Curriculum vitæ et studiorum

of Emilio Carfagna

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Information

Name: Emilio Carfagna.
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1 Short biography

Emilio Carfagna obtained the bachelor degree in Computer Engineering (L-08), "Robotics and automation" curriculum, in the academic year 2013/2014 from the University of Rome

"Tor Vergata" with a thesis entitled "*The FastSLAM algorithm for the localization of a mobile robot in a partially known environment*" and the master's degree in Automation Engineering (LM-25) in the academic year 2016/2017 from the University of Rome "Tor Vergata" discussing a thesis entitled "*Adaptive observers for the control of permanent magnet synchronous motors: new theoretical and experimental developments*".

Emilio Carfagna obtained the qualification to the profession of Industrial Engineer in the first session of 2018 from the Ministry of Education, University and Research.

After the thesis he continues his research activities at the Department of Sciences and Methods for Engineering of the University of Modena and Reggio Emilia with a PhD scholarship (XXXIV cycle) in Industrial Innovation Engineering and in 2022 he obtains the title of PhD with a thesis entitled "*Investigation of new control strategies for high-speed electrical drives*". From June 2021 to October 2021, he was Visiting Scholar at the Chair of Power Electronics, Christian-Albrechts-Universität, Kiel, Germany.

From 1 February 2022 he continues his research activities at the Department of Sciences and Methods for Engineering as a research fellow (SSD ING-IND/32) with a research project entitled "*Development of control strategies for high-speed electrical drives*".

Starting from 15 March 2023 he becomes Assistant professor (RTDA) with the same Department within the project "*Ecosystem for Sustainable Transition of Emilia-Romagna*" (ECOSISTER) - Spoke 3 "*Green manufacturing for a sustainable economy*".

He is author/co-author of more than 30 scientific articles published in international journals and in international conference proceedings. He is a reviewer of the journals IEEE Transactions on Industrial Electronics, IEEE Transactions on Power Electronics, IEEE Transactions on Industry Applications and several IEEE conferences. He is a member of the IEEE Industrial Electronics Society (IEEE IES) and of the Italian association of Converters, machines and electrical drives (CMAEL).

2 Academic positions and education

2.1 Actual position

From 15 March 2023 Emilio Carfagna becomes Assistant professor (RTDA) with the Department of Sciences and Methods for Engineering of the University of Modena and Reggio Emilia within the project "*Ecosystem for Sustainable Transition of Emilia-Romagna*" (ECOSISTER) - Spoke 3 "*Green manufacturing for a sustainable economy*".

2.2 Past positions

From 01 February 2022 to 14 March 2023 he has been Junior Research Fellow with the Department of Sciences and Methods for Engineering of the University of Modena and Reggio Emilia as a research fellow (SSD ING-IND/32) with a research project entitled "*Development*

of control strategies for high-speed electrical drives".
Supervisor: Prof. Emilio Lorenzani.

2.3 Certifications

Emilio Carfagna obtained the qualification to practice as an Industrial Engineer, section A, in the first session of 2018 from the Ministry of Education, University and Research.

2.4 Education

- from 01 November 2018 to 31 January 2022: Doctor of Philosophy (Ph.D. degree) in Industrial Innovation Engineering (ING-IND32), University of Modena and Reggio Emilia, Reggio Emilia, Italia.
  Thesis: "*Investigation of new control strategy for high-speed electrical drives*".
  Supervisor: Prof. Emilio Lorenzani.
- from 28 September 2015 to 27 February 2018: Master degree in Control Engineering (LM-25), University of Rome "Tor Vergata", Rome, Italy.
  Thesis: "*Adaptive observers for the control of permanent magnet synchronous motors: new theoretical and experimental developments*".
  Supervisor: Prof. Cristiano Maria Verrelli.
  Supporting supervisors: Prof. Stefano Bifaretti, Prof. Alessandro Lidozzi.
- from 03 October 2011 to 14 April 2015: Bachelor degree in Computer Engineering (L-08), "Robotics and Automation" curriculum, University of Rome "Tor Vergata", Rome, Italy.
  Thesis: "*The FastSLAM algorithm for the localization of a mobile robot in a partially known environment*".
  Relatore: Prof. Francesco Martinelli.

3 Teaching activities

Emilio Carfagna carried out his teaching activity in the bachelor degree courses of Mechatronic Engineering and Management Engineering at the University of Modena and Reggio Emilia:

- "Principles and applications of electricity" (channel A-K), bachelor degree course in Management Engineering at the University of Modena and Reggio Emilia, 54 hours (6 CFU), starting from the AY 2022/2023;
- "Electrical engineering and electrical machines", bachelor degree course in Mechatronic Engineering at the University of Modena and Reggio Emilia, 12 hours (1.3 CFU) in the AY 2023/2024, 10 hours (1.1 CFU) in the AY 2024/2025 and 27 hours (3 CFU) in the AY 2025/2026.

