Alessandro Bosso

POSTDOC AT THE UNIVERSITY OF BOLOGNA

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Education

PhD in Biomedical, Electrical and System Engineering
Nov. 2016 - Mar. 2020

ALMA MATER STUDIORUM - UNIVERSITY OF BOLOGNA
Bologna, Italy

- **Curriculum**: Automatic Control and Operational Research
- **Supervisor**: Prof. Andrea Tilli
- **PhD thesis title**: "Advanced Computational-Effective Control and Observation Schemes for Constrained Nonlinear Systems"
- **Visiting Scholar at the Ohio State University** (Sept. 2018 - Dec. 2018)

Master Degree in Automation Engineering
Oct. 2014 - Oct. 2016

ALMA MATER STUDIORUM - UNIVERSITY OF BOLOGNA
Bologna, Italy

- **Mark average**: 29.77 out of 30
- **Final mark**: 110 out of 110 Cum Laude
- **Master thesis supervisor**: Prof. Andrea Tilli
- **Master thesis title**: "Osservatore e controllore sensorless ad elevate prestazioni per propulsione elettrica di Unmanned Aerial Vehicles"
- Design of an automatic machine in collaboration with a company, presented during the event: "Workshop sulle attività di formazione orientate alla Progettazione e Costruzione di Macchine Automatiche - VI edizione"

Bachelor Degree in Automation Engineering
Sept. 2011 - Oct. 2014

ALMA MATER STUDIORUM - UNIVERSITY OF BOLOGNA
Bologna, Italy

- **Mark average**: 30 out of 30
- **Final mark**: 110 out of 110 Cum Laude
- **Bachelor thesis supervisor**: Prof. Andrea Tilli
- **Bachelor thesis title**: "Analisi e compensazione dei dead-time negli inverter utilizzati in azionamenti elettrici"

High School Leaving Qualification in Scientific Studies
2006 - 2011

LICEO SCIENTIFICO LEONARDO DA VINCI
Casalecchio di Reno, Italy

- **Final mark**: 100 out of 100

Skills

Control Theory	Nonlinear Control, Adaptive Control, Constrained Control, Hybrid Dynamical Systems, Distributed Control
Technology	UAV Propulsion, Mechatronic Systems, Electric Machines, Power Converters, Inertial Navigation Systems
Programming	C, Matlab, JAVA, LaTeX, bash, experience in real-time embedded programming
Matlab/Simulink	Detailed experience with several toolboxes: SimScape and SimPowerSystems, Fixed-Point Toolbox, Matlab/Simulink/Embedded Coder, Aerospace Toolbox, Yalmip, Neural Networks Toolbox, MPC Toolbox
Languages	Italian, English

Research Interests

Adaptive Constrained Control of Nonlinear Systems

Constraints are one of the most widespread challenges that must be faced in control systems design. Indeed, actuator saturations and safety restrictions are common to any engineering domain, and performance degradation is usually avoided through conservative choices such as component oversizing. With the aim of enhancing performance and sustainability in several applications, this research topic focuses on computational-effective solutions for systems with uncertainties and fast dynamics, where imposing constraints is particularly challenging.

Robust Hybrid Control of Dynamical Systems on Manifolds

In several control problems, a significant challenge arises if the controlled system evolves on a nonlinear manifold. For instance, this issue concerns applications with phase quantities and rotations, where the non-Euclidean state-space represents a major obstacle to global stabilization. Only discontinuous feedback can recover global results in this context. However, it is well-known that stability with static discontinuous feedback is non-robust for a large class of uncertainties. Consequently, this research activity focuses on the design of dynamic hybrid mechanisms (with hysteresis, clocks, and state machines), ensuring global and robust stabilization through rigorous Lyapunov-based arguments.

Distributed Adaptive Control of Heterogeneous Networks

The interest of this research activity is to enhance the application of distributed control strategies to networks of heterogeneous agents, which often occur in large-scale or human-related applications. In this context, adaptive systems theory is employed as a rigorous tool to recover homogeneous behaviors, only relying on local information for control design.

