
UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II
**DOTTORATO DI RICERCA / PHD PROGRAM IN
INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING**

Activities and Publications Report

PhD Student: **Sonia Zappia**

Student ID: DR994203

PhD Cycle: XXXV

PhD Cycle Chairman: Prof. Stefano Russo

PhD program student's start date: 19/12/2019

PhD program student's end date: 30/04/2023 (maternity leave from 20/11/2021 to 20/04/2022)

Supervisor: Prof. Giuseppe Ruello

e-mail: giuseppe.ruello@unina.it

Co-supervisor: Dr. Ilaria Catapano, Dr. Lorenzo Crocco

e-mail: catapano.i@irea.cnr.it ,crocco.l@irea.cnr.it

PhD scholarship funding entity:

no scholarship

General information

Sonia Zappia received in year 2019 the Master Science degree in Biomedical Engineering from the University of Naples Federico II. She attended a curriculum in electromagnetism within the PhD program in Information Technology and Electrical Engineering. She enrolled into the ITEE PhD program without a grant.

Study activities

Attended Courses

Year	Course Title	Type	Credits	Lecturer	Organization
1	Safety Critical Systems for Railway Traffic Management	Ad hoc course	3.3	Dr. Mario Barbareschi, Affiliation (Rete Ferroviaria Italiana)	DIETI
1	Matlab Fundamentals	Ad hoc course	2	Prof. Agostino De Marco, with: Dr. Stefano Marrone, Dr. Francesco Orefice	DIETI and Scuola Politecnica e delle Scienze di Base - UNINA
1	Innovation management, entrepreneurship and intellectual property.	Ad hoc course	5	Prof. Pierluigi Rippa Dipartimento di Ingegneria Industriale, Università di Napoli Federico II	Prof. Pierluigi Rippa - StartCup Campania 2020
1	Misure a Microonde e Onde Millimetriche	MsC course	9	Prof. C Curcio	DIETI
1	Machine Learning	Ad hoc course	3.6	Marco Aiello, Anna Corazza, Diego Gagnaniello, Francesco Isgrò, Roberto Prevete, Francesco Raimondi, Carlo Sansone	ITEE - ICTH
2	Professional skills in clinical environment for biomedical engineering	Ad hoc course	2	Prof. Ing. Gianni D'Addio	Prof. M.Cesarelli, Prof. P. Bifulco - DIETI
2	Electromagnetism	Ad hoc course	4	Prof. Daniele Riccio, DIETI	Scuola Superiore Meridionale
2	Progettazione in sicurezza elettromagnetica dell'ambiente ospedaliero.	MsC course	9	Prof. Giuseppe Ruello, DIETI	DIETI

Attended PhD Schools

Year	School title	Location	Credits	Dates	Organization
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Activities and Publications – Final Report

UNINA PhD in Information Technology and Electrical Engineering – XXXV Cycle

PhD candidate: Sonia Zappia

2	ESoA School – Title: Microwave Imaging and Diagnostics: Theory, Techniques and Applications.	Online	3	from 1/02/2021 to 5/02/2021	European School of AnteCNR-IREA, Università' Mediterranea di Reggio Calabria, Università'di Trento,
2	ESoA School – Title: Compressive Sensing as Applied to Electromagnetics Theory, Techniques, and EM Applications.	Online	3	From: 25.10.2021 To: 29.10.2021	ELEDIA Research Center, Trento