He has been supervisor/co-supervisor of degree thesis concerning the topics of static conversion of energy and electric drives in the field of industrial automation.

4 Scientific activities

Emilio Carfagna's main research activities focus on the study of power electronic converters in the field of industrial drives. The research topics addressed have led to the development of prototypes and analytical methodologies.
More specifically, the primary activities can be categorized into the following research areas:

- **electric drives:**
  - sensorless control of surface-mounted and interior permanent magnet synchronous machines using adaptive observers;
  - field-oriented control of stepper motors: position/speed estimation and field weakening;
  - high-speed electric drives and iron loss analysis;
  - field-oriented control of switched reluctance machines;
- **current source inverters (CSIs):**
  - control strategies for CSIs in high-speed drive systems and photovoltaic applications;
  - innovative high-efficiency single-stage CSI architectures;
  - sensorless control, resonance mitigation, and discontinuous current conduction mode;
- **hybrid amplifiers for piezoelectric actuators:**
  - development of parallel class-AB/class-D hybrid amplifiers;
  - loss reduction and energy recovery in the drive of high-dynamic piezoelectric actuators.

5 Technological activity

5.1 Industrial project

As research fellow and PhD student he was involved in the following industrial research activities:

- for System Ceramics Spa, he worked on simulations in PLECS and LTSpice environments of a hybrid architecture that combines a linear amplifier and class D architectures to drive piezoelectric loads and reduce power dissipation.
- for System Electronics (a division of System Ceramics SpA), he was involved in developing a full digital field-oriented drive for stepper motors in low-power industrial applications. Specifically, the work included simulations in Matlab/Simulink and PLECS, experimental implementation of vector control for two-phase machines, strategies in

the field weakening region to extend the achievable speeds of the drive, alignment procedures, and control in cases with encoders having few pulses per revolution;
- for Bosch Rexroth Oil Control Spa, he worked on sensorless speed control of a DC series motor for pneumatic and hydraulic applications.

5.2 Research project

As a PhD student, from June 15, 2021, to October 31, 2021, he was a Visiting Scholar at the Chair of Power Electronics, Christian-Albrechts-Universität, Kiel, Germany, under the supervision of Prof. Marco Liserre. In this role, he studied control systems for high-speed electric drives for surface-mounted permanent magnet machines, highlighting the importance of considering the presence of iron losses in the electric machine during control, especially when these losses are significant.

As a fixed-term researcher he participates in the project "*Ecosystem for Sustainable Transition of Emilia-Romagna*" (ECOSISTER) - Spoke 3 "*Green manufacturing for a sustainable economy*" within the work packages:

- WP1: "*Development of zero-pollution products, processes and production systems that minimize the energy demand and the use of hazardous and of non-renewable materials*". The project studies electric drives based on switched reluctance motors. The advantage of these motors is that they do not use permanent magnets, thereby reducing the activities of extraction and refining of materials;
- WP4: "*ICT Solutions and technologies for the design, construction, monitoring, and control of green, sustainable, safe and reconfigurable machines and industrial processes*". The project involves using stepper motors to control a gripper in collaborative robotic applications. The use of stepper motors is justified by their lower reliance on permanent magnets compared to commonly used solutions and the high torque they can provide at low speeds.

6 Publications

PhD thesis

1. Emilio Carfagna, "Investigation of New Control Strategies for High-Speed Electrical Drives", Reggio Emilia, 2022.
   Supervisor: Prof. Emilio Lorenzani.

Journal articles

2. C. M. Verrelli, S. Bifaretti, E. Carfagna, A. Lidozzi, L. Solero, F. Crescimbini, M. Di Benedetto, "Speed Sensor Fault Tolerant PMSM Machines: From Position-Sensorless

to Sensorless Control", in *IEEE Transactions on Industry Applications*, vol. 55, no. 4, pp. 3946-3954, July-Aug. 2019, doi: 10.1109/TIA.2019.2908337.

3. G. Migliazza, G. Buticchi, E. Carfagna, E. Lorenzani, V. Madonna, P. Giangrande, M. Galea, "DC Current Control for a Single-Stage Current Source Inverter in Motor Drive Application", in *IEEE Transactions on Power Electronics*, vol. 36, no. 3, pp. 3367-3376, March 2021, doi: 10.1109/TPEL.2020.3013301.

