



UNIVERSITÀ
POLITECNICA
DELLE MARCHE

**ARTLearn - Adaptation and Real-Time
LEARNing of modern robotic systems in
“VUCA” scenario**

Supervisor: Prof. Andrea Bonci

Department of Information Engineering

<https://dii.univpm.it/>



UNIVERSITÀ
POLITECNICA
DELLE MARCHE

Supervisor: Prof. Andrea Bonci

Research Group Description: the Supervisor

Prof. Andrea Bonci, PhD, MS, IEng.

Associate Professor in Control and Automation Engineering, DII,
UNIVPM Head of Automation Laboratory, a facility based in the
Faculty of Engineering, Marche Polytechnic University, Ancona.

Guest Professor at Rzeszow University of Technology, Poland.
Plenary Speaker at “30th International Baltic conference on Materials
Engineering and Modern Manufacturing 2023 (MEMM2023)
Works as Expert for EU to evaluate MSCA and EU project proposals

More than 100 peer-reviewed research articles
ORCID-id: <https://orcid.org/0000-0003-0265-1598>
([Publication List](#), H-index 19 according to Google Scholar; H-index
16 according to Scopus). More than 20 years of experience in
control engineering, robotics, optimization, nonlinear control,
autonomous vehicles and systems, AI and ML, vehicles dynamics,
industrial automation, robotic disassembly, embedded systems,
cyber-physical-systems, diagnosis and maintenance.

Author of four Patents on industrial control applications
Awarded project 1st prize: Edge4PdM-Edge computing for Predictive
Maintenance and diagnosis of machine driven by an electric motor

Involved in several international and national projects.

- European fundings:

- 2023-2026: **EDIH4Marche** “European Digital Innovation Hub for Marche”, Horizon Europe Digital G.A. 101084027. It supports companies through digital innovation in the context of Industry 4.0 and in implementing company's digital strategy.
- 2019-2022: **ENCORE** “ENergy aware BIM cloud Platform in a Cost-effective Building RENovation Context”, H2020 G.A. 820434. increase the share of renovated stock in Europe and worldwide by providing effective and affordable BIM tools that cover the whole renovation life-cycle (from data collection to project execution, and commissioning/delivery).

- National fundings:

- 2024-2025: Proof of Concept VALUE (VALUing the outcomes of the UnivErsity research) “**Edge4PdM** - Edge computing for Predictive Maintenance and diagnosis of machine driven by an electric motor”
- 2023-2026: “**CIRCULAR FASHION**-robotic disassembly for circular fashion and digital solutions for eco-design of apparel and fashion products” funded by INVITALIA and Italian Ministry of Economic Development (MISE).
- 2023-2026: “**Perseo** - enhancement of the GUCCI Logistic S.p.A. and PIGINI S.r.l. production capacity of footwear articles, through technological development of new production methods and machinery” funded by Italian Ministry of Industry and Made in Italy (MIMIT).
- 2020-2024: “**Electrospindle 4.0** Zero Defect Manufacturing” funded by Italian Ministry of Economic Development (MISE).
- 2019-2022: “**ARTES 4.0**-Advanced Robotics and enabling digital TEchnologies & Systems 4.0” National Competence Center on Industry 4.0, funded by Italian Ministry of Economic Development (MISE).



UNIVERSITÀ
POLITECNICA
DELLE MARCHE

Supervisor: Prof. Andrea Bonci

Research Group Description: Automation Lab Research Group



Automation Laboratory

https://dii.univpm.it/en-gb/aut_en/

STAFF: The group is currently composed by an **Assistant Professor**, a **Full Professor**, a **Researcher**, a **research fellows**, three **PhD students** and two **master students**.

RESEARCH ACTIVITY

The Automation Lab facility is devoted to research & development and technology transfer activities, the main research topics of Automation Lab are: Embedded systems, Robotics and AI solutions, Control systems engineering and applications, Cyber-Physical-Systems, Autonomous Driving vehicles, mobility and transportation, Diagnosis and predictive maintenance of machinery, Factory automation, Smart manufacturing, Industry 4.0 and 5.0, Factory production monitoring and optimization, Industrial energy monitoring, technological packaging solutions, control system design, autonomous systems .



RESEARCH AND PUBLICATIONS

<https://orcid.org/0000-0003-0265-1598>

<https://orcid.org/0000-0002-1997-8098>



EQUIPMENT

Industrial Collaborative Robot Omron TM5, Industrial Mobile robot MIR 200 equipped with Collaborative Robot UR5, Robot gripping tool set, 1/10 scale vehicles equipped with autonomous driving systems, Autonomous e-bike, Drones and UAVs, CP-Factory real scale production line, Industrial weighing and vibratory machines, Test bench for diagnosis and testing of electric motors, Lab instrumentation as Oscilloscopes, Power supplies, Signal generators,.