Attended Seminars

Year	Seminar Title	Credits	Lecturer	Lecturer affiliation	Organization
1 st	CYBERSECURITY AND FUZZING FOR ROBOTS, BLOCKCHAIN, AND MORE	0.2	Dr. Antonio Ken Iannillo	University of Luxembourg (UL)	Dr. Roberto Natella, University of Naples Federico II
1	Computational Biology: Large scale data analysis to understand the molecular bases of human diseases	0.2	Prof. Michele Ceccarelli	University of Naples Federico II	DIETI
1	Elettromagnetismo e Salute	0.2	Prof. Rita Massa	University of Naples Federico II	Prof Rita Massa, Dip di Fisica, Prof Giuseppe Ruello DIETI
1	How to Get Published with IEEE	0.4	Dr. Eszter Lukacs	IEEE	Dr.ssa Alessandra Scippa, DIETI
1	Large Scale Training of Deep Neural Networks	0.4	Dr. Giuseppe Fiameni	NVIDIA Artificial Intelligence Technology Center	DIETI
1	La programmazione europea e la ricerca. Nuovi scenari della programmazione europea dopo il 2020. La gestione di un progetto di ricerca.	0.4	Filippo Ammirati	TecUp	Innovation Village 2020 - University of Naples Federico II and TecUp
1	SAS Analytics	0.4	Dr. Cinzia Gianfiori	SAS Academic Program manager	SAS Academic Program Manager
1	Campi elettromagnetici pulsati: dal meccanismo d'azione alle applicazioni cliniche	0.3	Prof. Rita Massa	University of Naples Federico II	Prof Rita Massa, Dip di Fisica, Prof Giuseppe Ruello DIETI

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UNINA PhD in Information Technology and Electrical Engineering – XXXV Cycle

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1	Realtà Virtuale e Salute reale. Health 4.0 – Dal bit alla mente:spazi virtuali per la salute.	0.5	Valentino Megale	CEO di Software studios	Innovation Village 2020 - University of Naples Federico II and TecUp
1	Joint Design of Optics and Post-Processing Algorithms Based on Deep Learning for Generatin Advanced Imaging Features	0.4	Dr. Raja Giryes.	Tel Aviv University	IEEE Signal Processing Society
1	Virtual seminar on ‘Sensing’	0.8	Jerome Wenger, Carsten Rockstunhl, Leonetta Baldassarre, Monika Fleischer	SIOF working group Plasmonic & Nano-Optics	Plasmonica, Prof. Carlo Forestiere, DIETI
1	Applicazioni mediche dei campi elettromagnetici basate sull’incremento di temperatura: ipertermia e ablazione.	0.3	Prof. Marta Cavagnaro	Universita’ della Sapienza di Roma	Prof Rita Massa, Dip di Fisica, Prof Giuseppe Ruello DIETI
1	Non invasive Mapping of Electrical Properties using MRI	0.3	Dr. Riccardo Lattanzi	NYU Grossmann School of Medicine	Prof Rita Massa, Dip di Fisica, Prof Giuseppe Ruello DIETI
1	Exploring Autonomy in Robotic Flexible Endoscopy.	0.4	Prof. Pietro Valdastri	University of Leeds	Prof. Fanny Ficuciello, DIETI
1	How to Publish Open Access with IEEE to Increase the Exposure and Impact of Your Research	0.3	Dr. Paul Henriques	IEEE	Dr. Alessandra Scippa , DIETI
1	IBM Quantum: i primi computer quantistici per la ricerca e la didattica	0.4	Federico Mattei	IBM Q Ambassador	Federico Mattei IBM Q Ambassador
1	Estrapolazioni su segnali 4G e 5G	0.3	Prof Rita Massa	University of Naples Federico II	Prof Rita Massa, Dip di Fisica, Prof Giuseppe Ruello DIETI
1	Misure di segnali complessi	0.3	Prof.	University of Naples	Prof Rita Massa, Dip

