Sara Leccese

Distributed Control for Cyber-Physical Systems: design and application

Tutor: Prof. Stefania Santini

Cycle: XXXVIII

Year: First

Background & Info

- **MSc degree in Automation and Robotics Engineering, University of Naples Federico II**

- **Working team: DAiSt Lab (Prof. Stefania Santini)**

- **PhD start date: Academic Year 2022-2023**

- **Scholarship type: PNRR - DM 351 Ricerca**

Research Topic

- **Designing novel distributed control strategies ensuring the efficiency, robustness, and adaptability of multi-agent cyber-physical systems (CPS) on various domains.**

- **The idea is to tailor the theoretical results to emerging application of CPS, such as:**

  - **Smart Transportation Systems**

  - **Smart Grids**

  - **Smart Cities**

  - **Industry 4.0**
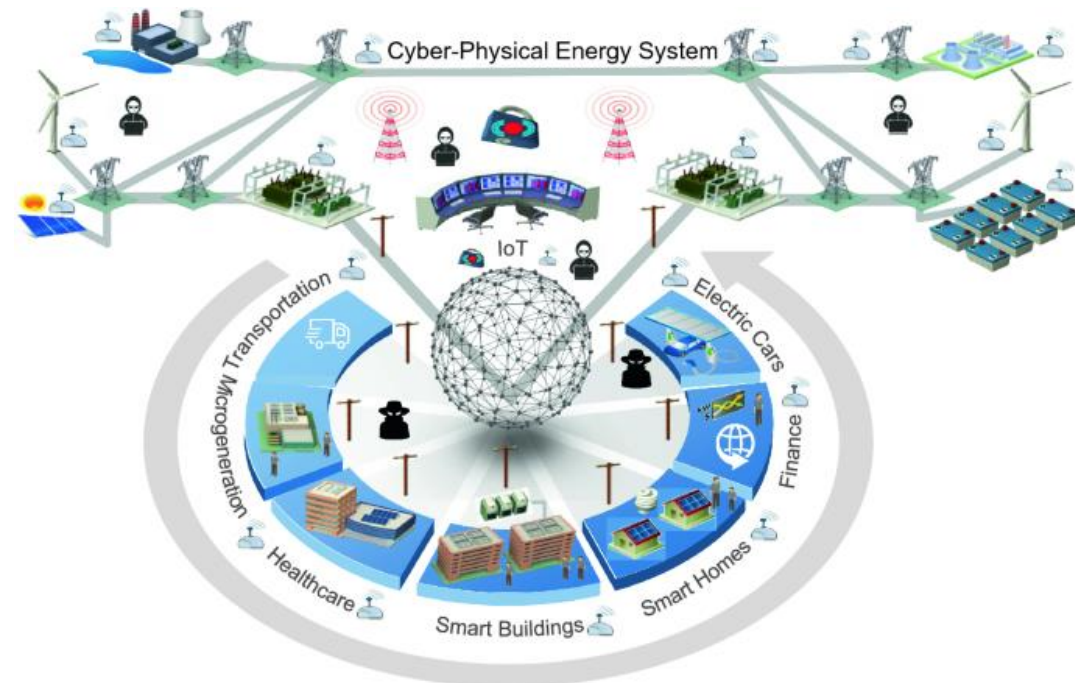
My First Year:
Study & Training activities(1/2)

- **The focus of my first-year activity is the acquisition of concepts related to distributed cooperative control strategies over communication impairments and their application to Power Systems and Intelligent Transportation Systems.**

Lai, Jingang, et al. "Resilient distributed multiagent control for AC microgrid networks subject to disturbances." IEEE Transactions on Systems, Man, and Cybernetics: Systems 52.1 (2021): 43-53.

W. Bai, H. Dong, Z. Zhang, and Y. Li, "Coordinated time-varying low gain feedback control of high-speed trains under a delayed communication network," IEEE Transactions on Intelligent Transportation Systems, vol. 23, no. 5, pp. 4331–4341, 2021.

Attended the EECI 2023 International Graduate School on Control – "Time-Delay and Sampled-Data System", by Prof. Emilia Fridman and Prof. Pierdomenico Pepe.

Attended the 2023 IEEE IAS Global Conference on Renewable Energy and Hydrogen Technologies (GlobConHT), Male, Maldives

Pepe, Pierdomenico, and Emilia Fridman. "On global exponential stability preservation under sampling for globally Lipschitz time-delay systems." *Automatica* 82 (2017): 295-300.

