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

PhD Student: Angela Marino

Cycle: XXXV

Training and Research Activities Report

Year: First

Tutor: prof. Augusto Aubry

Co-Tutor: Paolo Braca

Date: October 21, 2020

- ## Information:

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

- ## Study and training activities:

Activity	Type[1]	Hours	Credits	Dates	Organizer	Certificate[2]
Workshop, Intelligenza Artificiale ed Etica: La ricerca in IA alla prova delle sfide etiche	**Course**	**6**	**1.4**	**06/12/2019**	**DR. Roberto Prevete, DIETI**	**Y**
NVIDIA DLI Workshops 2019, Deep Learning for Computer Vision: Classification, Segmentation, and Recognition (6 hours)	**Course**	**7**	**0.5**	**16/12/2019**	**NVIDIA DLI Workshops 2019**	**Y**
Development of adaptive target detection techniques for FDA MIMO radar in presence of Gaussian interference with unknown covariance matrix. Development of advanced localization techniques exploiting jointly passive and active radar measurements for accurate target positioning.	**Research**		**3**	**01/11/2019 - 31/12/2019**		
Cybersecurity and fuzzing for robots,	**Seminar**	**1**	**0.2**	**13/01/2020**	**Roberto Natella**	**Y**

blockchain, and more, Prof. Dr. Antonio Ken Iannillo						
Assesment of the adaptive target detection techniques developed in the context of FIDA MIMO radar systems. Assesment of the developed localization techniques exploiting jointly passive and active radar measurements.	**Research**		**6**	**01/01/2020 - 29/02/2020**		
Scientific Programming and Visualization with Python	**Course**	**20**	**2**	**27/02/2020 - 06/03/2020**	**DiSt department- Scuola Politecnica e delle Scienze di Base - UNINA**	**Y**
Matlab Fundamentals	**Course**	**20**	**2**	**20/02/2020 - 23/02/2020**	**DIETI and Scuola Politecnica e delle Scienze di Base - UNINA**	**Y**
Deep Learning for Radar and Communications- MathWorks-	**Seminar**	**1**	**0.2**	**31/03/2020**	**Rick Gentile**	**N**
Computational Biology: Large Scale data analysis to understand the molecular bases of human diseases	**Seminar**	**1**	**0.2**	**09/04/2020**	**DIETI**	**Y**
Elettromagnetismo e salute	**Seminar**	**1**	**0.2**	**09/04/2020**	**Prof Rita Massa**	**N**

"How to get published with the IEEE?"	**Seminar**	**2**	**0.4**	**20/04/2020**	**Dr.ssa Alessandra Scippa, DIETI**	**Y**
Submission of the paper A. Marino, A. Aubry, A. De Maio, and P. Braca, "2D Constrained PBR Localization Via Active Radar Designation in 2020 IEEE Radar Conference (RadarConf20), Florence, Italy, September 2020. Finalization of the research activity regarding localization techniques exploiting jointly passive and active radar measurements, for journal submission.	**Research**		**7**	**01/03/2020 - 30/04/2020**		
Innovation management, entrepreneurship and intellectual property	**Course**	**18**	**5**	**05/05/2020 - 05/06/2020**	**Prof. Pierluigi Rippa - StartCup Campania 2020**	**Y**
Access the eLearning library on IEEE Xplore	**Seminar**	**1**	**0.2**	**04/05/2020**	**Dr. Eszter Lukacs**	**Y**
Virtualization technologies and their applications (lesson 1 and 2)	**Seminar**	**2**	**0.4**	**06/04/2020 - 07/04/2020**	**Luigi De Simone**	**Y**
SAS Analytics	**Seminar**	**2**	**0.4**	**14/05/2020**	**SAS Academic Program Manager**	**N**
Realtà Virtuale e salute reale. Health 4.0	**Seminar**	**2.5**	**0.5**	**15/05/2020**	**Valentino Magale**	**N**

