National Ph.D. Program in Autonomous Systems

http://dausy.poliba.it

Prof. Engr. Mariagrazia DOTOLI (mariagrazia.dotoli@poliba.it)

Full Professor in Automation
Department of Electrical and Information Engineering – Politecnico di Bari

Coordinator of the National Ph.D. Program in Autonomous Systems
July 11, 2022 from 12:00 (CEST)

12:00 - 12:15
Introduction to the National Ph.D. program in Autonomous System

12:15 - 12:30
Advantages and benefits of joining the program

12:30 - 13:00
Presentations by companies and research groups involved in the program

13:00 - 13:30
Admissions procedure

13:30 - 14:00
Questions and conclusion

How to ask a question during the event

1. Using the chat available in the “Question & Answer” section. You need to log in with your MS Teams account as logging in anonymously will not allow you to use the chat.

2. By sending an email to paolo.scarabaggio@poliba.it
Introduction to the National Ph.D. program in Autonomous System

More information: http://dausy.poliba.it/
Autonomous Systems

- Ongoing developments in Automation, Control Systems, Data Science, and Artificial Intelligence are expected to heavily influence the role of engineering in our society.

- One of the enabling technologies of the digital transition is **Autonomous Systems (AS)**, which are systems capable of automatically achieving a given goal without the intervention of a human operator.

- AS are capable of learning and independently performing decision-making tasks.

- AS are becoming the leading drive of technologies such as industry 4.0, autonomous vehicles, drones, smart grids, precision agriculture.
The DAUSY National Ph.D. Program

- The **Doctoral program (Ph.D.) in AUtonomous SYstems (DAUSY)** [http://dausy.poliba.it/](http://dausy.poliba.it/) is a newly funded national program aiming at providing high-profile skills, as well as rigorous research training, to prepare PhD students and become versatile professionals and knowledgeable researchers while cooperating in a nation-wide network with international visibility.

- The major focus will be on Automation Engineering, together with its connections to Theoretical and Applied Mechanics, Optimization, Communication Systems, Information Theory, Machine Learning, Computing, Mathematics, and Signal Processing.

- DAUSY will establish a **doctoral school with critical mass and quality** to systematize the expertise on Autonomous Systems (AS) distributed in the country and involve **students from Italy and worldwide**.
General information on DAUSY

The National Ph.D. Program in Autonomous Systems DAUSY

- Politecnico di Bari (Poliba) - administrative headquarters
- 25 participating institutions (24 universities and a national research center)
- 13 partner universities
- 46 Italian and 22 foreign professors and researchers

Program overview

Degree awarded:
Ph.D. in Autonomous Systems

Language:
English

Program length:
Three years full-time (in presence)

Location:
24 universities, 1 research center

Starting date:
November 1, 2022

Funding:
35 fully paid scholarships
Benefits

- A meaningful job in a dynamic and ambitious Ph.D. program with the possibility to present your work at international conferences.

- Enrolment at one of the prestigious 24 universities and 1 research centre in Italy, with the possibility to spend several months at national industrial companies and/or international research centres or universities.

- Full-time employment for 3 years.

- A gross monthly salary and benefits (such as pension contributions, maternity leave, and unemployment benefits).
Scholarship amounts for 2022/25

Scholarships for the 2022/25 triennium are determined as follows:

- **Net scholarship for research periods in Italy**
  about **1200 €/month**

- **Net scholarship for research periods abroad**
  about **1800 €/month**

- **Research budget 20% (total in the 3 years)**
  about **12000€**

- **Almost tax-free**
  **120-160 €/year**

* The research budget can be used for registrations for on-site and online conferences; photocopies; posters; textbooks; computers and related equipment; expenses for publishing publications and language course

** Taxes are calculated based on the Italian ISEE (Equivalent Financial Situation Index).
Main research directions of DAUSY

- **Design and develop AS**, with applications to smart manufacturing, autonomous vehicles, smart grids, robotics, and many more engineering fields.

- **Develop smart control algorithms** (e.g., AI-enabled control, data-driven control, vision-based control) for smart AS environments such as smart cities, autonomous vehicles and mobile robots, smart grids, sustainable mobility systems, smart buildings, and smart homes.

- **Develop testing platforms** for emerging techniques to advance engineering AS applications (e.g., cyber-physical systems, digital twin techniques).

- **Design automated and high-performance industrial systems**, studying issues related to distributed control and supervision for systems composed of networks of sensors, actuators, and collaborative robots.

- Design and operation of **AS to guarantee their reliability and security**, ensuring their proper functioning even under uncertainty (robustness), monitoring and predicting failures, ensuring that confidentiality and privacy requirements are not violated, countering both physical and cyberattacks, and designing secure processes in environments where automated and human systems interact.
Course schedule

The course lasts 3 years-180 ECTS, including any period of study and research abroad and internships in public/private institutions

General planning of activities:

Selection of candidates

Start of activities

Courses, Seminars, Summer School

Ph.D. thesis
Research activities

Experience abroad

Experience in company / P.A. / research centre

Evaluation of the first year

Evaluation of the second year

Evaluation for admission to the final exam

Final exam

NOTE: MINIMUM REQUIREMENT FOR ADMISSION TO FINAL EXAM: The Ph.D. student is co-author of 1 (3) scientific articles in an international journal (in proceedings of international conferences) indexed in Scopus or ISI/Web of Science databases.
Activities carried out by the Ph.D. student

- The Ph.D. student is required to carry out activities for an amount of 60 ECTS per year, for a total of 180 ECTS throughout the academic course.
- The Ph.D. student and the tutor set the training activities and submit it to the prior approval of the Academic Board.
- At the beginning of the first year, the Academic Board requires a detailed plan of activities (provisional plan) that the Ph.D. student intends to carry out in the three years.
Activities carried out by the Ph.D. student

The activities carried out by the Ph.D. student are divided into:

- Didactic activities: min 36 – max 60 ECTS (of the total 180 ECTS)
  - **Courses**
    - Attendance of institutional university courses in order to integrate basic knowledge;
    - Attendance of third level courses to acquire specific knowledge;
    - Ph.D. school courses;
    - Improvement of the knowledge of foreign languages;
    - Soft skills.
  - **Participation at conferences, seminars, etc.**
    - Participation at seminars, national and international conferences on topics of interest;
    - Contribution (poster, proceedings …) to international congresses/workshops.

- Research activity: min 120 – max 144 ECTS (of the 180 total ECTS)
  - **Activities with the supervision of the tutor**
    - Training activities with the tutor.
  - **Laboratory activities**
    - Laboratory activities to acquire operative skills.
  - **Research and individual study activities**
    - Research and individual study activities on topics of interest.
  - **Research activities abroad**
    - Any possible internships abroad, as internships at companies, universities and institutions, to acquire specific technical skills.

OUTCOME OF THE PHD PROGRAM: The Ph.D. student is expected, at the end of the triennium, to be a co-author of 1 (3) scientific articles in an international journal (in proceedings of international conferences) indexed in Scopus or ISI/Web of Science databases.
Curricula

The Ph.D. is structured in 3 curricula that specifically address different topics and application areas and differ and complement each other in technological and methodological terms.