Caiazzo, Bianca, Emilia Fridman, and Xuefei Yang. "Averaging of systems with fast-varying coefficients and non-small delays with application to stabilization of affine systems via time-dependent switching." Nonlinear Analysis: Hybrid Systems 48 (2023): 101307.

itee PhD
information technology
electrical engineering

My First Year:
Study & Training activities(2/2)

**-Some of the attended seminars are listed as follows:**

- **Using Delays for Control, Prof. Emilia Fridman**
- **Asymptotic Stability and Gamma-Stability of Linear Time Invariant Time Delays Systems (LTI-TDS) - Leveraging algebraic tools for analytical results, Prof. Rifat Sipahi**
- **Legendre polynomials for Delay Systems: Modelling and Stability, Prof. Alexandre Seuret**
- **ISS for delay systems: an overview and some open questions, Antoine Chaillet**

-Other attended Courses are listed as follows-

- **Information Systems and Business Intelligence**
- **Test Mining**
- **Academic Entrepreneurship**

Research activity:
Problem Statement(1/2)

- The contemporary landscape of CPS presents several challenges such as: time-varying communication topologies, real time decision making, robustness, scalability and resilience.
- The paradigm is shifting towards distributed control, ensuring efficient and resilient operation in interconnected environments.
- The aim of the research is design, deployment and validation of distributed and fully decentralized cooperative control strategies for CPSs is a Multi-Agent Systems (MASs) fashion.
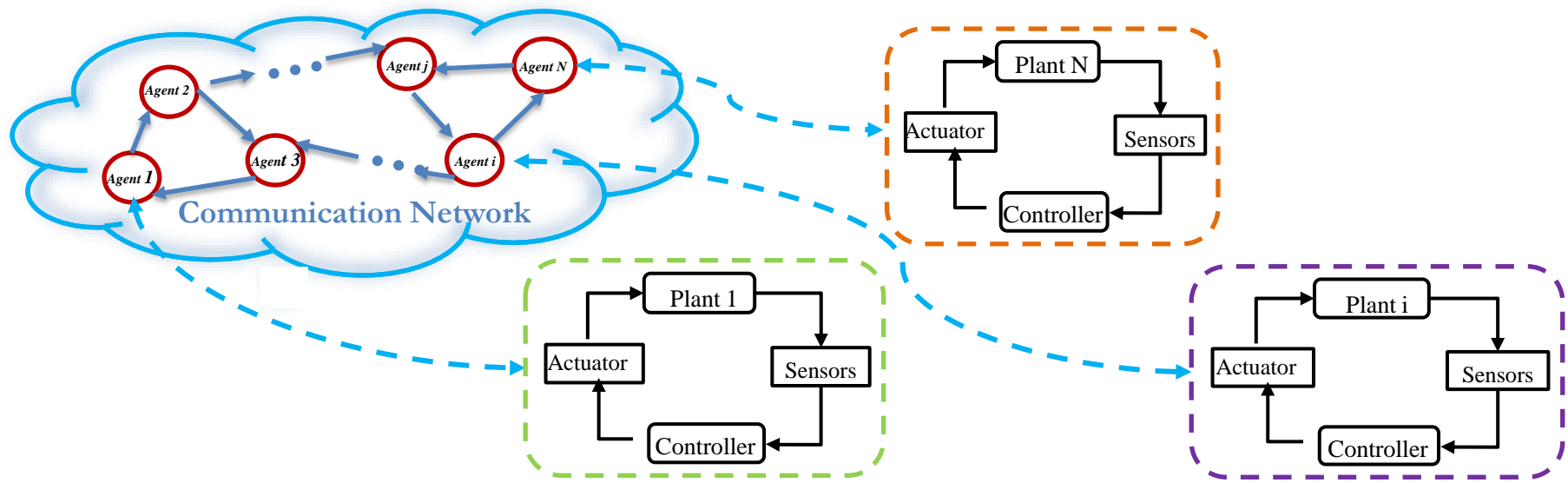
Research activity:
Problem Statement(2/2)

Thanks to the various CPS applications, results will contribute to the advancement of control methodology in various sectors, such as intelligent transportation system, energy, and industry, with the following main aims:

- **Efficient resource utilization**

- **Scalability and Flexibility**

- **Resilience and Fault Tolerance**

- **Energy efficiency**

My Products

[1] 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, To appear.

[2] 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,

doi: 10.1109/GlobConHT56829.2023.10087542.

Next Year

- **The main objective of the newt year is to keep on working on distributed control problem for networked control systems, considering heterogeneous nonlinear agents sharing information via a non-ideal communication network.**

- **Besides robustness and resilience of the proposed methodologies with respect to nonlinearity effects and unavoidable communication impairments, another important issue to be addressed is related to the achievement of the global exponential stability and ISS stability of the closed loop system.**

- **Testing and validation on realistic co-simulation platform based on MATLAB/Simulink environment together with dSPACE tools.**

Study and training activities - credits earned

	Courses	Seminars	Research	Tutorship	Total
Bimonth 1	0	1.3	8.1	0	10
Bimonth 2	0	2.5	7.5	0	10
Bimonth 3	4	0.2	5.8	0	10
Bimonth 4	0	0.7	0.3	0	10
Bimonth 5	4	0.3	5.7	0	10
Bimonth 6	12	0.3	1.7	0	14
Total	20	5.4	29.1	0	64
Expected	20 - 40	5 - 10	10 - 35	0 – 4.8	