UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

DOTTORATO DI RICERCA / PHD PROGRAM IN
INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING

Activities and Publications Report

PhD Student: Sara Leccese

Student DR number: DR996621

PhD Cycle: XXXVIII
PhD Chairman: Prof. Stefano Russo

PhD program student's start date: 01/11/2022
PhD program student's end date: 31/10/2024

Supervisor: Stefania Santini

e-mail: stefania.santini@unina.it

Co-supervisor: N/A

e-mail: N/A

PhD scholarship funding entity: Università Federico II, PNRR - DM 351 Ricerca

General information

Sara Leccese received in year 2022 the Master Science degree in Automation and Robotics Engineering from the University of Napoli Federico II. She attended a curriculum in Automatic Control within the PhD program in Information Technology and Electrical Engineering. She received a grant from Università Federico II.

Study activities

Attended Courses

Year	Course Title	Type	Credits	Lecturer	Organization
1st	Academic Entrepreneurship	Ad hoc course	4	Prof. Pierluigi Rippa, Silvia Cosimato, Nadia Di Paola - DIE Unina	ITEE
1st	TEST MINING	MSc course	6	Prof. Flora Amato	DIETI and Scuola Politecnica e delle Scienze di Base - UNINA
1st	INFORMATION SYSTEMS AND BUSINESS INTELLIGENCE	MSc course	6	Prof. Flora Amato	DIETI and Scuola Politecnica e delle Scienze di Base - UNINA
2nd	Big Data Architecture and Analytics	Ad hoc course	5	Prof. Giancarlo Sperlì	ITEE
2nd	Smart Roads and Cooperative Driving	MSc course	6	Prof. Angelo Coppola	DICEA and Scuola Politecnica e delle Scienze di Base - UNINA
3rd	Series of lectures on Hybrid Lyapunov techniques	External course	4	Prof. Luca Zaccarian, LAAS-CNRS and University of Trento	University of Seville, Spain

Attended PhD Schools

Year	School title	Location	Credits	Dates	Organization
1st	INTERNATIONAL GRADUATE SCHOOL ON CONTROL (IGSC)-Time-Delay and Sampled-Data System	PARIS-SACLAY, Paris, France	4	11-14/04/2023	EECI 2020- International Graduate School on Control, Prof. Emilia Fridman; Prof. Pierdomenico Pepe

Attended Seminars

Year	Seminar Title	Credits	Lecturer	Lecturer affiliation	Organization
1st	COMPLEX NETWORKS SYSTEMS: INTRODUCTION AND OPEN CHALLENGES	0.3	Prof. Pietro De Lellis	DIETI-Unina	Scuola Superiore Meridionale (SSM) Colloquia
1st	GINGER, GYROSCOPES IN GENERAL RELATIVITY	0.3	Dr. Agela Di Virgilio	Research centre: NFN Sez. Pisa – Italy	SSM
1st	Back and forth between the infinite and the finite: a numerical view of time delay systems.	0.3	Prof. Dimitri Breda	University of Udine	TDS Webniar
	FROM CYBER SITUATIONAL AWARENESS TO ADAPTIVE CYBER DEFENSE: LEVELING THE CYBER PLAYING FIELD	0.4	Prof. Massimiliano Albanese	George Mason University, Virginia, USA	ITEE
1st	Progettazione di strategie di controllo in ambiente Simulink	0.6	Ing. Gianfranco Fiore	Mathworks	ITEE
1st	Is control a solved problem for aerial robotics research?	0.2	Prof. Antonio. Franchi	University of. Twente	ITEE
1st	Multi-robot Control of Heterogeneous Herds	0.3	Prof. Eduardo Montijano	University of. Zaragoza	ITEE
1st	Industry 4.0 Fundamentals in Bosch Applications.	2	Prof. Ing. Mariagrazia Dotoli, Eng. Martino Bruni	Bosch	Unina
1st	Using Delays for Control	0.2	Prof. Emilia Fridman	Tel Aviv University	Uniroma1
1st	Asymptotic Stability and Gamma-Stability of Linear Time Invariant Time Delays Systems (LTI-TDS) - Leveraging algebraic tools for analytical results.	0.2	Prof. Rifat Sipahi	Northeastern University, USA	TDS Webinar
1st	Boundary feedback stabilization of freeway traffic networks: ISS control and experiments.	0.3	Prof. Christophe Prieur	CNRS, France	ISS Seminar