C1 - AS for Automation
- Industry 4.0
- Collaborative robotics
- Automation in manufacturing
- Sensor-actuator networks
- Simulation and optimization
- Supervisory control
- Sustainability and green automation

C2 - AS for Smart Environments
- Autonomous vehicles
- Cyberphysical system
- Consensus
- Distributed optimization
- Formation control
- Mobile robotics
- Networked control
- Smart cities
- Smart grids

C3 - AS for Monitoring and Security
- Cyberattacks
- Fault diagnosis
- Fault prognosis
- Brain-computer interaction
- Human-robot interaction
- Safety of processes
- Opacity
The 3 curricula have as a common research base the cross-cutting methodologies and approaches that are foundational to systems engineering, such as modelling and control methodologies.
Coordinator
Prof. Mariagrazia Dotoli, Politecnico di Bari
mariagrazia.dotoli@poliba.it

- Full Professor in Automatic Control at Politecnico di Bari
- Senior Editor of the IEEE TRANS. ON AUTOMATION SCIENCE AND ENGINEERING
- Associate Editor of the IEEE TRANS. ON SYSTEMS, MAN, AND CYBERNETICS.
- General chair of the 2024 IEEE Conference on Automation Science and Engineering (CASE)
- General chair of 2021 29th Mediterranean Conference on Control and Automation
- Member of the International Program Committee of 80+ international conferences.
- Author of 270+ publications, h-index 34 in Scopus
- Expert evaluator of the European Commission since the 6th Framework Programme
# Academic Board

[http://dausy.poliba.it/phd/people/](http://dausy.poliba.it/phd/people/)

## C1 – AS for Automation

**Curriculum Representative:**
Prof. CAVALLO Alberto, Università degli Studi della Campania Luigi Vanvitelli

[alberto.cavallo@unicampania.it](mailto:alberto.cavallo@unicampania.it)

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
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<tbody>
<tr>
<td>ABENI Luca</td>
<td>Scuola Superiore Sant'Anna</td>
</tr>
<tr>
<td>ARIOLA Marco</td>
<td>Università degli Studi di Napoli Parthenope</td>
</tr>
<tr>
<td>BASILE Francesco</td>
<td>Università degli Studi di Salerno</td>
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<tr>
<td>CARLI Raffaele</td>
<td>Politecnico di Bari</td>
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<tr>
<td>COLANERI Patrizio</td>
<td>Politecnico di Milano</td>
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<tr>
<td>CONSOLINI Luca</td>
<td>Università degli Studi di Parma</td>
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<tr>
<td>DABBENE Fabrizio</td>
<td>Consiglio Nazionale delle Ricerche</td>
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<tr>
<td>DELLI PRISCOLI Francesco</td>
<td>Università degli Studi di Roma &quot;La Sapienza&quot;</td>
</tr>
<tr>
<td>D’IPPOLITO Filippo</td>
<td>Università degli Studi di Palermo</td>
</tr>
<tr>
<td>GALEANI Sergio</td>
<td>Università degli Studi di Roma &quot;Tor Vergata&quot;</td>
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<tr>
<td>GIUA Alessandro</td>
<td>Università degli Studi di Cagliari</td>
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<tr>
<td>LONGHI Sauro</td>
<td>Università Politecnica delle Marche</td>
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<td>MANCINI Adriano</td>
<td>Università Politecnica delle Marche</td>
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<tr>
<td>MOCENNI Chiara</td>
<td>Università degli Studi di Siena</td>
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<tr>
<td>NOTARSTEFANO Giuseppe</td>
<td>Alma Mater Studiorum - Università di Bologna</td>
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<tr>
<td>PINAMONTI Andrea</td>
<td>Università degli Studi di Trento</td>
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<tr>
<td>VISIOLI Antonio</td>
<td>Università degli Studi di Brescia</td>
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<td>ZACCARIAN Luca</td>
<td>Università degli Studi di Trento</td>
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C2 – AS for Smart Environments
Curriculum Representative:
Prof. GIARRÈ Laura, Università di Modena e Reggio Emilia
laura.giarre@unimore.it

Name | Affiliation
--- | ---
BEMPORAD Alberto | Scuola IMT Alti Studi Lucca
CALAFIORE Giuseppe Carlo | Politecnico di Torino
CASAVOLA Alessandro | Università della Calabria
DE LELLIS Pietro | Università degli Studi di Napoli Federico II
DOTOLI Mariagrazia | Politecnico di Bari
FALCONE Paolo | Università di Modena e Reggio Emilia
FERRARA Antonella | Università degli Studi di Pavia
FRASCA Mattia | Università degli Studi di Catania
PARLANGELI Gianfranco | Università del Salento
SACONE Simona | Università degli Studi di Genova
SCHENATO Luca | Università degli Studi di Padova
VALIGI Paolo | Università degli Studi di Perugia
VASCA Francesco | Università degli Studi del Sannio
C3 – AS for Monitoring and Security

Curriculum Representative:
Prof. PASCUCCI Federica, Università degli Studi Roma Tre
federica.pascucci@uniroma3.it

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<tr>
<th>Name</th>
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<tr>
<td>BEVILACQUA Vitoantonio</td>
<td>Politecnico di Bari</td>
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<tr>
<td>CHISCI Luigi</td>
<td>Università degli Studi di Firenze</td>
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<td>DI BENEDETTO Maria Domenica</td>
<td>Università degli Studi dell'Aquila</td>
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<td>FIORINI Paolo</td>
<td>Università degli studi di Verona</td>
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<td>FREDDI Alessandro</td>
<td>Università Politecnica delle Marche</td>
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<td>PALUMBO Pasquale</td>
<td>Università degli Studi di Milano Bicocca</td>
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<td>PARISINI Thomas</td>
<td>Università degli Studi di Trieste</td>
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<td>PIRO Giuseppe</td>
<td>Politecnico di Bari</td>
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<td>POLLINI Lorenzo</td>
<td>Università di Pisa</td>
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<td>SACILE Roberto</td>
<td>Università degli Studi di Genova</td>
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<td>SIMANI Silvio</td>
<td>Università Degli Studi Di Ferrara</td>
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<tr>
<td>VON ELLENRIEDER Karl Dietrich</td>
<td>Libera Università di Bolzano</td>
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The Ph.D. has an international scope, cooperating with numerous European and non-European universities

Foreign members of the board:

