and Coordinate-Uncoupled Maneuver models (White-Noise Acceleration, Wiener-Process Acceleration, Study of Singer and Mean-Adaptive Acceleration model). I have continued the study of localization problem for multiplatform radar systems, developing and testing different algorithms.

I have currently spent four months abroad in the current year.

7. Tutorship

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8. Plan for year three

For the third year of the PhD course, the plan is to continue the research activities focused on localization and tracking for multiplatform radar systems, possibly considering the case of multiple transmitters. Furthermore, the design of tracking algorithms exploiting angular constraints resulting from the characteristics of the radiation pattern will be investigated. If possible, the devised algorithms will be tested on real data.

Three months from February 2022 to April 2022 will be spent in Netherlands Organisation for Applied Scientific Research (TNO), Delft, Netherlands, where the tutor will be Dr Laura Anitori. The research activities will focus on the acquisition of measurements from real sensors and the consequent testing of the developed localization and tracking algorithms.

Finally, the title of the thesis will be “Advanced Target Localization Strategies for Multiplatform Systems via Constrained Optimization.”