1st	Legendre polynomials for Delay Systems: Modelling and Stability	0.2	Prof. Alexandre Seuret	University of Seville	TDS Webinar
1st	Let's Use Delays in Adaptive Control!	0.3	Prof. Iasson Karafyllis	National Technical University of Athens	ISS Webinar
2nd	AI for Rails	0.4	Prof. Vittorini	Dieti	ITEE
2nd	Input-to-State Stability and converse Lyapunov Theorem for Linear Difference Equations and Hyperbolic Partial Differential Equations.	0.3	Prof. Delphine Bresch Pietri	MINES ParisTech, France	ISS Seminar
2nd	Balancing-based model reduction for delay systems.	0.3	Prof. Nathan van de Wouw	Eindhoven University of Technology, Netherlands	TDS Webinar
2nd	The Characterization of ISS for time-delay systems: Results and Counterexamples.	0.3	Prof. Fabian Wirth	University of Passau, Germany	ISS Seminar
2nd	Dynamics with implicit state-dependent delay and post-Newtonian gravitational models	0.3	Prof. Erik Verriest	Georgia Institute of Technology, USA	TDS Webinar
2nd	Social Network Analysis: Methods and Applications	0.4	Prof. Giancarlo Sperlì	DIETI, Unina	ITEE
2nd	Introduction to Large Language Models: Evolution and the current state	0.4	Prof. Giancarlo Sperlì	DIETI, Unina	ITEE
2nd	Towards gain-optimal ISS controllers for finite state systems	0.3	Prof. Antoine Girard	CentraleSupélec, Paris, France	ISS Seminar
2nd	Stabilization of systems of coupled hyperbolic PDEs and characterization of their ISS properties using Lyapunov functions	0.3	Prof. Jean Auriol	CNRS	ISS Seminar
2nd	On the resilience of Control Systems for Autonomous Driving Under Cyber-Attacks	0.3	Prof. Alberto Petrillo	DIETI,Unina	Automotive Cyber Security Academy(ACSA-2024), University of Salerno
2nd	From ACE Technologies to Sustainable, Accessible and Equitable Urban Mobility:	0.4	Prof. Mauro Salazar	Eindhoven University of	ITEE

	An Optimization Journey			Technology, Netherlands	
3rd	AI and Enabling Technologies for Social Robots.	0.3	Prof. Silvia Rossi	Unina	ITEE
3rd	Stability Guarantees under Sampling for Retarded Nonlinear Systems	0.2	Prof. Pierdomenico Pepe	University of Aquila	TDS Webinar
3rd	Bridging Physics to Biomedical Sciences	0.2	Prof. Carlo Altucci		SSM Scientific Colloquia
3rd	A stability analysis technique called trajectory-based approach.	0.3	Prof. Leilei Cui, Prof. Eduardo Sontag	Massachusetts Institute of Technology, Massachusetts and Northeastern University, Boston, USA	ISS Seminar
3rd	ISS properties of gradient systems	0.3	Prof. Frédéric Mazenc	L2S Centrale Supélec, France	ISS Seminar
3rd	Time Delays, Hopf Bifurcation and Synchronization	0.3	Prof. Sue Ann Campbell	University of Waterloo, Canada	ISS Seminar
3rd	*IEEE ITSS Italian Chapter Annual Meeting and PhD Award 2025*	1	Prof. Stefania Santini, Prof. Simona Sacone	Unina and University of Genova	*IEEE ITSS Italian Chapter*

Research activities

Sara Leccese participated in the research on the design of distributed control strategies for Multi-Agent Systems (MASs) within a Networked Control Systems (NCS) framework, with applications to Cyber-Physical Systems (CPSs) and, in particular, Cyber-Physical Energy Systems (CPESs) such as microgrids. Over the three-year research period, the main focus has been on three fundamental directions: (1) the design of distributed controllers enabling the transition from continuous-time to digital implementation through sampled-data techniques; (2) the enhancement of communication efficiency via event-triggered mechanisms for cooperative control; (3) the resilience of these adavanced strategies to system nonlinearities, external disturbances, and network-induced phenomena. Based on these research directions, the main contributions can be summarized as follows:

A. Establishment of stability and performance guarantees for sampled-data implementations of continuous-time controllers, explicitly considering discretization effects, Zero-Order-Hold actuation, and state/input delays.
B. Development of distributed cooperative and event-triggered control strategies that enable consensus and synchronization among agents despite limited communication bandwidth

and unknown external disturbances. These approaches ensure stability, robustness, and efficient use of network resources by reducing unnecessary transmissions.