Sensorless Control of Electric Machines

This research activity involves developing advanced controllers and observers for electric machines without position/speed sensors. Such solutions are very convenient for robustness, cost, and space reasons. In this respect, a primary effort concerns applying adaptive and hybrid techniques and group theory to achieve robust global results. This way, it is possible to reduce the mechanical information to a minimum. The developed methods are rigorously treated with control theory tools and validated in experimental tests.

Active Collaborations

Andrea Serrani
PROFESSOR AT THE OHIO STATE UNIVERSITY   *Columbus, OH, USA*
- Research activities on adaptive control of nonlinear systems subject to input and state constraints

Luca Zaccarian
DIRECTEUR DE RECHERCHE AT THE LAAS-CNRS   *Toulouse, France*
PROFESSOR AT THE UNIVERSITY OF TRENTO   *Trento, Italy*
- Development of hybrid control techniques for robust global stabilization of nonlinear systems

Simone Baldi
PROFESSOR AT THE SOUTHEAST UNIVERSITY   *Nanjing, China*
- Collaboration on adaptive tracking of distributed nonlinear systems

Research Projects

ACMEC   "Additive manufacturing e tecnologie Cyber-physical per la MECcatronica del futuro" - Coordinator: Prof. Andrea Tilli
POSITION: CONTROL SYSTEMS RESEARCHER

This project pertains to developing a novel mechatronics design approach, and it is supported by the European Regional Development Fund (POR-FESR Emilia Romagna 2014/2020). On the one hand, the aim is to bolster the introduction of additive manufacturing in actuator and mechanism design, optimizing efficiency and reducing materials, thus increasing the applications' sustainability. On the other hand, novel cyber-physical technologies are exploited to achieve high-performance control of the developed structures. My involvement in the project is related to the following areas:
- advanced control of a four-bar linkage mechanism via nonlinear adaptive and constrained techniques;
- identification and regulation of an experimental synchronous reluctance machine, obtained through additive manufacturing.

Publications

Journals

- **Alessandro Bosso**, Christian Conficoni, Davide Raggini, and Andrea Tilli. "A Computational-Effective Field-Oriented Control Strategy for Accurate and Efficient Electric Propulsion of Unmanned Aerial Vehicles." IEEE/ASME Transactions on Mechatronics.

- Andrea Tilli, **Alessandro Bosso**, and Christian Conficoni. "Towards sensorless observers for sinusoidal electric machines with variable speed and no mechanical model: A promising approach for PMSMs." Systems & Control Letters 123 (2019): 16-23.

Conferences

- **Alessandro Bosso**, Ilario A. Azzollini, Simone Baldi, and Luca Zaccarian. "A Hybrid Distributed Strategy for Robust Global Phase Synchronization of Second-Order Kuramoto Oscillators." Submitted to the IEEE 60th Conference on Decision and Control (CDC), 2021.

- Andrea Tilli, Elena Ruggiano, **Alessandro Bosso**, and Alessandro Samorì. "Low Energy Accurate Periodic Motion of an Underactuated Mechanism: Mass Distribution and Nonlinear Spring Shaping ." Submitted to the IEEE/ASME International Conference on Advanced Intelligent Mechatronics, 2021.

- Andrea Tilli, **Alessandro Bosso**, Elena Ruggiano, and Alessandro Samorì. "Periodic Motion Optimization for an Underactuated Mechanical System through Synergistic Structure-Control Design." Accepted for presentation at the 29th Mediterranean Conference on Control and Automation (MED), 2021.

- **Alessandro Bosso**, Ilario A. Azzollini and Andrea Tilli. "A semi-global hybrid sensorless observer for permanent magnets synchronous machines with unknown mechanical model." 21st IFAC World Congress, 2020.

- Andrea Tilli, Elena Ruggiano, Christian Conficoni, and **Alessandro Bosso**. "A Hybrid Adaptation Strategy for Repetitive Control of an Uncertain-Delay Lagrangian System." 21st IFAC World Congress, 2020.