Planning 5G under EMF constraints: challenges and opportunities.	**Seminar**	**2**	**0.4**	**18/05/2020**	**Prof. Luca Chiaraviglio - University of Rome Tor Vergata - Dr.ssa A. Cacciapuoti, Dr. M. Caleffi - DIETI**	**N**
APEF Webinar-	**Seminar**	**2**	**0.4**	**19/05/2020**	**Associazione Professori Emeriti Federiciani**	**N**
Joint Design of Optics a Learning for Generating Advanced Imaging Features	**Seminar**	**2**	**0.4**	**19/05/2020**	**IEEE Computational Imaging Technical Committee**	**N**
Virtual Seminars on "Sensing"	**Seminar**	**4**	**0.8**	**20/05/2020**	**Plasmonica** **Prof. Carlo Forestiere, DIETI**	**Y**
Adversarial Attacks On Image Classifiers	**Seminar**	**2**	**0.4**	**10/06/2020**	**CVPL CV & ML**	**N**
Exploring Autonomy in Robotic Flexible Endoscopy	**Seminar**	**2**	**0.4**	**12/06/2020**	**Prof. Fanny Ficuciello**	**Y**
AI Webinars Series on Deep Learning for CINI AIIA Labs	**Seminar**	**1.5**	**0.3**	**29/06/2020**	**NVIDIA AI Technology**	**N**

					Centre (NVAIT C)	
Submission of the paper A. Marino, A. Aubry, A. De Maio, and P. Braca, "2D Constrained PBR Localization Via Active Radar Designation" for SET-284 RSM, (Warsaw, Poland), Oct. 2020. Journal submission of the paper A. Aubry, P. Braca, A. De Maio, and A. Marino "2D PBR Localization Complying with Constraints Forced by Active Radar Measurements". Development of 3D localization techniques jointly exploiting active and passive sensing systems.	**Research**		**6**	**01/05/2020 – 30/06/2020**		
Machine Learning	**Course**	**20**	**4**	**06/07/2020 2- 17/07/2020**	**ITEE - ICTH**	**Y**
Free Virtual Seminar: Deep Learning in Wireless Communications	**Seminar**	**1**	**0.2**	**24/07/2020**	**Yue Gao - Chair of IEEE ComSoc TCCN**	**N**
Development of 3D localization techniques exploiting both active and passive sensing systems.	**Research**		**6**	**01/07/2020 – 31/08/2020**		
Strategic Orientation for STEM Research & Writing	**Course**	**18**	**3.6**	**16/07/2020 - 17/09/2020**	**ITEE - ICTH**	**N**

Algorithmic Accountability – Affidabilità e responsabilità degli algoritmi	**Seminar**	**2**	**0.4**	**24/09/2020**	**Fondazione Ugo Borboni**	**N**
Radar Conference Virtual Summer School (10 hours of lectures)	**Seminar**	**10**	**2**	**19/09/2020 - 16/10/2020**	**IEEE AESS Radar Summer School**	**Y**
Tecniche Di Elaborazione Dei Segnali Per La Bioingegneria	**Course**	**72**	**9**	**18/03/2020 – 12/06/2020 (exam on 19/10/2020)**	**MSc course**	**Y**
Implementation of 3D localization techniques exploiting both active and passive sensing systems.	**Research**		**6**	**01/09/2020 - 31/10/2020**		

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

- **Study and training activities - credits earned**

	Courses	Seminars	Research	Tutorship	Total
Bimonth 1	**1.9**	**0**	**3**	**0**	**4.9**
Bimonth 2	**0**	**0.2**	**6**	**0**	**6.2**
Bimonth 3	**4**	**1**	**7**	**0**	**12**
Bimonth 4	**5**	**4.6**	**6**	**0**	**15.6**
Bimonth 5	**4**	**0.2**	**6**	**0**	**10.2**
Bimonth 6	**12.6**	**2.4**	**6**	**0**	**21**
Total	**27.5**	**8.4**	**34**	**0**	**69.9**
Expected	**30 - 70**	**10 - 30**	**80 - 140**	**0 – 4.8**	

- **Research activity:**

a) **Design of localization techniques exploiting jointly passive and active radar measurements.**

TOPIC

Combining passive and active radars in various deployment configurations, such as static and mobile, can provide geometric, signal, and scattering diversity to reach an enhanced situation awareness. Target localization via the joint use of passive and active radars is of particular interest for instance in the case of harbour surveillance, where an active rotating radar is complemented with a Passive Bistatic Radar (PBR). In fact, the antenna scanning velocity is typically about 6 seconds per rotation, and it could be necessary to acquire further measurements in order to correctly localize fast possibly manoeuvring targets. Employing a passive radar which points its beam under a designation by the active system can increase (or also provide when not available at the active radar side) the amount of information useful for the localization. The research activity conducted in this context focuses on the design and assessment of a novel approach for elliptic localization in PBR systems, capitalizing target information gathered by an active radar.

METHODOLOGY

Leveraging the LS estimation methodology, the elliptic localization problem has been formulated as a constrained optimization problem aimed at minimizing the model equation discrepancy from the measured parameters while accounting for specific constraints on the feasible target positions. Specifically, the position restrictions induced both by the PBR main-beam size and by the available side-information have been forced. To tackle the resulting non-convex optimization problem, advanced optimization theory tools have been used, in particular the Karush-Kuhn-Tucker (KKT) optimality conditions have been exploited.