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	nell'ambiente: Sistemi 5G		Giuseppe Ruello	Federico II	di Fisica, Prof Giuseppe Ruello DIETI
1	Valutazione dei livelli di esposizione e del rispetto dei limiti Antenne e 5G	0.3	Prof. Giuseppe Ruello	University of Naples Federico II	Prof Rita Massa, Dip di Fisica, Prof Giuseppe Ruello DIETI
2	Telemedicina in Italia: casi di successo	0.6	Prof. Giovanni D'Addio	University of Naples Federico II	Prof. Giovanni D'Addio UNINA
2	Digital Project Management: Practices, process, techniques, tools and scientific approach	0.2	Prof. Dario Carotenuto	CEO at ReXoLcomSrl, GUARDIA DIGITALE SRL and CISO at Opera Santa Maria del Fiore di Firenze	Dipartimento di Fisica "Ettore Pacini" and DIETI
2	L'esperienza del progetto di teleriabilitazione NEUROREAB	0.6	Ingg. D. Furno, L. Romanelli	-	Dipartimento di Fisica "Ettore Pacini" and DIETI
2	Andrà tutto bene: Images, texts, Emojis & Geodata in a sentiment Analysis Pipeline"	0.3	Dr. Serena Pelosi.	-	Dipartimento di Fisica "Ettore Pacini" and DIETI
2	Telemedicina, e-health e mobile health si può davvero usare il digitale nel percorso assistenziale?	0.6	Dott.ssa Simonetta Scalvini	-	Prof Giovanni D'Addio, DIETI
2	Stroke and its imaging in the acute phase: a neurological point of view	0.2	Eric Jouvent	-	Politecnico di Torino, Istituto de Biofisica e Engenharia Biomedica FCencias
2	Neuroradiologic tools for acquiring images of the brain and its diseases.	0.2	Enrico Tedeschi	-	Politecnico di Torino, Istituto de Biofisica e Engenharia Biomedica FCencias
2	At the Nexus of Big Data, Machine Intelligence and Human Cognition	0.2	Prof. George S. Djorgovski	University of California	Dipartimento di Fisica "Ettore Pacini" and DIETI
2	Exploiting Deep Learning and Probabilistic Modeling for Behavior Analytics	0.2	Prof. Giuseppe Manco,	Research Director at ICAR-CNR.	Dipartimento di Fisica "Ettore Pacini" and DIETI

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2	Force and visual Control for Safe Human – Robot Interaction	0.2	Prof. Bruno Siciliano	University of Naples Federico II	PRISMA Lab DIETI
2	GDPR basics for computer scientists	0.3	Dr. Ringo Wenning	European Research Consortium for Informatics and Mathematics	Prof. P. Bonatti, DIETI
2	Synthetic MRI: physical principles and applications	0.2	Prof. Angelo Galante	University of Aquila	Prof Rita Massa, Dip di Fisica, Prof Giuseppe Ruello DIETI
2	Static magnetic field exposure monitoring of MRI workers: methods and practical implementations	0.2	Prof. Angelo Galante	University of Aquila	Prof Rita Massa, Dip di Fisica, Prof Giuseppe Ruello DIETI
2	Data Driven Transformation in WINDTRE through Managers voice	0.2	Marcello Savarese, Erica Bertone and Amida Kudasheva	-	Dipartimento di Fisica “Ettore Pacini” and DIETI
2	Advances in Machine Learning for Modelling and Understanding in Earth Sciences	0.2	Gustau Camps Valls	Universitat de València	IEEE Geoscience and Remote Sensing
2	Designing a Socially Assistive Robot for adaptive and personalized assistance to patients with dementia	0.2	Dr. Antonio Andriella	University of Naples Federico II	Prof.ssa S. Rossi, PRISCA Lab. – DIETI
2	Visual Interaction and Communication in Data Science	0.4	Marco Quartulli	Vicomtech	Dipartimento di Fisica “Ettore Pacini” and DIETI
2	Robo Ludens: A game design taxonomy for human – robot interaction	0.2	Dr. John Edison Munoz Cardona	-	Prof.ssa S. Rossi, PRISCA Lab. – DIETI
2	Emotions in Reinforcement Learning Agents.	0.2	Prof. Joost Broekenes	Leiden Institute of Advanced Computer Science (LIACS)	Prof.ssa S. Rossi, PRISCA Lab. – DIETI