4. G. Migliazza, E. Carfagna, G. Buticchi, F. Immovilli, E. Lorenzani, "Effect of Semiconductor Parasitic Capacitances on Ground Leakage Current in Three-Phase Current Source Inverters", in *Energies*, vol. 14, no. 21, 7364, November 2021, doi: 10.3390/en14217364.

5. G. Migliazza, E. Carfagna, F. Bernardi, E. Lorenzani, "Optimized Parallel Hybrid Amplifier (OPHA) for Print-Head Piezoelectric Actuators with Trapezoidal Waveforms", in *IEEE Journal of Emerging and Selected Topics in Power Electronics*, vol. 10, no. 2, pp. 2330-2338, April 2022, doi: 10.1109/JESTPE.2021.3138585.

6. C. M. Verrelli, E. Carfagna, M. Frigieri, A.S. Crinto, E. Lorenzani, "A New Bernard-Praly-Like Observer for Sensorless IPMSMs", in *Automatica*, vol. 140, p. 110266, June 2022, doi: 10.1016/j.automatica.2022.110266.

7. F. Bernardi, E. Carfagna, G. Migliazza, G. Buticchi, F. Immovilli, E. Lorenzani, "Performance Analysis of Current Control Strategies for Hybrid Stepper Motors", in *IEEE Open Journal of the Industrial Electronics Society*, vol. 3, pp. 460-472, 2022, doi: 10.1109/OJIES.2022.3185659.

8. G. L. Fidone, G. Migliazza, E. Carfagna, D. Benatti, F. Immovilli, G. Buticchi, E. Lorenzani, "Common Architectures and Devices for Current Source Inverter in Motor-Drive Applications: A Comprehensive Review", in *Energies*, 2023, 16, 5645, doi: 10.3390/en16155645.

9. D. Benatti, G. Migliazza, E. Carfagna, F. Immovilli, E. Lorenzani, "Novel Single-Stage Current Source Inverter: Extension to Low-Speed Region in Motor Drive Applications", in *IEEE Transactions on Industrial Electronics*, vol. 71, no. 9, pp. 10335-10345, Sept. 2024, doi: 10.1109/TIE.2023.3335461.

10. E. Carfagna, G. Migliazza, M. Medici, E. Lorenzani, "Performance Comparison Between Microstepping and Field-Oriented Control for Hybrid Stepper Motors", in *Energies*, 2025, 18, 553, doi: 10.3390/en18030553.

11. E. Carfagna, C.M. Verrelli, G. Migliazza, F. Bernardi, E. Lorenzani, "Stator Flux Observers for Speed-Controlled PMSMs in Low-Speed Sensorless Applications: Comparative Tests and Hybrid Strategy", in *IEEE Transactions on Control Systems Technology*, vol. 33, no. 5, pp. 1905-1912, Sept. 2025, doi: 10.1109/TCST.2025.3536203.

12. D. Benatti, G. Migliazza, E. Carfagna, F. Immovilli and E. Lorenzani, "Improved SVM Pattern for Single-Stage CSI With Discharge Path in Electric Drives Applications", in *IEEE Transactions on Industrial Electronics*, vol. 72, no. 12, pp. 12276-12285, Dec. 2025, doi: 10.1109/TIE.2025.3569957.

13. D. Benatti, G. Migliazza, E. Carfagna, F. Immovilli and E. Lorenzani, "Critical Issues of Alignment Procedures for a Novel Single-Stage Current Source Inverter with Discharge Path", in *IEEE Access*, vol. 13, pp. 125796-125804, 2025, doi: 10.1109/ACCESS.2025.3588694.

14. E. Carfagna, G. Migliazza, G. Buticchi and E. Lorenzani, "Direct Voltage Measurement for Sensorless Control of Single-Stage Current Source Inverter in Motor Drive Applications", in *IET Power Electronics*, vol. 18, no. 1: e70152, 2025, doi: 10.1049/pel2.70152.

15. G. Migliazza, E. Carfagna, F. Immovilli and E. Lorenzani, "Four Quadrants Operations of Single-Stage CSI with Discharge Path in Motor Drives Applications", in *IEEE Transactions on Industrial Electronics*, doi: 10.1109/TIE.2026.3679792.

International conferences

16. R. Brugioni, E. Carfagna, E. Lorenzani, F. Immovilli, "Critical Aspects and Strategies for Sensorless Control of IPMSM based on Low-Frequency Voltage Injection", in *2019 IEEE 10th International Symposium on Sensorless Control for Electrical Drives (SLED)*, pp. 178-183, Turin, Italy, 2019, doi: 10.1109/SLED.2019.8896331.