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
<th>Curricula</th>
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<tr>
<td>ASTOLFI Daniele</td>
<td>UNIVERSITÉ CLAUDE BERNARD LYON 1</td>
<td>C3. AS FOR MONITORING AND SECURITY</td>
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<tr>
<td>BAMIEH Bassam</td>
<td>UNIVERSITY OF CALIFORNIA SANTA BARBARA</td>
<td>C2. AS FOR SMART ENVIRONMENTS</td>
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<tr>
<td>BAUSO Dario</td>
<td>UNIVERSITY OF GRONINGEN</td>
<td>C1. AS FOR AUTOMATION</td>
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<td>BULLO Francesco</td>
<td>UNIVERSITY OF CALIFORNIA SANTA BARBARA</td>
<td>C2. AS FOR SMART ENVIRONMENTS</td>
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<td>DAHLEH Munther</td>
<td>MASSACHUSSETS INSTITUTE OF TECHNOLOGY</td>
<td>C1. AS FOR AUTOMATION</td>
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<tr>
<td>DESCHUTTER Bart</td>
<td>DELFT UNIVERSITY OF TECHNOLOGY</td>
<td>C2. AS FOR SMART ENVIRONMENTS</td>
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<tr>
<td>DELLE MONACHE Maria Laura</td>
<td>UNIVERSITY OF CALIFORNIA BERKELEY</td>
<td>C2. AS FOR SMART ENVIRONMENTS</td>
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<td>DEY Subhrakanti</td>
<td>UPPSALA UNIVERSITY</td>
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<td>FRANCHI Antonio</td>
<td>UNIVERSITY OF TWENTE</td>
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<td>GRAMMATICO Sergio</td>
<td>DELFT UNIVERSITY OF TECHNOLOGY</td>
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<td>JOHANSSON Karl H.</td>
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<td>McLOONE Sean</td>
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<td>MORBIDI Fabio</td>
<td>UNIVERSITY OF PICARDIE JULES VERNE</td>
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<td>PAPPAS George J.</td>
<td>UNIVERSITY OF PENNSYLVANIA</td>
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<td>PORFIRI Maurizio</td>
<td>NYU TANDON SCHOOL OF ENGINEERING</td>
<td>C2. AS FOR SMART ENVIRONMENTS</td>
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<td>QUEINNEC Isabelle</td>
<td>UNIVERSITÉ FÉDÉRALE TOULOUSE MIDI-PYRÉNÉES,</td>
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<tr>
<td>SASTRY Shankar</td>
<td>UNIVERSITY OF CALIFORNIA BERKELEY</td>
<td>C3. AS FOR MONITORING AND SECURITY</td>
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<td>SERRANI Andrea</td>
<td>OHIO STATE UNIVERSITY</td>
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<td>SHORTEN Robert N.</td>
<td>IMPERIAL COLLEGE LONDON</td>
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<td>STEFANOPOULOU Anna G.</td>
<td>UNIVERSITY OF MICHIGAN, ANN ARBOR</td>
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<td>TARBOURIECH Sophie</td>
<td>UNIVERSITÉ FÉDÉRALE TOULOUSE MIDI-PYRÉNÉES,</td>
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<td>VALAVANIS Kimon P.</td>
<td>UNIVERSITY OF DENVER</td>
<td>C1. AS FOR AUTOMATION</td>
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Network of collaborations

Companies and research centres that are co-financing or hosting Ph.D. scholarships

- **Public administrations**
  - ARST – Trasporti Regionali della Sardegna S.p.A.
  - ENEA - Smart Cities and Communities Laboratory
  - IEIIT-CNR, Torino

- **Companies**
  - BluHub
  - Circle S.p.A.
  - CNH INDUSTRIAL ITALIA S.p.A.
  - GlaxoSmithKline S.p.A.
  - ICAM S.r.l.
  - Iveco Defense Vehicles
  - Mafin S.r.l.
  - SCHNELL S.p.A.
  - STAM S.r.l.
  - Thales Alenia Space Italia S.p.A.
The course catalogue of the DAUSY Ph.D. program includes courses offered in international, national, and local doctoral schools, offering a unique educational network. [http://dausy.poliba.it/phd/teaching-course-catalogue/](http://dausy.poliba.it/phd/teaching-course-catalogue/)

**Ph.D. students must carry out didact activities of 36-60 ECTS credit points (out of the total 180 ECTS necessary to complete the PhD) among:**

- International Graduate School in Control
- SIDRA Doctoral School
- Local Courses
- Seminars
- Workshops
- Ph.D. Research Seminars

Courses will be organized centrally and in presence (International Graduate School in Control, SIDRA Doctoral School, local courses) or in a hybrid mode (Seminars Workshops, Research Seminars) in order to

- allow students to choose freely the best learning mode
- let students to belong to a nation-wide and international network of contacts in AS
Available scholarships

More information: http://dausy.poliba.it/phd/application/
<table>
<thead>
<tr>
<th>Research theme title</th>
<th>Hosting institution</th>
<th>Contact</th>
<th>Research period abroad</th>
<th>Research period at research center / company / P.A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Advanced learning and control methods with life science applications</td>
<td>Consiglio Nazionale delle Ricerche</td>
<td>Alessandro Borri (<a href="mailto:alessandro.borri@iasi.cnr.it">alessandro.borri@iasi.cnr.it</a>) Fabrizio Dabbene (<a href="mailto:fabrizio.dabbene@ieiit.cnr.it">fabrizio.dabbene@ieiit.cnr.it</a>)</td>
<td>(optional)</td>
<td>(optional)</td>
</tr>
<tr>
<td>4. Performance-aware and resilient supervisory control of cyber-physical and industrial automation systems</td>
<td>Università di Salerno</td>
<td>Prof. Francesco Basile (<a href="mailto:fbasile@unisa.it">fbasile@unisa.it</a>)</td>
<td>(to be defined)</td>
<td>(optional)</td>
</tr>
<tr>
<td>13. Supervision and control techniques for energy management in the More Electric Aircraft</td>
<td>Università della Campania “Luigi Vanvitelli”</td>
<td>Prof. Alberto Cavallo (<a href="mailto:alberto.cavallo@unicampania.it">alberto.cavallo@unicampania.it</a>)</td>
<td>Institute for Aerospace Technology, University of Nottingham, UK</td>
<td>(optional)</td>
</tr>
<tr>
<td>19. Sensor network and data analysis to support decision and governance of complex systems</td>
<td>Università di Palermo</td>
<td>Prof. Filippo D’Ippolito (<a href="mailto:filippo.dippolito@unipa.it">filippo.dippolito@unipa.it</a>)</td>
<td>LAAS-CNRS</td>
<td>(optional)</td>
</tr>
<tr>
<td>21. Advanced control allocation techniques for large multi-agent systems and large sensors/actuators networks</td>
<td>Università di Roma “Tor Vergata”</td>
<td>Prof. Sergio Galeani (<a href="mailto:sergio.galeani@uniroma2.it">sergio.galeani@uniroma2.it</a>)</td>
<td>Department of Electrical and Computer Engineering, Ohio State University, USA</td>
<td>(optional)</td>
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</table>