2	L'avvincente storia degli acceleratori	0.3	Prof. V.G. Vaccaro	University of Naples Federico II	Prof Rita Massa, Dip di Fisica, Prof Giuseppe Ruello DIETI
2	End-to-End	0.4	Dr. Jaime Llorca	New York University	5G Academy – Prof. Tulino
2	Metodologie scalari e Vettoriali di misura dell'esposizione e tecniche di estrapolazione	0.4	Dr Sara Adda . Dr Daniele Franci, Eng Settimio Pavoncello	-	Prof. Nicola Pasquino (DIETI, UNINA)
2	SAR Polarimetry: Theory, Machine Learning & Applications.	0.4	Prof.A. Iodice	University of Naples Federico II	Prof. A. Iodice, DIETI – Unina

Research activities

Sonia Zappia's activity is devoted to discussing the application of advanced THz imaging techniques in two research areas: non-destructive inspection of food quality and characterization of multifunctional scaffolds used in biomedical applications.

The motivations behind the use of THz imaging systems can be found in the numerous advantages offered by this technology, including high spatial resolution, the use of non-ionizing radiation, and ability to penetrate non-conductive materials like glass, plastic, and cardboard. Furthermore, unlike other non-destructive techniques, THz Time of Flight (ToF) imaging has the advantage of allowing a 3D characterization of the object under test.

Concerning the first research area, a performance assessments of THz system capabilities is provided to confirm the effectiveness of THz imaging techniques. It emerged that, THz waves are characterized by the ability to pass through a wide variety of packaging materials allowing us to control the quality of packaged products. On the other hand, THz waves are able to detect low density material hidden in food products through a non-destructive monitoring.

The second research activity focuses on the use of THz imaging for the characterization of magnetic scaffolds (MagS) used in various biomedical applications. Their wide use in several medical treatments motivates an increasing demand of advanced techniques for non-destructive quality assessment procedures aimed at verifying the absence of defects and, more generally, dedicated to the characterization of MagS. In fact, the manufacturing process are often associated to a non-uniform final spatial distribution of magnetic nanoparticles (MNPs) in the biomaterial, which could compromise the therapeutic efficacy of MagS. To this end, a new approach to characterizing MagS using THz imaging is proposed, a challenge that has yet to be thoroughly investigated by the scientific community. The proposed approach allows for a quantitative characterization of MagS in terms of their estimated thickness and refractive index. Additionally, it enables to identify the areas of the scaffold wherein MNP are mainly concentrated and thus, it gives us information about MNP spatial distribution.

Tutoring and supplementary teaching activities

Credits summary

PhD Year	Courses	Seminars	Research	Tutoring / Supplementary Teaching
1 st	22.9	6.8	27.1	-
2 nd	21	6.9	43.7	-
3 rd	0	0	59	-

Research periods in institutions abroad and/or in companies

PhD Year	Institution / Company	Hosting tutor	Period	Activities
1 st	-	-	-	-
2 nd	-	-	-	-
3	-	-	-	-

PhD Thesis

In the PhD Thesis, Sonia Zappia discussed the application of advanced THz imaging techniques in two research areas: non-destructive inspection of food quality and characterization of multifunctional scaffolds used in biomedical applications.

Regarding the first research activity, it is known that the detection of foreign body contamination, packaging failures, and items with poor characteristics is a significant concern in the food industry. In this framework, Terahertz (THz) systems offer a promising solution due to their non-invasive ability to detect surface defects and foreign bodies contaminations. The thesis demonstrates the effectiveness of THz technology in detecting and imaging contaminants located on the surface or few mm deep inside the food products, opening up possibilities for industrial applications.