17. G. Migliazza, E. Carfagna, F. Bernardi, E. Lorenzani, "Ground Leakage Current in Three-Phase Current Source Inverters Depending on Power Semiconductors Parasitic Capacitances", in *2020 IEEE Energy Conversion Congress and Exposition (ECCE)*, pp. 2125-2130, Detroit, MI, USA, 2020, doi: 10.1109/ECCE44975.2020.9235947.

18. E. Carfagna, G. Migliazza, F. Immovilli, C. M. Verrelli, E. Lorenzani, "PMSM-Model-Based Sensorless Control of Hybrid Stepper Motors: Performance and Robustness to Parameters Dispersion", in *IECON 2020 - 46th Annual Conference of the IEEE Industrial Electronics Society*, pp. 1063-1068, Singapore, 2020, doi: 10.1109/IECON43393.2020.9254711.

19. D. Benatti, C. Alosa, E. Carfagna, F. Immovilli, E. Lorenzani, "Assessment of Master-Slave and Droop Control Strategies in Multi-Three-Phase Drives", in *2021 IEEE Workshop on Electrical Machines Design, Control and Diagnosis (WEMDCD)*, pp. 163-168, Modena, Italy, 2021, doi: 10.1109/WEMDCD51469.2021.9425685.

20. E. Carfagna, E. Lorenzani, K. Debbadi, S. Pugliese, M. Liserre, "Iron Losses Impact on High-Speed Drives", in *2021 IEEE Energy Conversion Congress and Exposition (ECCE)*, pp. 5217-5224, Vancouver, BC, Canada, 2021, doi: 10.1109/ECCE47101.2021.9595750.

21. E. Carfagna, G. Migliazza, G. Buticchi, E. Lorenzani, Z. Xu, Z. Zou, H. Zhang, "PLL-Based Sensorless Control for Single-Stage Current Source Inverter in Motor Drive Application", in *IECON 2021 - 47th Annual Conference of the IEEE Industrial Electronics Society*, Toronto, ON, Canada, 2021, doi: 10.1109/IECON48115.2021.9589803.

22. G. Migliazza, E. Carfagna, G. Buticchi, F. Immovilli, E. Lorenzani, "Extended Speed Range Control for a Current Source Inverter Variable Speed Drive", in *IECON 2021 - 47th Annual Conference of the IEEE Industrial Electronics Society*, Toronto, ON, Canada, 2021, doi: 10.1109/IECON48115.2021.9589501.

23. E. Carfagna, G. Migliazza, F. Bernardi, E. Lorenzani, C. M. Verrelli, "Stator Flux Observer for the Sensorless Speed Control of Synchronous Machines with Uncertain Torque Constant", in *2022 IEEE Energy Conversion Congress and Exposition (ECCE)*, Detroit, MI, USA, 2022, doi: 10.1109/ECCE50734.2022.9948132.

24. Q. Peng, G. Buticchi, G. Migliazza, N. Tan, S. Guenter, E. Carfagna, G. L. Fidone, "Active Thermal Control for Lifetime Equalization in CSI7-based Modular Photovoltaic Integration System", in *8th IEEE Workshop on the Electronic Grid (eGrid)*, Karlsruhe, DE, 2023, doi: 10.1109/eGrid58358.2023.10380960.

25. G. L. Fidone, G. Migliazza, E. Carfagna, F. Immovilli, D. Benatti and E. Lorenzani, "Power Losses and THD Analysis of Current Source Inverters in Motor Drive Applications: A Comparative Study of Control Schemes", in *2024 International Conference on Electrical Machines (ICEM)*, Torino, Italy, 2024, pp. 1-7, doi: 10.1109/ICEM60801.2024.10700297.

26. G. L. Fidone, G. Migliazza, E. Carfagna, F. Immovilli and E. Lorenzani, "Resonance Damping for Single-Stage Current Source Inverters in Motor Drive Applications", in *IECON 2024 - 50th Annual Conference of the IEEE Industrial Electronics Society*, Chicago, IL, USA, 2024, pp. 1-6, doi: 10.1109/IECON55916.2024.10906042.

27. E. Carfagna, G. Migliazza and E. Lorenzani, "Improved Field Oriented Control for Switched Reluctance Machines With Large Step Response Capability", in *2025 IEEE Workshop on Electrical Machines Design, Control and Diagnosis (WEMDCD)*, La Valletta, Malta, 2025, pp. 1-6, doi: 10.1109/WEMDCD61816.2025.11014190.