Prospective candidates please contact the referent Professors at the above email for any clarification about the scholarship or suggestions about the application.
<table>
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<tr>
<th>Research theme title</th>
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<tbody>
<tr>
<td>24. Model-based design for increasing reliability and safety of autonomous systems</td>
<td>Università Politecnica delle Marche</td>
<td>Prof. Longhi Sauro (<a href="mailto:sauro.longhi@univpm.it">sauro.longhi@univpm.it</a>)</td>
<td>Department of Mechanical Engineering, Eindhoven University of Technology</td>
<td>(optional)</td>
</tr>
<tr>
<td>5. Awareness in human-human and human-robot interactions</td>
<td>Università di Siena</td>
<td>Prof. Chiara Mocenni (<a href="mailto:chiara.mocenni@unisi.it">chiara.mocenni@unisi.it</a>)</td>
<td>(to be defined)</td>
<td>(to be defined)</td>
</tr>
<tr>
<td>25. Decision and control techniques for collaborative robotics in automated warehouses</td>
<td>Politecnico di Bari</td>
<td>Prof. Mariagrazia Dotoli (<a href="mailto:mariagrazia.dotoli@poliba.it">mariagrazia.dotoli@poliba.it</a>)</td>
<td>Department of Mechanical &amp; Aerospace Engineering, The State University of New Jersey, USA</td>
<td>ICAM S.r.l.</td>
</tr>
<tr>
<td>26. Decision and control techniques for fleets of cooperative robots in automated warehouses</td>
<td>Politecnico di Bari</td>
<td>Prof. Mariagrazia Dotoli (<a href="mailto:mariagrazia.dotoli@poliba.it">mariagrazia.dotoli@poliba.it</a>)</td>
<td>Department of Maritime and Transport, Delft University of Technology, The Netherlands</td>
<td>ICAM S.r.l.</td>
</tr>
<tr>
<td>35. Self-diagnosis and total fault prediction solutions based on data and signals in autonomous machines for structural steel processing</td>
<td>Università Politecnica delle Marche</td>
<td>Prof. Longhi Sauro (<a href="mailto:sauro.longhi@univpm.it">sauro.longhi@univpm.it</a>)</td>
<td>Department of Electronic Engineering, Maynooth University, Ireland</td>
<td>SCHNELL S.p.A.</td>
</tr>
<tr>
<td>28. Development of solutions for mobile and collaborative robotics in complex environments</td>
<td>Università di Bologna</td>
<td>Prof. Lorenzo Marconi (<a href="mailto:lorenzo.marconi@unibo.it">lorenzo.marconi@unibo.it</a>)</td>
<td>Wageningen Centre for Development Innovation, The Netherlands</td>
<td>STAM S.r.I.</td>
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<tbody>
<tr>
<td>7. Smart control systems for rural energy communities</td>
<td>Politecnico di Bari</td>
<td>Prof. Mariagrazia Dotoli (<a href="mailto:mariagrazia.dotoli@poliba.it">mariagrazia.dotoli@poliba.it</a>)</td>
<td>Delft Center for Systems and Control, Delft University of Technology, USA</td>
<td>(optional)</td>
</tr>
<tr>
<td>9. Machine learning paradigms for fast and faithful approximations of model predictive controllers</td>
<td>Scuola IMT Alti Studi Lucca</td>
<td>Prof. Alberto Bemporad (<a href="mailto:alberto.bemporad@imtlucca.it">alberto.bemporad@imtlucca.it</a>)</td>
<td>Department of Engineering Science, University of Oxford, UK</td>
<td>(optional)</td>
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<tr>
<td>10. Model-based and data-driven learning and control of complex network systems</td>
<td>Università del Salento</td>
<td>Prof. Gianfranco Parlangeli (<a href="mailto:gianfranco.parlangeli@unisalento.it">gianfranco.parlangeli@unisalento.it</a>)</td>
<td>Purdue University, USA</td>
<td>(optional)</td>
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<tr>
<td>11. Emergent behaviors in opinion dynamics</td>
<td>Università del Sannio</td>
<td>Prof. Francesco Vasca (<a href="mailto:vasca@unisannio.it">vasca@unisannio.it</a>)</td>
<td>Linkoping University, Sweden</td>
<td>(optional)</td>
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<tr>
<td>12. Control Strategies for Energy Harvesting Systems</td>
<td>Università della Calabria</td>
<td>Prof. Alessandro Casavola (<a href="mailto:a.casavola@dimes.unical.it">a.casavola@dimes.unical.it</a>)</td>
<td>Department of Electrical and Electronic Engineering, Imperial College London, UK</td>
<td>(optional)</td>
</tr>
<tr>
<td>16. Robust control of traffic networks with heterogenous vehicles</td>
<td>Università di Genova</td>
<td>Prof. Simona Sacone (<a href="mailto:simona.sacone@unige.it">simona.sacone@unige.it</a>)</td>
<td>University of Technology of Compiègne, France</td>
<td>(optional)</td>
</tr>
<tr>
<td>17. Exploiting Predictive capabilities in motion control for autonomous vehicles operating in crowded environments</td>
<td>Università di Modena e Reggio Emilia</td>
<td>Prof. Laura Giarré (<a href="mailto:laura.giarre@unimore.it">laura.giarre@unimore.it</a>)</td>
<td>Chalmers University of Technology, Sweden</td>
<td>(optional)</td>
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Prospective candidates please contact the referent Professors at the above email for any clarification about the scholarship or suggestions about the application.
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<tr>
<th>Research theme title</th>
<th>Hosting institution</th>
<th>Contact</th>
<th>Research period abroad</th>
<th>Research period at research center / company / P.A.</th>
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<tbody>
<tr>
<td>18. Advanced modeling and control of complex systems</td>
<td>Università di Padova</td>
<td>Prof. Luca Schenato (<a href="mailto:l.schenato@unipd.it">l.schenato@unipd.it</a>)</td>
<td>Department of Mechanical Engineering, UC Santa Barbara, USA</td>
<td>(optional)</td>
</tr>
<tr>
<td>22. Mathematical theory for control and optimization of evolutionary phenomena</td>
<td>Università di Trento</td>
<td>Prof. Andrea Pinamonti (<a href="mailto:andrea.pinamonti@unitn.it">andrea.pinamonti@unitn.it</a>)</td>
<td>Laboratoire Jacques-Louis Lions, Sorbonne université, France</td>
<td>(optional)</td>
</tr>
<tr>
<td>23. Shared-control framework for smart human-vehicle cooperation in the context of autonomous and assisted driving</td>
<td>Università di Trento</td>
<td>Prof. Francesco Biral (<a href="mailto:Francesco.biral@unitn.it">Francesco.biral@unitn.it</a>)</td>
<td>Universität der Bundeswehr München, Germany</td>
<td>(optional)</td>
</tr>
<tr>
<td>30. Monitoring and optimally managing goods movements on multimodal networks</td>
<td>Università di Genova</td>
<td>Prof. Simona Sacone (<a href="mailto:simona.sacone@unige.it">simona.sacone@unige.it</a>)</td>
<td>Delft University of Technology, The Netherlands</td>
<td>Circle S.p.A.</td>
</tr>
<tr>
<td>32. Predictive maintenance, fault and anomaly detection for chemical and pharmaceutical processes</td>
<td>Università di Parma</td>
<td>Prof. Luca Consolini (<a href="mailto:luca.consolini@unipr.it">luca.consolini@unipr.it</a>)</td>
<td>GSK R&amp;D center in Rockville, USA</td>
<td>GlaxoSmithKline S.p.A</td>
</tr>
<tr>
<td>8. Learning and control of complex networks and financial systems</td>
<td>Politecnico di Torino</td>
<td>Prof. Giuseppe Calafiore (<a href="mailto:Giuseppe.calafiore@polito.it">Giuseppe.calafiore@polito.it</a>) Dr. Giulia Fracastoro (<a href="mailto:giulia.fracastoro@polito.it">giulia.fracastoro@polito.it</a>)</td>
<td>College of Engineering and Computer Science, University of Hanoi, Vietnam</td>
<td>IIEIT-CNR, Torino</td>
</tr>
<tr>
<td>31. Motion planning, control and coordination of off-road autonomous mining trucks</td>
<td>Università di Modena e Reggio Emilia</td>
<td>Prof. Paolo Falcone (<a href="mailto:falcone@unimore.it">falcone@unimore.it</a>) Dr. Marianna Vivolo (<a href="mailto:marianna.vivolo@ivecogroup.com">marianna.vivolo@ivecogroup.com</a>)</td>
<td>Department of Electrical Engineering, Chalmers University, Sweden</td>
<td>Iveco Defense Vehicles</td>
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Prospective candidates please contact the referent Professors at the above email for any clarification about the scholarship or suggestions about the application.
### Research theme title

1. Decision and Control Techniques for Intelligent Diagnostic and Surgery Using Digital Twins

2. Model based security and monitoring system for resilient industrial control systems

3. Model based security and monitoring system for resilient industrial control systems

4. Distributed multi-object estimation for cooperative autonomous systems

5. Artificial Intelligence in Autonomous Robotic Service Fleet Management for the Smart Cities of the Future

6. Fault Diagnosis and Security in Smart Cities

### Hosting institution

- Politecnico di Bari
- Università di Roma Tre
- Università di Firenze
- Università di Pisa
- Università di Cagliari

### Contact

- Prof. Mariagrazia Dotoli (mariagrazia.dotoli@poliba.it)
- Prof. Federica Pascucci (federica.pascucci@uniroma3.it)
- Prof. Luigi Chisci (luigi.chisci@unifi.it)
- Prof. Giorgio Battisti (giorgio.battistelli@unifi.it)
- Prof. Alessandro Giua (giua@unica.it)

### Research period abroad

- School of Engineering – Bioengineering Research Institute, University of Edinburgh, UK
- Centre for Informatics and Systems, University of Coimbra, Portugal
- Chalmers University of Technology, Sweden
- Division of Systems Engineering, Boston University, USA
- ARST – Trasporti Regionali della Sardegna S.p.A.