C. Tailoring the theoretical developments to Cyber-Physical Energy Systems (CPESs) through the design of fully distributed digital control strategies that optimize network resource utilization while ensuring coordinated operation and resilience against cyber-attacks and modeling uncertainties. The proposed approaches have been validated through realistic simulations and hardware-in-the-loop experiments on a high-fidelity real-time simulation platform.

Tutoring and supplementary teaching activities

CONTROLLI AUTOMATICI SSD: ING-INF/04, Prof. Stefania Santini a.a. 2023/2024 and 2024/2025

Credits summary

PhD Year	Courses	Seminars	Research	Tutoring / Supplementary Teaching
1st	20	5.9	29.1	0
2nd	12	4	45.1	1.6
3rd	4	2.6	51.8	1.6

Research periods in institutions abroad and/or in companies

PhD Year	Institution / Company	Hosting tutor	Period	Activities
2nd	University of Seville (US), Spain	Prof. Alexander Seuret	28/09/2024-31/10/2024	Research on distributed sampled-data and event-triggered control for multi-agent systems, leveraging tools such as hybrid systems theory.
3rd	University of Seville (US), Spain	Prof. Alexander Seuret	01/11/2024-30/03/2025	Research on distributed sampled-data and event-triggered control for multi-agent systems, leveraging tools such as hybrid systems theory. Preparation of the following papers: 1. Event-triggered distributed consensus for multi-agent systems under bounded-in-average disturbances, using LMI-based Laplacian design and projection matrices. 2. Event-triggered control for heterogeneous multi-agent systems, based on a hybrid systems formulation, guaranteeing uniform dwell-time, global exponential weighted consensus, with application on microgrids.

PhD Thesis

In the PhD Thesis, Sara Leccese focuses on the development of distributed control strategies for networked systems, aiming to ensure efficient, resilient, and reliable operation of modern cyber-physical infrastructures. The rapid advancement of digital and communication technologies has significantly increased interest in Cyber-Physical Systems (CPSs), due to their applicability across several engineering domains. CPSs integrate physical processes with sensing, computation, and communication layers, enabling real-time monitoring, intelligent decision-making, and improved operational performance.

Within this framework, a key challenge is designing distributed control protocols that coordinate agents using only local and neighbouring information. The increasing reliance on digital platforms makes this task even more critical, as network-induced phenomena, such as time-varying delays, packet losses, and limited bandwidth, can compromise stability and performance. Additionally, digital implementation introduces discretization effects, Zero-Order-Hold actuation, and potentially asynchronous updates, all of which must be carefully addressed in the control design.

To tackle these issues, this thesis investigates distributed control strategies based on sampled-data and event-triggered frameworks. Sampled-data control provides rigorous tools to analyse and implement continuous-time controllers in digital platforms, while event-triggered control further improves efficiency by updating actions only when necessary, reducing computational load and network usage. The proposed methods are applied to microgrids, integrating distributed generation, storage, and controllable loads, offering a realistic testbed to validate coordination, efficiency, and resilience in real-world CPS applications

Research products

Research results appear in 2 papers published and 3 under review in international journals, 9 contributions to international conferences.

List of scientific publications

International journal paper

1. Caiazzo, B., Leccese, S., Pepe, P., Petrillo, A., & Santini, S.
   Global Exponential Stability Preservation under Sampling and Approximated Delay-Dependent Feedbacks for Nonlinear Systems with Time-Varying Delays,
   IEEE Transactions on Automatic Control
   Volume: 70, Issue: 10, October 2025
   DOI: 10.1109/TAC.2025.3567250

2. Basile, G., Leccese, S., Petrillo, A., Rizzo, R., & Santini, S.
   Sustainable DDPG-based Path Tracking for Connected Autonomous Electric Vehicles in extra-urban scenarios,
   IEEE Transactions on Industry Applications,
   2024, pp. 1-13, 2024
   DOI: 10.1109/TIA.2024.3444733

3. Andreotti, A., Caiazzo, B., Leccese, S., Petrillo, A., Santini, S., & Vaccaro, A.
   Real-Time Assessment of Dynamic Event-Triggered Controllers for Islanded Microgrids via High-fidelity Cyber-Physical Platform,
   Under review (2025)

4. Leccese, S., Albea, C., Santini, S., Zaccarian, L., & Seuret, A.
   Uniform dwell-time and robustness in distributed event-triggered weighted consensus,
   Under review (2025)