The second research activity focuses on the use of THz imaging for the characterization of magnetic scaffolds (MagS) used in various biomedical applications. Due to their wide use in several medical treatments, there is an increasing demand of advanced techniques for non-destructive quality assessment procedures aimed at verifying the absence of defects and, more generally, dedicated to the characterization of MagS. In fact, the manufacturing process are often associated to a non-uniform final spatial distribution of magnetic nanoparticles (MNPs) in the biomaterial, which could compromise the therapeutic efficacy of MagS. This thesis proposes a new approach to characterizing MagS using THz imaging, a challenge that has yet to be thoroughly investigated by the scientific community. The proposed data processing approach allows for a quantitative characterization of MagS in terms of their estimated thickness and refractive index. Additionally, it

enables to identify the areas of the scaffold wherein MNP are mainly concentrated and thus, it gives us information about MNP spatial distribution.

Publications

Research results appear in 2 papers published in international journals, 1 published international book chapter, 4 contributions to international conferences and 3 contributions to national conferences.

List of scientific publications

International journal papers

Lodi, M. B., Curreli, N., Zappia, S., Pilia, L., Casula, M. F., Fiorito, S., ... & Fanti, A. (2021).
Influence of magnetic scaffold loading patterns on their hyperthermic potential against bone tumors.
IEEE Transactions on Biomedical Engineering, 69(6), 2029-2040. DOI: 10.1109/TBME.2021.3134208

Zappia S, Scapatucci R, Lodi MB, Fanti Alessandro, Ruello Giuseppe, Crocco Lorenzo, Catapano Ilaria (2023)
Non-Destructive Characterization of Magnetic Polymeric Scaffolds using Terahertz Time-of-Flight Imaging
IEEE Transactions on Terahertz Science and Technology - (Accepted paper)

International book chapter

Zappia S, Crocco L, Catapano I (2021)
Book title: Terahertz Technology
Chapter title: THz Imaging for food inspections: A technology review and future trends.
Intechopen, DOI: 10.5772/intechopen.97615

International conference papers

Scapatucci, R., Zappia, S., Catapano, I., Ruello, G., Bellizzi, G., Pasquino, N., ... & Crocco, L. (2021, March).
Broadband Electromagnetic Sensing for Food Quality Control: A Preliminary Experimental Study.
In *2021 15th European Conference on Antennas and Propagation (EuCAP)* .
Online, 15-20/03/2020, (pp. 1-5), IEEE, DOI: 10.23919/EuCAP51087.2021.9411022

Catapano I, S. Zappia, G. Ludeno, F. Soldovieri
THz Imaging activities at IREA - CNR
9th International THz-Bio Workshop,
Online Meeting, Apr. 19-23 2021, in Workshop Co-chairs (p.65), CNR, link: /THz-BioWorkshop-libro-def_compressed.pdf.

Scapatucci R, Palmeri R, Ricci M, Tobon Vasquez JA, Zappia S, Vipiana F, Crocco L
Contaminants Detection in Industrial Products Through Microwave Imaging and Compressive Sensing Techniques
Ursi International Symposium on Electromagnetic Theory 2023, (URSI) EMTS 2023

University of British Columbia Vancouver, BC, Canada, 23-26 May 2023 (Accepted Conference Paper)

Zappia S, Scapatucci S, Ruello G, Crocco L, Catapano I

Non-Destructive Inspection of Chocolate Cream with THz Imaging

In *2023 17th European Conference on Antennas and Propagation (EuCAP)* .

Florence, Italy, 26-31 March 2023, IEEE (not yet available online)

National conference papers

Zappia S, Catapano I, Scapatucci R, Crocco L

Terahertz Imaging for Food Quality Inspection

VI National Conference Interaction between electromagnetic fields and biosystems, (ICEmB 2022)

Cagliari (Italy), July 2022

S Zappia, L Crocco, R Scapatucci, MB Lodi, A Fanti, and I Catapano,

Terahertz imaging of magnetic scaffolds

VI National Conference Interaction between electromagnetic fields and biosystems, (ICEmB 2022),

Cagliari (Italy), July 2022

S Zappia, L Crocco, R Scapatucci, I Catapano

TeraHertz Inspections of Chocolate Cream Samples

11th URSI ITNC Meeting

Catania (Italy), September 2022

Date 13/04/2023

PhD student signature



Supervisor signature