### Research period at research center / company / P.A.

- (optional)
- (optional)
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<th>Contact</th>
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<th>Research period at research center / company / P.A.</th>
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<tr>
<td>27. Control, coordination and monitoring of autonomous agents, with application to the agrifood field</td>
<td>Università dell’Aquila</td>
<td>Prof. Maria Domenica Di Benedetto (<a href="mailto:mariadomenica.dibenedetto@univaq.it">mariadomenica.dibenedetto@univaq.it</a>)</td>
<td>University Polytechnic Hauts-de-France, France</td>
<td>BluHub</td>
</tr>
<tr>
<td>34. Predictive Maintenance and Anomaly Detection for Agricultural Tractors Components</td>
<td>Università Politecnica delle Marche</td>
<td>Prof. Sauro Longhi (<a href="mailto:sauro.longhi@univpm.it">sauro.longhi@univpm.it</a>)</td>
<td>Universite de Lorraine, France</td>
<td>CNH INDUSTRIAL ITALIA S.p.A.</td>
</tr>
<tr>
<td>6. Decision and Control Techniques for Energy Management of Smart Cities</td>
<td>Politecnico di Bari</td>
<td>Prof. Mariagrazia Dotoli (<a href="mailto:mariagrazia.dotoli@poliba.it">mariagrazia.dotoli@poliba.it</a>)</td>
<td>Automatic Control Department, Universitat Politècnica de Catalunya, Spain</td>
<td>ENEA - Smart Cities and Communities Laboratory</td>
</tr>
<tr>
<td>33. Causal representation learning for time series monitoring in continuous food manufacturing processes</td>
<td>Università di Verona</td>
<td>Prof. Paolo Fiorini (<a href="mailto:paolo.fiorini@univr.it">paolo.fiorini@univr.it</a>)</td>
<td>Computer Science Department, Technische Universität Darmstadt, Germany</td>
<td>Mafin S.r.l.</td>
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</table>

Prospective candidates please contact the referent Professors at the above email for any clarification about the scholarship or suggestions about the application
Scholarship 1

Research theme title: Decision and Control Techniques for Intelligent Diagnostic and Surgery Using Digital Twins

Contacts: Prof. Mariagrazia Dotoli (mariagrazia.dotoli@poliba.it)

Curriculum of DAUSY: C3 AS for Monitoring and Security

Hosting University/Research Centre: Polytechnic of Bari

Description:

Digital twins (DTs) are virtual replicas of physical entities that go beyond a still image and encompass the dynamic functionality of the real-life object. Widely used in industries such as construction and aviation, the DT concept is being recently applied in the healthcare industry with the aim of creating molecular and phenotypic copies of human beings that can allow, for instance, to trial different therapies to elucidate the most efficacious treatment for the real-life patient. DTs can be also employed to improve diagnosis and treatment using the integration and clinical exploitation of complex data. Applied to medicine and public health, DTs enable learning and discovering new knowledge, new hypothesis generation, and testing. They are poised to play a key role in formulating highly personalized treatments and interventions in the future.

Against this background, this project will develop decision and control tools that address the emerging need of intelligent supporting systems for the diagnostics and surgery of severe diseases such as tumors. On the one hand, the DT of a patient will be created with the aim of offering to the medical team a preview of the intervention area and access routes, with a detailed and interactively editable view. On the other hand, a simulator (based on machine learning and optimization techniques) will be developed so that the surgery can be planned in multidisciplinary team meetings, practiced and optimized beforehand, and referenced during the operation to verify anatomy and avoid inadvertent damage to structures. The real-time model of the patient will also give rise to clinical trials where new instruments, techniques or therapies are first tried on the DT, thus minimizing risks to the patient.

Type of scholarship: Project funded by the Hosting Institution

Research period abroad: 6 months, University of Edinburgh School of Engineering – Bioengineering Research Institute

Research period in a research centre/company/P.A.: Optional/To be defined
Scholarship 2

Research theme title: Advanced learning and control methods with life science applications

Contacts: Dr. Alessandro Borri (alessandro.borri@iasi.cnr.it), Dr. Fabrizio Dabbene (fabrizio.dabbene@ieiit.cnr.it)

Curriculum of DAUSY: C1 AS for Automation

Hosting University/Research Centre: Consiglio Nazionale delle Ricerche (seat of Torino)

Description:
The core activities of this PhD will be centered on efficient techniques for modeling, learning and control of complex systems arising in life sciences, with focus on biological and medical systems. Examples of such models involve molecular systems biology, glucose-insulin regulatory system, tumor growth and treatment, cardiorespiratory dynamics and control, neurosciences. On the methodological side, the PhD will investigate modern machine learning techniques for the modeling and identification of the system, and advanced control techniques such as hybrid and model predictive control approaches.

Type of scholarship: Project funded by the Hosting Institution

Research period abroad: Optional/To be defined

Research period in a research centre/company/P.A.: Optional/To be defined
Research theme title: Model based security and monitoring system for resilient industrial control systems

Contacts: Prof. Federica Pascucci (federica.pascucci@uniroma3.it)

Curriculum of DAUSY: C3 AS for Monitoring and Security

Hosting University/Research Centre: University of Roma Tre

Description:
Over the past decade, industrial control systems have experienced a massive integration with information technologies. Industrial networks have undergone numerous technical transformations to protect operational and production processes, leading today to a new industrial revolution. Nowadays, indeed, industrial control devices are one of the major targets for hackers due to their exposure to threats: the principle of “air gaps” (disconnecting the industrial control network from the operational networks) is not anymore feasible in a connected world. Despite the importance of protecting such systems, cybersecurity related issues have not been given due consideration.

The goal of this project is to improve the security and the resilience of cyber physical systems by exploiting early detection and risk analysis. The research project will fall in the cross-cutting edges among control engineering, cybersecurity, and machine learning. The application area will be focused on digital control systems operated over communication networks prone to cyber-attacks.

The research will focus on developing novel system analysis and design methodologies that jointly consider both the risk (i.e., impact and cascading effects) and detectability of attacks under uncertainties. It will exploit model-based approaches related to fault diagnosis and data-driven solutions such as machine learning. The developed methods shall support the design of anomaly detection and control algorithms for improving security and resilience. These algorithms will be validated by simulation and on experimental testbeds.