- **Alessandro Bosso**, Andrea Tilli, and Christian Conficoni. "A robust sensorless controller-observer strategy for PMSMs with unknown resistance and mechanical model." 21st IFAC World Congress, 2020.

- **Alessandro Bosso**, Andrea Serrani, Christian Conficoni, and Andrea Tilli. "Constrained-Inversion MRAC: An Approach Combining Hard Constraints and Adaptation in Uncertain Nonlinear Systems." IEEE 58th Conference on Decision and Control (CDC), 2019.

- **Alessandro Bosso**, Ilario A. Azzollini, and Simone Baldi. "Global Frequency Synchronization over Networks of Uncertain Second-Order Kuramoto Oscillators via Distributed Adaptive Tracking." IEEE 58th Conference on Decision and Control (CDC), 2019.

- **Alessandro Bosso**, Nicola Mimmo, Christian Conficoni, and Andrea Tilli. "Global Observability Analysis of Aided-INS for UAVs Equipped with Visual Odometry Systems." 2018 European Control Conference (ECC). IEEE, 2018.

- Matteo Barbieri, **Alessandro Bosso**, Christian Conficoni, Roberto Diversi, Matteo Sartini, and Andrea Tilli. "An Onboard Model-of-signals Approach for Condition Monitoring in Automatic Machines." Enterprise Interoperability: Smart Services and Business Impact of Enterprise Interoperability (2018): 263-269.

- Andrea Tilli, Christian Conficoni, and **Alessandro Bosso**. "A UGAS Sensorless Observer for Permanent Magnets Synchronous Machines including Estimation and Compensation of Dead-Times Effects." IFAC-PapersOnLine 50.1 (2017): 1891-1897.

- Andrea Tilli, **Alessandro Bosso**, Christian Conficoni, and Ahmad Hashemi. "Integrated Control of Motion and Contactless Power Transfer for Doubly-Fed Induction Machines in Complex Rotary Apparatuses." IFAC-PapersOnLine 50.1 (2017): 13129-13135.

- **Alessandro Bosso**, Christian Conficoni, and Andrea Tilli. "Multirotor UAV flight endurance and control: the drive perspective." IECON 2016-42nd Annual Conference of the IEEE Industrial Electronics Society. IEEE, 2016.

Honors & Awards

2013	**Winner of the "Award of Merit" for the academic year 2012/2013**, University of Bologna	*Bologna, Italy*

Schools and Courses

2018	**SIDRA Summer School**, held by the Italian automatic control research community (SIDRA)	*Bertinoro, Italy*
2018	**EECI course: Computational issues in non-linear control and estimation**, held by Arthur Krener	*Padova, Italy*
2017	**7th oCPS PhD School on Cyber-Physical Systems**, held by IMT Lucca	*Lucca, Italy*
2017	**SIDRA Summer School**, held by the Italian automatic control research community (SIDRA)	*Bertinoro, Italy*
2017	**EECI course: Local methods for non-linear systems and control**, held by Rodolphe Sepulchre and Fulvio Forni	*Padova, Italy*
2016	**SIDRA Summer School**, held by the Italian automatic control research community (SIDRA)	*Bertinoro, Italy*
2015	**Machine Learning Crash Course**, held by the University of Genova	*Genova, Italy*

Professional Affiliations

IEEE Membership *2019-2021 (ongoing)*

Member of the IEEE Control Systems Society and the CSS Technical Committee on Hybrid Systems

Other Interests & Activities

Activity as a Reviewer

- **Journals**: Automatica; IEEE Transactions on Automatic Control (TAC); Systems and Control Letters; Control Systems Letters; European Journal of Control; IEEE/ASME Transactions on Mechatronics.
- **Conferences**: Confence on Decision and Control (CDC); IFAC World Congress; American Control Conference.

Activity as an Examiner

- **Expert Member in Automation Engineering** for the Italian professional practice examination "Esame di Stato".

Extracurricular Activities

- Former professional artistic wheel skater: attendance, for many years, to international competitions as a member of the Italian national team. Participation, in particular, to four European Championships.