28. D. Benatti, E. Carfagna, G. Migliazza and E. Lorenzani, "Study of the Equivalent Model of a Single-Stage Current Source Inverter with Discharge Path", in *14th International*

Conference on Power Electronics, Machines and Drives (PEMD Europe 2025), Turin, Italy, 2025, pp. 185-190, doi: 10.1049/icp.2025.2028.

29. D. Benatti, G. Migliazza, E. Carfagna, F. Immovilli and E. Lorenzani, "Design Considerations for Single-Stage Current Source Inverters with Discharge Path with Surface-Mounted PMSMs", in *IECON 2025 - 51th Annual Conference of the IEEE Industrial Electronics Society*, Madrid, Spain, 2025, pp. 1-6, doi: 10.1109/IECON58223.2025.11221025.

30. G. L. Fidone, E. Carfagna, G. Migliazza, F. Immovilli and E. Lorenzani, "Resonance Investigation for Single-Stage Current Source Inverters in Electric Drives Applications", in *IECON 2025 - 51th Annual Conference of the IEEE Industrial Electronics Society*, Madrid, Spain, 2025, pp. 1-6, doi: 10.1109/IECON58223.2025.11221058.

31. E. Carfagna, G. Migliazza, F. Immovilli and E. Lorenzani, "Position/Force Control with Direct Voltage Limitation for a Robotic Gripper with DC Motor", in *2025 IEEE 4th Industrial Electronics Society Annual On-Line Conference (ONCON)*, Kharagpur, India, 2025, pp. 1-6, doi: 10.1109/ONCON68412.2025.11384293.

7 Organization and participation in conferences and collaborations with journals

- He is a member of the organizing committee for the international conference IET PEMD Power Electronics, Machines and Drives Europe 2025, held in Turin, Italy from June 11 to 12, 2025.
- He was session chair of the following conferences:
  - oral session 4b1: "*Machine design efficiencies*", 10a: "*Additive manufacturing of ferromagnetic cores for electrical machines*" and 11a: "*Renewable Papers*" at IET PEMD 2025, Turin, Italy, 11-12 June 2025;
  - poster presentation 4b2: "*Machine and drives*" at IET PEMD 2025, Turin, Italy, 11-12 June 2025.
- Emilio Carfagna presented scientific papers in the following international conferences:
  - IEEE 10^{th} International Symposium on Sensorless Control for Electrical Drives (SLED), Turin, Italy from 09 to 10 September 2019, poster session for [16];
  - IECON 2020 - 46^{th} Annual Conference of the IEEE Industrial Electronics Society (IES), Singapore, Singapore from 18 to 21 October 2020, online session for [18];
  - ECCE 2021 - IEEE Energy Conversion Congress and Exposition (ECCE), Vancouver, British Columbia, Canada from 10 to 14 October 2021, online session for [20];

  - IECON 2021 - 47^{th} Annual Conference of the IEEE Industrial Electronics Society (IES), Toronto, Ontario, Canada from 13 to 16 October 2021, online session for [21];
  - ECCE 2022 - IEEE Energy Conversion Congress and Exposition (ECCE), Detroit, Michigan, USA from 09 to 13 October 2022, online session for [23];
  - WEMDCD 2025 - IEEE Workshop on Electrical Machine Design, Control and Diagnostics (WEMDCD), Valletta, Malta, from 9 to 10 April 2025, poster session for [27];
  - PEMD 2025 - Power Electronics, Machines and Drives | 14th Edition, Turin, Italy, from 11 to 12 June 2025, oral session for [28];
  - IECON 2025 - 51^{st} Annual Conference of the IEEE Industrial Electronics Society (IES), Madrid, Spain from 15 to 17 October 2025, poster sessions for [29, 30];
  - ONCON 2025 - IEEE Industrial Electronics Society Annual On-Line Conference (ONCON), India from 11 to 13 December 2025, online session for [31].
- He is a reviewer for several international journals: IEEE Transactions on Industrial Electronics, IEEE Transactions on Transportation Electrification, IEEE Transactions on Power Electronics, IEEE Transactions on Industry Applications, IEEE Transactions on Energy Conversion, IEEE Transactions on Control Systems Technology, IEEE Open Journal of Industrial Electronics Society, Control Engineering Practice, IET Power Electronics.
- He is also a reviewer for scientific papers presented at various international IEEE conferences organized by the Industry Applications Society (IAS) and the Industrial Electronics Society (IES).

Additional information

What declared in the curriculum vitae et studiorum corresponds to the truth according to art. 75 and 76 of the DPR 445/2000.

Date
Reggio Emilia, 22 June 2026