Type of scholarship: Project funded by the Hosting Institution

Research period abroad: 6 months, University of Coimbra – Centre for Informatics and Systems

Research period in a research centre/company/P.A.: Optional/To be defined
Scholarship 4

**Research theme title:** Performance-aware and resilient supervisory control of cyber-physical and industrial automation systems

**Contacts:** Prof. Francesco Basile (fbasile@unisa.it)

**Curriculum of DAUSY:** C1 AS for Automation

**Hosting University/Research Centre:** University of Salerno

**Description:**

Today's technological society is permeated by complex systems composed by multiple smart elements and devices interacting together by way of communication networks, often called distributed cyber-physical systems (CPSs). Examples of CPSs are connected autonomous vehicle systems, automated warehouse systems, smart grids and buildings. Many computing subsystems in CPSs and industrial automation control systems are based on commercial-off-the-shelf smart components, endowed with communication capabilities. These components provide a significant level of control, lower deployment and operational costs in comparison to the traditional vendor-specific proprietary and closed-source systems. However, the coordination of these components to guarantee certain performance levels represents a challenging problem. In addition, they expose the control systems to vulnerabilities and threats.

There is a great potential in this area for developing novel approaches using methodologies that pertain to discrete event systems (DESs). Indeed, both the coordination and the cyber-attacks affect essentially the higher levels of the control architecture, where the discrete event view of the system is the most effective description of the system dynamics.

The goal of the research is to improve the state of the art by using timed models for the synthesis of supervisory control systems guaranteeing a certain performance level and also resilience against cyber-attacks.

**Type of scholarship:** Project funded by the Hosting Institution

**Research period abroad:** Optional/To be defined

**Research period in a research centre/company/P.A.:** Optional/To be defined
Scholarship 5

**Research theme title:** Awareness in human-human and human-robot interactions

**Contacts:** Prof. Chiara Mocenni (chiara.mocenni@unisi.it)

**Curriculum of DAUSY:** C1 AS for Automation

**Hosting University/Research Centre:** University of Siena

**Description:**

The aim of the training project is to study the impact of awareness on individual decision-making processes in different scenarios, such as human-human, human-robot, and human-environment interactions. This is an important aspect in many different fields as we might expect that in all cases, the higher the individuals' level of awareness, the higher their well-being. Cognitive and behavioral factors, involved in awareness and self awareness, will be investigated to understand the mechanisms of individual and group decision-making. Moreover, since robot devices that establish a functional relationship with a human give rise to complex human-technology systems, the aim of the research will be to develop suitable interpretive models from a cognitive viewpoint, as well as new principles and evaluative models from a moral viewpoint. Moreover, our purpose is to analyze the impact that aware decisions may have on environmental management, and, on the other hand, how extreme environmental events affect human behavior. The efforts in understanding awareness will allow us to design technologies and methodologies considering all the cognitive, social, ethical, and environmental implications related to their adoption.

**Type of scholarship:** The scholarship will be financed by research grants of the PhD supervisors

**Research period abroad:** Optional/To be defined

**Research period in a research centre/company/P.A.:** Optional/To be defined
Scholarship 6

Research theme title: Decision and Control Techniques for Energy Management of Smart Cities

Contacts: Prof. Mariagrazia Dotoli (mariagrazia.dotoli@poliba.it)

Curriculum of DAUSY: C3 AS for Monitoring and Security

Hosting University/Research Centre: Polytechnic of Bari

Description:

A smart city is a sustainable and efficient urban centre that provides a high quality of life to its inhabitants through optimal management of its resources. Energy management is one of the most demanding issues within such urban centres owing to the complexity of the energy systems and their vital role. As a consequence, to increase smartness, cities should improve present systems and implement new solutions in a coordinated way and through an optimal approach, by profiting from the synergies among all the involved urban actors. Against this background, this project will develop decision and control tools that address the emerging need of intelligent energy management systems for smart cities and related subsystems such as energy clusters, districts, communities, smart buildings, and smart homes. On the one hand, optimization tools devoted to the strategic management of urban energy systems will be investigated to make urban infrastructure and facilities more energy efficient and environmentally friendly in a cost effective manner. On the other hand, this project will define decision and control techniques for the operational management of urban smart energy systems, with the final aim of ensuring the transition towards a low-carbon energy sector and the efficient and sustainable use of natural resources from users’ perspective.

The research will be applied to real urban case studies in collaboration with the Smart Cities and Communities Laboratory of the Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA).

Type of scholarship: DM 351/2022 - Project on Public Administration

Research period abroad: 6 months, Universitat Politècnica de Catalunya - Automatic Control Department

Research period in a research centre/company/P.A.: 6 months, ENEA - Smart Cities and Communities Laboratory
Research theme title: Smart control systems for rural energy communities

Contacts: Prof. Mariagrazia Dotoli (mariagrazia.dotoli@poliba.it)

Curriculum of DAUSY: C2 AS for Smart Environments

Hosting University/Research Centre: Polytechnic of Bari

Description:
Over the decades, both the rural sector and energy grids have encountered significant challenges, such as the lack of power supply to agricultural farms and the difficulties of renewable energy use in electricity networks. To overcome and address these issues, this project will develop new decision and control techniques aimed at merging smart farms, renewable energy, and rural small consumers into Rural Energy Communities (RECs), using surplus renewable energy and distributed storage for the agriculture sector and the smart farm. The overall objective of this project is thus to define new control architectures and frameworks for RECs, as enabling tools to transform the rural grid from a rigid and weak system to a flexible and sustainable asset. In particular, control mechanisms integrating optimization, game theory, and learning will be developed aimed at making RECs capable of conveniently integrating smart farms and greenhouses. Thanks to the innovative control framework and leveraging on loads flexibility, these REC stakeholders will be enabled to trade local energy exchanges, optimally share common energy resources, and pursue instantaneous self-consumption, while reducing overall costs and improving sustainability.

This project will devote particular attention to highlighting the peculiarities of rural energy distribution with respect to urban energy communities and will target the need of gaining substantial improvements in terms of network resilience and efficiency, favouring the introduction of innovative control frameworks in support of rural energy systems operations and of their future economic and industrial sustainability.

Type of scholarship: DM 351/2022 – Project on PNRR (Italy's Recovery and Resilience Plan)

Research period abroad: 6 months, Delft University of Technology – Delft Center for Systems and Control

Research period in a research centre/company/P.A.: Optional/To be defined
Scholarship 8

Research theme title: Learning and control of complex networks and financial systems

Contacts: Prof. Giuseppe Calafiore (giuseppe.calafiore@polito.it), Dr. Giulia Fracastoro (giulia.fracastoro@polito.it)

Curriculum of DAUSY: C2 AS for Smart Environments

Hosting University/Research Centre: Polytechnic of Torino

Description:

The core activities of this PhD will be centered on efficient techniques for the modeling and control of complex networked systems. From the methodological side, we shall explore linear and nonlinear techniques for identification/learning of complex models of interconnected systems from available observed data, and control techniques for influencing the system in order to obtain a desired behavior. These techniques will be applied to practical models such as pandemic evolution models and financial liability networks, and will inform public decision makers for designing appropriate crisis management policies.

Type of scholarship: DM 351/2022 – Project on Public Administration

Research period abroad: 6-18 months, College of Engineering and Computer Science of Vietnam University in Hanoi, Vietnam

Research period in a research centre/company/P.A.: 6-18 months, Research center of IEIITCNR, Torino
Research theme title: Machine learning paradigms for fast and faithful approximations of model predictive controllers

Contacts: Prof. Alberto Bemporad (alberto.bemporad@imtlucca.it)

Curriculum of DAUSY: C2 AS for Smart Environments

Hosting University/Research Centre: IMT School for Advanced Studies Lucca

Description:

The contemporary quest for easily embeddable control systems with increasing efficiency is shedding light on the impressive potential of machine learning approaches to design proxies for traditional, possibly model-based, control techniques. Among them, model predictive control (MPC) has been shown to benefit the most since surrogate MPC-based policies synthesized through machine learning paradigms typically feature almost inexpensive online evaluation while retaining some flavour of optimality.

