



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

PhD Student: Eros Cicarelli

Cycle: XXXIX

Training and Research Activities Report

Year: 2023-2024, First

Tutor: Prof. Amedeo Capozzoli

Co-Tutor:

Prof. Ana Arboleya Arboleya

Prof. Claudio Curcio

Prof. Angelo Liseno

Prof. Manuel Sierra Castañer

Date: October 31, 2024

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Author: Eros Ciccarelli

1. Information:

- **PhD student:** Eros Ciccarelli
- **DR number:** DR997200
- **Date of birth:** 15/06/1999
- **Master Science degree:** Electronic Engineering
- **University:** Università degli Studi di Napoli Federico II
- **Doctoral Cycle:** XXXIX
- **Scholarship type:** PNRR Partenariato Esteso PE14, “RESTART – RESearch and innovation on future Telecommunications systems and networks, to make Italy more smART”
- **Tutor:** Prof. Amedeo Capozzoli
- **Co-tutor:** Prof. Claudio Curcio, Prof. Angelo Liseno

2. Study and training activities:

Activity	Type ¹	Hours	Credits	Dates	Organizer	Certificate ²
Antennas for Satellite Applications	Course	40	3	27/05/2024 – 31/05/2024	Dr. G. Toso, Dr. E. Gandini, European School of Antennas (ESoA)	Y
English B1 Level Course	Course	30	3.75	30/01/2024 – 25/05/2024	Centro Linguistico di Ateneo Federico II	Y
Innovation and Entrepreneurship	Course	12	4	12/06/2024 – 26/06/2024	Prof. Pierluigi Rippa	Y
Quantum technologies: state of the art and perspectives	Seminar	2	0.4	08/02/2024	Prof. Fabio Villone	Y
Antenna Measurement Challenges and Opportunities – the Next Ten Years	Seminar	1	0.2	02/05/2024	Prof. Claudio Curcio	Y
Antenna Diagnostics – Identifying and Understanding Antenna Diseases	Seminar	1	0.2	06/05/2024	Prof. Claudio Curcio	Y

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IA e 5G: Tecnologie Abilitanti per la Manutenzione Predittiva	Seminar	1	0.2	10/05/2024	Prof. Antonia Maria Tulino	Y
5G & Digital Transformation: A View from an Unconventional Perspective	Seminar	4	0.8	10/05/2024	Prof. Antonia Maria Tulino	Y
Regolazione in Tema di Intelligenza Artificiale alla Luce dell' Ai Act	Seminar	5	1	13/05/2024	Prof. Antonia Maria Tulino	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	0	0	3	0	3
Bimonth 2	0	0.4	5	0	5.4
Bimonth 3	0	0	8	0	8
Bimonth 4	6.75	2.4	6	0	15.15
Bimonth 5	4	0	6	0	10
Bimonth 6	0	0	7	0	7
Total	10.75	2.8	35	0	48.55
Expected	30 - 70	10 - 30	80 - 140	0 - 4.8	

3. Research activity:

The research activity concerns advanced systems to test high-performance Reconfigurable Intelligent Surfaces (RIS'). Indeed, the testing of this kind of intelligent surfaces requires radiators which can realize complex waveforms in the near-field to emulate a class of fields which can illuminate the surface. Standard systems typically available in anechoic environments can realize time-varying waves but are not capable to generate spatially complex waveforms as those that can be present in indoor or urban applications. Therefore, it is necessary to develop systems capable to realize not only complex time-varying fields, but also spatially complex fields. This can be reached by array systems whose elements are properly excited and spatially displaced to achieve the bandwidth required by the applications and adequate complexity.

The research activity of the Ph.D. is twofold. From the one hand side, it regards the development of radiating systems. From the other hand side, a source modelling is addressed.

A first part of the research activity dealt with the synthesis of equivalent radiators, radiating panels able to generate electromagnetic fields which can be radiated/scattered by objects embedded in a sphere with known radius in the time domain. The method has been developed for the case of a linear, 2D

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equivalent radiator. The design strategy subdivides the synthesis procedure in two steps. During the first step, the panel is modelled as a spatially continuous radiator while, in the second step, a discrete counterpart of the continuous panel is considered to get its practical realization as an array. During the first year, the activity has focused on the first step. The performance of the approach has been numerically analyzed, showing promising results.

The second part of the research activities dealt with the modelling of objects (radiators/scatterers) with an oblong shape. In particular, the problem of the stable numerical evaluation of the vector spheroidal harmonics has been faced starting from the scalar ones. The use of this modal functions allows an efficient and effective representation of the radiated/scattered fields generated by objects which can be conveniently fitted by a spheroidal surface. Indeed, the reduction of the number of basis functions exploited to represent the fields has beneficial effects in the characterization of radiators as well in solutions of inverse problems. To evaluate the scalar spheroidal wavefunctions of interest, a computational scheme by Gumerov et al. in 2014 has been adopted. The numerical derivatives (first and second) necessary for the evaluation of the vector functions starting from the scalar ones have been stably computed directly from the polynomial expansions used to represent the latter. This approach has been extensively numerically validated. First, its advantage against other classical approaches, as the one exploiting spherical wavefunctions for the field representation, has been proven. Second, the accuracy has been assessed by comparing the field representation performance with numerical references provided by a commercial electromagnetic software.

The last part of the research activity has been pursued within a collaboration with the Universidad Politécnica de Madrid and the Universidad Rey Juan Carlos on advanced measurement systems for the fast and flexible Near-Field characterization of radiators/scatterers, based on the use of a robotic arm and probe arrays.

4. Research products:

Conference Paper:

Title: An Approach for the Generation of Echos in Time-Domain,

Authors: A. Capozzoli, E. Ciccarelli, C. Curcio, A. Liseno,

Status: published,

Conference name: 2024 IEEE International Symposium on Antennas and Propagation and ITNC-USNC-URSI Radio Science Meeting, in Florence (Italy), 14/07/2024 – 19/07/2024.

Conference Paper:

Title: Vector Spheroidal Harmonics to Modelling Radiation/Scattering from Oblong Objects,

Authors: E. Ciccarelli, F. Bevilacqua, A. Capozzoli, C. Curcio, A. Liseno,

Status: published,

Conference name: 46th Annual Meeting and Symposium of the Antenna Measurement Techniques Association (AMTA) , in Cincinnati (Ohio, US), 27/10/2024 – 01/11/2024.

5. Conferences and seminars attended

Conferences:

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Participation as speaker at the 2024 IEEE International Symposium on Antennas and Propagation and ITNC-USNC-URSI Radio Science Meeting, in Florence (Italy), 14/07/2024 – 19/07/2024.

Presented work: An Approach for the Generation of Echos in Time-Domain.

Participation as speaker at the 46th Annual Meeting and Symposium of the Antenna Measurement Techniques Association (AMTA), in Cincinnati (Ohio, US), 27/10/2024 – 01/11/2024.

Presented work: Vector Spheroidal Harmonics to Modelling Radiation/Scattering from Oblong Objects.

6. Activity abroad:

The period abroad ranges from 06/09/2024 to 30/12/2024, at the Universidad Politécnica de Madrid (UPM), in Madrid (Spain), in cooperation with the Rey Juan Carlos University in Madrid.

The research activities consisted of the development, on Graphics Processing Units (GPUs), of SVO approaches for the optimized characterization of large planar radiators/scatterers by using probe arrays and robotic arms.

In the academic year 2023-2024, the first of the ITEE PhD Program, a total of 50 days are spent in the Universidad Politécnica de Madrid: from 06/09/2024 to 25/10/2024.

7. Activity in partner companies:

NA.

8. Tutorship

NA.