5. Leccese, S., Lui, D. G., Petrillo, A., & Santini, S.
   Virtual Coupling Formation Control for Heterogeneous High-Speed-Trains with Uncertain Dynamics, Nonuniform Communication Delays and Switching Topologies,
   Under review (2024)

International conference papers

1. Leccese, S., Caiazzo, B., Petrillo, A., Santini, S., & Seuret, A.
   Weighted network design for practical average consensus in perturbed Multi-Agent Systems.
   2nd IFAC Workshop on Control of Complex Systems (COSY)
   Paris, France, Jun 2025, IFAC-PapersOnLine, 59(11), 102-107, Elsevier.
   DOI: 10.1016/j.ifacol.2025.09.532

2. Caiazzo, B., Leccese, S., Petrillo, A., & Santini, S.
   Improving the communication overhead in vehicles platoon: a novel dynamic event-triggered predictor method
   IEEE International Conference on Intelligent Transportation Systems (ITSC)
   Gold Coast, Australia, November 2025, to appear

3. Caiazzo, B., Leccese, S., Pepe, P., Petrillo, A., Santini, S.
   From piece-wise constant to continuous time-varying delays: Global Exponential Stability Preservation for Nonlinear Systems Under Sampling
   IEEE 63rd Conference on Decision and Control (CDC) (pp. 948-953). IEEE
   DOI: 10.1109/CDC56724.2024.10886602

4. Andreotti, A., Caiazzo, B., Leccese, S., Petrillo, A., Redi, L., & Santini, S.
   Grid Interactive Smart Buildings Coordination in Multi-Area Power Systems: A Delay-Robustness Analysis.
   International Conference on Smart Cities and Green ICT Systems, SMARTGREENS, Proceedings (pp. 48-55). Science and Technology Publications, Lda.

5. Andreotti, A., Caiazzo, B., Leccese, S., Lui, D. G., Petrillo, A., & Santini, I. S.
   Prescribed-Time Consensus Control for the Voltage Restoration in Inverter-based Islanded Microgrids
   IEEE American Control Conference (ACC)
   Toronto, Canada, Jul. 2024, (pp. 1783-1788). IEEE.
   DOI: 10.23919/ACC60939.2024.10644633

6. Andreotti, A., Caiazzo, B., Leccese, S., Petrillo, A., & Santini, S.
   A Unified Distributed Digital Control Architecture for Secondary Control in Islanded Microgrids
   IFAC Control of Power and Energy Systems (CPES)
   Rabat, Morocco, Jul. 2024, IFAC-PapersOnLine, 58(13), 74-79, Elsevier.
   DOI: 10.1016/j.ifacol.2024.07.462

7. Andreotti, A., Caiazzo, B., Leccese, S., Petrillo, A., Santini, S., & Vaccaro, A.
   Assessment of a Dynamic Event-Triggered Voltage Control for Islanded Microgrids Using High-Fidelity Cyber-Physical Platform
   International Conference on Smart Energy Systems and Technologies (SEST)
   Torino, Italy, Sept. 2024, (pp. 1-6), IEEE.
   DOI: 10.1109/SEST61601.2024.10694578

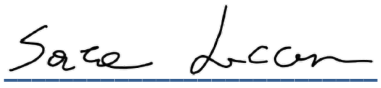
8. B. Caiazzo, E. Fridman, S. Leccese, A. Petrillo, S. Santini
   Voltage Recovery in SOA-based Virtual Microgrids via Time-Delay Approach to Averaging
   IFAC, 22nd World Congress 2023 of the International Federation of Automatic Control
   Yokohama, Japan, IFAC-PapersOnLine, vol 56 (pp 905-910), Elsevier.
   DOI: 10.1016/j.ifacol.2023.10.1680

9. G. Basile, S. Leccese, A. Petrillo, R. Rizzo and S. Santini,
   Sustainable DDPG-based Path Tracking For Connected Autonomous Electric Vehicles in extra-urban scenarios,
   2023 IEEE IAS Global Conference on Renewable Energy and Hydrogen Technologies (GlobConHT),
   Male, Maldives, 2023, (pp. 1-7), IEEE
   DOI: 10.1109/GlobConHT56829.2023.10087542

Awards and Prizes

The Young Author Award of the 2nd IFAC Workshop of Control of Complex Systems (COSY), for the paper: *Weighted network design for practical average consensus in perturbed Multi-Agent Systems.* Co-authored by Bianca Caiazzo, Alberto Petrillo, Stefania Santini, Alexandre Seuret.

Date 23/10/2025

PhD student signature 

Supervisor signature