Nevertheless, accompanying those learning-based controllers with rigorous certificates demonstrating their reliability in terms of stability and performance of the closed-loop system when called to replace the original MPC law based on online optimization denotes a key challenge. Therefore, the PhD student will investigate a combination of machine learning and control theoretical methods to approximate MPC laws outperforming the original policy from a computational perspective, while retaining rigorously-proven stability properties. Relevant approaches may hence look in several directions, including for instance active learning to reduce the number of samples and the corresponding computational effort required to learn the approximate MPC law; supervised/unsupervised learning with possible dual-mode implementation to safely merge optimal explicit solutions and deep neural approximations; learning dynamic output-feedback MPC laws by using recurrent neural networks. The thesis will thus focus on the theoretical soundness of the proposed approaches to learning-based controller approximation, algorithmic aspects, and on testing the effectiveness of the developed methods on case-studies of practical relevance spanning from automotive and aerospace applications to industrial process and energy dispatch control.

Type of scholarship: DM 351/2022 – Project on PNRR (Italy’s Recovery and Resilience Plan)

Research period abroad: 6 months, University of Oxford - Department of Engineering Science

Research period in a research centre/company/P.A.: Optional/To be defined
Research theme title: Model-based and data-driven learning and control of complex network systems

Contacts: Prof. Gianfranco Parlangeli (gianfranco.parlangeli@unisalento.it)

Curriculum of DAUSY: C2 AS for Smart Environments

Hosting University/Research Centre: University of Salento

Description:

The recent technology advances involving interconnected intelligent devices have posed new challenges in the design paradigms for complex systems. The interconnection topology and the local protocols fundamentally affect the dynamical processes of these complex networks and generate relevant collective features (such as aggregation/collaboration, consensus or clustering). Moreover, subsets of nodes may condition the global evolution or may be used to retrieve information on other nodes. Exploring the capabilities of the complex network and identifying main features of the network structure is a research challenge to address that can have a significant impact in several domains as traffic control, social networks, or swarm robotics. The interconnection among network clusters is often affected by adjustable local interaction, so that the value of local parameters may have a strong impact on the overall system performance. The design and tuning of these local interactions and parameters, e.g., by minimizing suitable global performance metrics (e.g., energy consumption) is a challenge to be addressed. Moreover, a timely research direction involves the combination of model-based system-theoretical tools with data-driven approaches (e.g., from Artificial Intelligence) that have shown to be extremely successful in several domains and that allow the designer to take advantage from the availability of massive data.

Considering the above framework, the proposed PhD program will deal with: (i) the investigation of network features with their impact on global behaviors and fundamental limitations of the complex system, (ii) novel approaches for the design of local interactions by taking into account performance indexes and global constraints, and (iii) the exploration of combined system theoretical approaches and data-driven tools to learn and control the network system. The developed methodological studies will be applied to concrete applications scenarios from cooperative robotics.

Type of scholarship: DM 351/2022 – Project on PNRR (Italy's Recovery and Resilience Plan)

Research period abroad: 6-9 months, Purdue University, West Lafayette, USA

Research period in a research centre/company/P.A.: Optional/To be defined
Scholarship 11

**Research theme title:** Emergent behaviors in opinion dynamics

**Contacts:** Prof. Francesco Vasca (vasca@unisannio.it)

**Curriculum of DAUSY:** C2 AS for Smart Environments

**Hosting University/Research Centre:** University of Sannio

**Description:**

The research project is the area of analysis of dynamic social networks through graph theory. Dynamic interconnected systems can be represented as switching networks whose paradigm is applicable in different sectors. Opinion dynamics are characterized by relationships between autonomous agents each with its own state dynamics, with connections that depend on the relative distance between the respective state variables. The dynamic behavior is determined by the commutations of the links between the nodes of the network. For this class of systems, network analysis requires advanced modeling and control techniques: from hybrid systems to averaging techniques, from Lyapunov stability to dynamic graphs. The project intends to deepen the aforementioned methodologies, drawing inspiration from applications for the dynamics of opinions in social networks.

**Type of scholarship:** DM 351/2022 – Project on PNRR (Italy’s Recovery and Resilience Plan)

**Research period abroad:** 6 months, Linkoping University, Sweden

**Research period in a research centre/company/P.A.:** Optional/To be defined
Scholarship 12

**Research theme title:** Control Strategies for Energy Harvesting Systems  
**Contacts:** Control Strategies for Energy Harvesting Systems (a.casavola@dimes.unical.it)  
**Curriculum of DAUSY:** C2 AS for Smart Environments  
**Hosting University/Research Centre:** University of Calabria  
**Description:**  
Energy harvesting systems and the related control problems have attracted the attention of many researchers in recent years. Depending on the applicative contexts the energy sources can be different, but the purpose is always that of recovering that energy that would otherwise be lost as heat. In automotive engineering, examples include energy recovering and conversion from exhaust emission in turbocharged car engines, the absorption of the kinetic energy in the brakes, the vibrations of the engines and the suspension systems. If such systems did equip a hybrid or electrical vehicle, the harvested energy could be used to recharge the vehicle's battery and hence extend its mileage. In the context of sensor networks, it provides a means of powering electronics where there are no conventional power sources, eliminating the need for frequent battery replacements and running wires to end applications. This is especially true in underwater or marine applications. The focus of the research will be on the study and development of control strategies suitable for the maximization of the harvested energy while satisfying, at the same time, other control specifications. This is the case, for example, in regenerative suspension systems where the maximization of the energy harvested by road unevenness has to be traded off with other requirements, such as the desired drive comfort and road handling. In other cases, as in wind-turbine or wave energy conversion, the maximization of the recovered energy is a major concern and the challenges are more related to maintaining the operation within safe operative constraints. It is well known that the optimal solution in most cases is anti-causal (it depends on the future of some exogenous signals) and one of the challenges will be to find suitable causal approximations. Model Predictive Control (or Economic MPC) strategies seem to offer a good starting point for their capability to deal with future predictions of system variables, optimizing the control actions with respect to meaningful cost indices and inherently handling constraints. The research will be assessed by cases study on regenerative suspension systems and marine wave energy conversion set-ups.  

**Type of scholarship:** DM 351/2022 – Project on PNRR (Italy's Recovery and Resilience Plan)  
**Research period abroad:** 6 months, Imperial College London - Department of Electrical and Electronic Engineering  
**Research period in a research centre/company/P.A.:** Optional/To be defined
Research theme title: Supervision and control techniques for energy management in the More Electric Aircraft

Contacts: Prof. Alberto Cavallo (alberto.cavallo@unicampania.it)

Curriculum of DAUSY: C1 AS for Automation

Hosting University/Research Centre: University of Campania “Luigi Vanvitelli”

Description:

The More Electric Aircraft concept (MEA) is one of the most discussed topics of the recent decades inside the aircraft field. Basically, it aims to replacing hydraulic, pneumatic and mechanic devices onboard with their electrical counterparts. Obviously, this approach increases the complexity of the electric network onboard, creating drawbacks and opportunities. The main drawback is the impossibility for a human operator to control “manually” all the devices. This in turn calls for advanced automated controllers and supervisors. The opportunities are that within the control logics it is possible to insert optimization objectives in order to improve also energy management onboard, reduce weight (and thus fuel consumption) and implement health-monitoring and fault-management strategies.