UNIVERSITÀ
POLITECNICA
DELLE MARCHE

Dean: Prof. Franco Chiaraluce

Department description

<https://dii.univpm.it/en-gb/home/>

The **Department of Information Engineering (DII)** was established in 2011 following the merge of the previous DIBET (Department of Biomedical, Electronics and Telecommunication engineering) and DIIGA (Department of Computer, Management and Automation engineering).

The Department is a self-managing organizational branch of the university dedicated to scientific research and teaching, and contributes to the so called Third Mission of the Higher Education Institution through the dissemination of scientific research findings amongst the community.

Its main aims are to plan, organize and regularly assess the quality of the research activities carried out in the scientific sectors and disciplines under its jurisdiction; to plan, organize and manage bachelor and master courses in Information Engineering and, last but not least, to provide cultural and educational activities and contribute to training and guidance issues according to the students' needs.

AT A GLANCE



2024



250+
Publications



71
Research staff



BACHELOR DEGREES:

Biomedical Engineering, Electronic Engineering and Digital Technologies, Computer and Automation Engineering, Information Engineering for Videogame and Virtual Reality.

MASTER DEGREES:

Biomedical Engineering (in English), Electronic Engineering, Computer and Automation Engineering.

BACHELOR DEGREE WITH PROFESSIONAL ORIENTATION: Industrial and Information Systems.

> 4 M€
Research income



112 PhD, Post-doc,
Research fellows

DII coordinates the PhD in Information Engineering, organized in two curricula:
- Biomedical, Electronics, Telecommunication Engineering and Nanotechnologies (IBETN)
- Computer, Management and Automation Engineering (IIGA)



Research laboratories 32

11 Scientific Areas:

IINF-01/A, IINF-02/A, IINF-03/A, IINF-04/A, IINF-05/A, IBIO-01/A,
IMIS-01/B, IIET-01/A, IEGE-01/A, MATH-06/A, ECON-04/A



UNIVERSITÀ
POLITECNICA
DELLE MARCHE

Supervisor: Prof. Andrea Bonci

**Project Idea: ARTLearn - ADAPTATION AND REAL-TIME
LEARNING OF MODERN ROBOTIC SYSTEMS IN “VUCA”
SCENARIO**

Background:

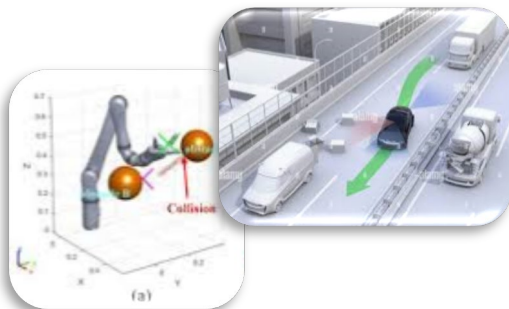
Adaptation and real-time learning pose crucial challenges for modern robotics, especially when robots (fixed or mobile) operate in dynamic and unstructured environments, such as volatile, uncertain, complex, and ambiguous (VUCA) scenarios. These aspects are even more relevant in tasks involving interaction with flexible (nonrigid) objects, as the object itself can generate unpredictable situations.

The synergy between nonlinear control, learning, and hierarchical control techniques can lead to solutions that contemplate control determinism, experiential learning from the environment, and increased autonomy. Nonlinear optimal control methods can enable the use of adaptive objective functions, dependent on the state of the system with respect to the environment, and to react in a controlled manner to changing situations. Reinforcement-learning (RL) artificial intelligence (AI) techniques enable adaptation to unexpected situations, allowing optimal strategies to be learned through direct experience with the environment. In addition, the synthesis of a hierarchical controller (including bio-inspired type) would improve autonomy performance in the long run, facilitating decision-making and task allocation as general situations change, while considering safety constraints.

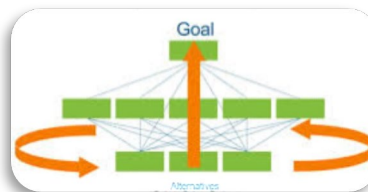
Project OBJECTIVES:

- - To evaluate specific objective functions for nonlinear optimal control strategies of robotic system.
- - To investigate the use of Reinforcement learning strategies in realistic simulated environment involving interaction with flexible (nonrigid) objects.
- - To evaluate and synthesize a hierarchical controller architecture for the robotic system.
- - To test the developed solution in real-world scenario involving a real robotic system

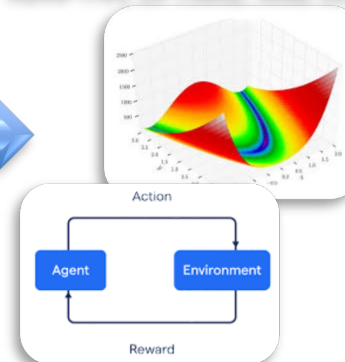
VUCA SCENARIO



HIERARCHICAL DECISION MAKING



ADAPTIVE OPTIMIZ. AND LEARNING



REALTIME ADAPTION

