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

PhD Student: Giuseppe D'Ambrosio

Cycle: XXXVIII

Training and Research Activities Report

Year: 2022-2023, First

Giuseppe D'Ambrosio

Tutor: Prof. Angelo Liseno

Co-Tutor: Prof. Amedeo Capozzoli, Prof. Claudio Curcio

Date: December 12, 2023

Training and Research Activities Report

PhD in Information Technology and Electrical Engineering

Cycle: **Author:**

1. Information:

- **PhD student: Giuseppe D'Ambrosio**
- **DR number: DR996973**
- **Date of birth: 15/07/1997**
- **Master Science degree: INGEGNERIA DELLE TELECOMUNICAZIONI E DEI MEDIA DIGITALI University: Università degli Studi di Napoli Federico II**
- **Doctoral Cycle: XXXVIII**
- **Scholarship type: PNRR Partenariato Esteso PE14, RESearch and innovation on future Telecommunications systems and networks (RESTART)**
- **Tutor: Prof. Angelo Liseno**
- **Co-tutor: Prof. Amedeo Capozzoli, Prof. Claudio Curcio**

2. Study and training activities:

Activity	Type[1]	Hours	Credits	Dates	Organizer	Certificate[2]
How to boost your PhD	Courses	16	4	19/04/2023	Prof. Antigone Marino	Y
Misure a microonde e onde millimetriche	Courses	72	9	27/06/2023	Prof. Claudio Curcio	Y
Academic entrepreneurship	Courses	17	4	12/07/2023	Prof. Pierluigi Rippa	Y
How to Publish Under the CARE-CRUI Open Access Agreement with IEEE	Seminar	1.5	0.3	05/04/2023	CARE-CRUI and IEEE	Y
Machine Learning Learning-Enabled Optimization and Synthesis of Metasurface Antenna	Seminar	3	0.6	05/04/2023	Professor Zhi Ning Chen, Dr. Peiqin Liu	Y
Challenges in Antenna Measurements for Space and Defense Application	Seminar	1	0.2	15/06/2023	Prof. Claudio Curcio	Y
Ricerca e formazione nella società della transizione digitale	Seminar	5	1	22/09/2023	CINI (Consorzio Interuniversitario Nazionale per l'Informatica)	Y

Space-Time Modulated Metasurfaces for Reconfigurable Intelligent Surface Enabled 5G/6G Communications	**Seminar**	**1**	**0.2**	**31/10/2023**	**Prof. Giacomo Oliveri**	**Y**
3D-printing of hybrid structures from Meta-Atoms to dielectrics, metamaterials and antennas	**Seminar**	**2**	**0.4**	**20/10/2023**	**Prof. Angelo Liseno**	**Y**

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					
Bimonth 2			**5**		**5**
Bimonth 3	**4**	**0.9**	**6**		**10.9**
Bimonth 4	**9**	**0.2**	**6**		**15.2**
Bimonth 5	**4**		**4**		**8**
Bimonth 6		**1.6**	**5**		**6.6**
Total	**17**	**2.7**	**26**		**45.7**
Expected	**30 - 70**	**10 - 30**	**80 - 140**	**0 – 4.8**	

3. Research activity:

A first part of the research activity concerns the analysis of the capabilities of an approach based on neural networks (NN') in the solution of a canonical electromagnetic inverse problem, that is the inverse source.
Indeed, such a study is of interest in the synthesis of reconfigurable intelligent surfaces (RIS').
These activities have been developed in collaboration with the Consiglio Nazionale delle Ricerche, Istituto per il Rilevamento Elettromagnetico dell'Ambiente.
The skills acquired in this phase can be used to train neural networks able to efficiently simulate the reflecting behavior of the elements - macro elements of a RIS, according to the geometrical and electrical parameters.
The second part of research activity concerned with the design and characterization of metasurfaces with reconfiguration capabilities based on the use of pin diodes or varactors, as addressed in the literature. The behavior of a single element of a metasurface has been simulated to evaluate its scattering response in amplitude and phase. Furthermore, more complex structures, made of NxN elements, have been simulated to assess the reconfiguration capabilities achievable with available solution. Numerical results have been obtained by using a commercial simulation software (Ansys HFSS). In this context, also dynamic approaches to control the antenna beam have been studied, typically exploited in reflectarray antennas.
Concerning the synthesis of the reflecting surface, a synthesis procedure developed for the case of reflectarray antennas has been updated.
The synthesis approach is a multistage strategy trading off the complexity and accuracy of the electromagnetic model with a computational efficiency. At the earlier stages, a simplified model is exploited to reduce the computational complexity. Subsequently, more refined models are introduced to increase the accuracy, but with an increased computational complexity. These steps, however, profit of the results obtained at the previous stages to avoid the trapping into false solutions and to reduce the computational burden.

The synthesis stage considered during the first year of the PhD course exploits a scalar phase-only model.
Even this algorithm is made of two stages. Initially, the unknown phases have been expanded by using few Zernike polynomials, while in the second stage the unknown phases have been represented by means the impulsive functions to effectively exploit the degrees of freedom of the reflecting structure.
The synthesis involved reflecting surfaces radiating pencil beams and flat-top beams.
The activity idea has been developed in collaboration with the Università di Firenze and with the Politecnico di Torino.

4. Research products:

Journal Paper:

Title: Resolution-Enhanced Electromagnetic Inverse Source: a Deep Learning Approach,

Authors: A. Capozzoli, I. Catapano, C. Curcio, G. D'Ambrosio, G. Esposito, G. Gennarelli, A. Liseno, G. Ludeno, F. Soldovieri,

Status: published,

Journal name: IEEE Antennas and Wireless Propagation Letters.

Conference Paper:

Title: A Deep Learning Approach to Electromagnetic Inverse Source

Authors: A. Capozzoli, I. Catapano, C. Curcio, G. D'Ambrosio, G. Esposito, G. Gennarelli, A. Liseno, G. Ludeno, F. Soldovieri,

Status: published,

Conference name: 24th International Conference on Applied Electromagnetics and Communications (ICECOM), in Dubrovnik (Croatia), 27/09/2023-29/09/2023.

5. Conferences and seminars attended

Volunteer at the 17th European Conference on Antennas and Propagation (EUCAP), in Florence (Italy), 26/03/2023-31/03/2023.

Participation as a speaker at the 24th International Conference on Applied Electromagnetics and Communications (ICECOM), in Dubrovnik (Croatia), 27/09/2023-29/09/2023.
Presented work: "A Deep Learning Approach to Electromagnetic Inverse Source".

6. Activity abroad:

7. Tutorship

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