RESULTS

An efficient optimization strategy has been designed to solve the formulated localization problem, providing a closed-form optimal location estimate which involves the computation of elementary functions. Specifically, the position estimate has been obtained selecting among at most fourteen candidate closed-form location achieving the lowest objective function value. The analyses have revealed that the proposed technique outperforms the counterparts in terms of Root Mean Square Error RMSE for both a static and dynamic scenario. Otherwise stated, the results have demonstrated the effectiveness of a holistic passive/active radar localization procedure which properly exploits the active radar information.

Possible future research includes:

- the integration of a filtering approach (for example Kalman or particle filtering) in the localization strategy to improve the target position estimation;
- the exploitation of a joint passive/active radar configuration to counter jammers.

b) **Design of adaptive target detectors for FDA-MIMO Radars**

TOPIC

Frequency diverse array (FDA) radar has sparked intense interest from the research community in recent years. Different from the phased array radar, which provides an angle-dependent transmit beampattern, the FDA can generate a range-angle-time-dependent response by introducing a small

frequency increment across adjacent array elements. To overcome some limitations of standard FDA radars, such as the complicate processing of radar interfaces or the existence of angle-range pairs where the transmitted signals do not optimally combine, Multiple Input Multiple Output (MIMO) techniques have been suggested in combination with FDA, leading to the FDA-MIMO radar concept. Until now, target detection problem in FDA-MIMO radar context has received a limited attention in the radar signal processing community, hence, to fill this relevant gap, some adaptive decision rules have been designed in this research activity to cope with intrinsic and specific challenges arising in this kind of surveillance systems.

METHODOLOGY

Leveraging advanced statistical signal processing tools, in particular adaptive detection theory, new detectors have been proposed to detect point like targets, embedded in homogeneous Gaussian disturbance, where the interference covariance matrix, as well as the range and echo-amplitude of the target have been assumed unknown. Both the one-step and the two-step design methodologies have been considered at the receiver design stage where a set of secondary data (free of useful targets contributions) is considered available, to infer disturbance characteristics.

RESULTS

An optimization procedure, with a polynomial computational complexity, has been designed to determine the ML estimate of all the unknown parameters under both the hypothesis, which lay the ground for the computation of the theoretical one-step and two-step GRLT receivers. Furthermore, to reduce the computational burden, approximated solution methods have been designed:

1) Finite grid search method: the range interval associated with the cell under test (CUT) is discretized in a finite number of points to approximate the optimal search;
2) Grid search with Newton-based refinement strategy: this is implemented to avoid possible excessive straddle loss of the grid search approach.

At the analysis stage, a detection performance comparison among the proposed adaptive detectors, the benchmarks (clairvoyant) as well as some mismatched architectures has been carried on. The results have highlighted the capabilities of the proposed adaptive strategies to reliably detect targets with performance quite close to that of the clairvoyant structures.

Possible future research studies include:

- the synthesis of adaptive detectors exploiting other design criteria and accounting for the presence of some specific interference scenarios;
- analysis on measured FDA-MIMO radar data.

- **Research products:**
- L. Lan, A. Marino, A. Aubry, A. De Maio, G. Liao, and J. Xu, “Design of adaptive detectors for FDA-MIMO radar”, IEEE 11th Sensor Array and Multichannel Signal Processing Workshop, SAM 2020, Published, 2020.

- L. Lan, A. Marino, A. Aubry, A. De Maio, G. Liao, and J. Xu, "Design of GLR-Based Detectors for FDA-MIMO radar," IEEE 5th International Workshop on Metrology for AeroSpace, MetroAeroSpace, Published, 2020.
- L. Lan, A. Marino, A. Aubry, A. De Maio, G. Liao, and J. Xu, "GLRT-Based Adaptive Target Detection in FDA-MIMO Radar", IEEE Transactions on Aerospace & Electronic Systems, IEEE TAES, Accepted for publication, 2020.
- A. Marino, A. Aubry, A. De Maio, and P. Braca, "2D Constrained PBR Localization Via Active Radar Designation" , 2020 IEEE Radar Conference, RadarConf20, Published, 2020.
- 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, Under Revision (RQ).

5. Conferences and seminars attended

- 2020 IEEE Radar Conference (Florence, Italy), Sept. 2020, RadarConf20, Florence, 21-25 September 2020. 1 paper presented.

6. Activity abroad:

None

7. Tutorship

None