All the above objectives require solid mathematical approaches, in order to prove stability and performance of the proposed solutions, also in the presence of strong nonlinearities, uncertainties, quickly varying loads. Another interesting aspect to be addressed is how to implement the proposed strategy, whether using a centralized control or single agents to be coordinated using, e.g., consensus-based approaches. Mathematical modelling at different levels of abstractions is also a crucial activity. Correspondingly, numerical simulation at different levels will be addressed, from simple basic Simulink models to physical modelling and Hardware-in-the-loop software.

Type of scholarship: DM 351/2022 – Project on PNRR (Italy’s Recovery and Resilience Plan)

Research period abroad: 12 months, University of Nottingham, Institute for Aerospace Technology, Faculty of Engineering

Research period in a research centre/company/P.A.: Optional/To be defined
**Scholarship 14**

**Research theme title:** Fault Diagnosis and Security in Smart Cities

**Contacts:** Prof. Alessandro Giua (giua@unica.it)

**Curriculum of DAUSY:** C3 AS for Monitoring and Security

**Hosting University/Research Centre:** University of Cagliari

**Description:**

A smart city is a place where traditional networks and services are made more efficient with the use of digital solutions for the benefit of its inhabitants and business. From the perspective of automation and control, three key aspects are particularly relevant in this context. a) Smart cities are examples of large-scale distributed plants whose overall behaviour derives from the interaction of multiple agents and where monitoring and control can only be enforced in a decentralized fashion. b) Different heterogeneous services co-exist and interact with each other: this requires adopting very general models, capable of describing hybrid systems, characterized by both time-driven and event-driven dynamics. c) To ensure the secure behaviour of the overall systems while satisfying privacy concerns even in the presence of malicious attacks, it is necessary to implement and manage a high-level infrastructure capable of monitoring the overall behaviour of the system.

The objective of this thesis is that of addressing the issue of security and privacy in smart cities with a unifying approach that is not service-dependent but could be applied in different applicative domains. The reference paradigm that will be adopted for the modelling and analysis is that of cyber-physical systems, which integrate sensing, computation, control and networking into physical objects and infrastructure, connecting them to the Internet and to each other.

The approach that will be adopted is that of extending to the more general setting of cyber-physical systems recent approaches, that have been developed by the discrete-event systems community to address problems of fault diagnosis, privacy analysis and enforcement, and resilience to cyber-attacks. The proposed methodologies will be developed in view of enabling their technology transfer toward a platform that could be used by local administrations to offer these new services to users.

**Type of scholarship:** DM 351/2022 – Project on PNRR (Italy's Recovery and Resilience Plan)

**Research period abroad:** 6 months, Division of Systems Engineering, Boston University, Boston. Massachusetts, USA.

**Research period in a research centre/company/P.A.:** 6 months, ARST – Trasporti Regionali della Sardegna S.p.A.
Scholarship 15

**Research theme title:** Distributed multi-object estimation for cooperative autonomous systems

**Contacts:** Proff. Luigi Chisci (luigi.chisci@unifi.it), Giorgio Battistelli (giorgio.battistelli@unifi.it)

**Curriculum of DAUSY:** C3 AS for Monitoring and Security

**Hosting University/Research Centre:** University of Firenze

**Description:**

In the context of autonomous navigation systems, it is fundamental that each mobile agent (e.g., ground vehicle, drone or underwater autonomous vehicle) be capable to self-localize and, simultaneously, build a map of the surrounding environment, possibly exploiting cooperation among the agents. This task is a challenging one, with many open research issues, also in view of various practical difficulties such as, for instance, the finite resolution and limited field-of-view of the sensors, the non-point-like nature of some (extended) objects of interest, the possible occurrence of several types of failures in the inter-agent communication including the ones due to cyber-attacks. A possible methodological approach to the above multi-object estimation task, to be investigated in this project, is the random finite set approach which aims to jointly: (1) detect objects present in the scene; (2) estimate their number and, for each object, kinematic state and geometrical shape; (3) identify, possibly with the aid of machine learning techniques, the type of each object. From a theoretical viewpoint, the work will focus on distributed fusion of multi-object information from multiple sources (agents) explicitly accounting for the different agents fields-of-view and presence of extended objects. The work will also develop efficient distributed multi-object estimation algorithms for cooperative autonomous agents and assess their effectiveness in realistic simulation scenarios as well as in challenging real-world case-studies.

**Type of scholarship:** DM 351/2022 – Project on PNRR (Italy's Recovery and Resilience Plan)

**Research period abroad:** 6-12 months, Chalmers University of Technology, Göteborg, Sweden

**Research period in a research centre/company/P.A.:** Optional/To be defined
Research theme title: Robust control of traffic networks with heterogenous vehicles

Contacts: Prof. Simona Sacone (simona.sacone@unige.it)

Curriculum of DAUSY: C2 AS for Smart Environments

Hosting University/Research Centre: University of Genova

Description:
The presence of different types of vehicles (traditional vehicles, partially or fully automated and connected vehicles, electric vehicles) in traffic networks is nowadays becoming a reality which poses the challenge of designing new modelling and control frameworks. The traditional modelling methods that have been developed in the last decades are no more adequate to traffic flows in which such heterogeneous vehicles have to coexist. On the other hand, innovative modelling techniques need suitable calibration which is not yet possible since real measurements about such a kind of process are not available due to very low or even null penetration rate of those new vehicle categories in current networks. This makes it necessary to design optimization and control techniques in which several modelling uncertainties are present and must be effectively tackled. The present research project addresses this need by adopting robust optimization and control techniques in which some features of new flows of not traditional vehicles are considered as model uncertainties.

Type of scholarship: DM 351/2022 – Project on PNRR (Italy's Recovery and Resilience Plan)

Research period abroad: 6 months, University of Technology of Compiegne, Heudiasyc Lab, France

Research period in a research centre/company/P.A.: Optional/To be defined
Scholarship 17

**Research theme title:** Exploiting Predictive capabilities in motion control for autonomous vehicles operating in crowded environments

**Contacts:** Prof. Laura Giarré (laura.giarre@unimore.it)

**Curriculum of DAUSY:** C2 AS for Smart Environments

**Hosting University/Research Centre:** University of Modena and Reggio Emilia

**Description:**

The scientific theme will be the development of learning-based, predictive motion planning and control algorithms for autonomous vehicles operating with safety guarantees in complex and highly dynamic environments. Compared to the state-of-the-art algorithms, the idea is to enable persistent safety guarantees by interwinding learning, prediction and control tools. This objective will be achieved by imposing some property to the learning-based prediction tools and by introducing ad-doc safety set constraints. Particular attention to assisted autonomous vehicle operating in crowded environment for people with impairment, by exploiting well known techniques of autonomous driving. Prediction and learning are the enabling key of the entire project. Designing safety and smoothness requirements for a mobile vehicle operating in a crowded environment is a challenging task. This design problem is well-known in autonomous driving, where the balance between safety and user’s acceptance are of primary importance, but low cost sensors and acceptability need to be exploited when designed assisting vehicles.

The hypothesis underlying this research activity is that, in order to enable a safe yet smooth operation, the motion should be planned by anticipating the behavior of the surrounding crowd and the user. For this reason, we will approach the motion planning and control problem by resorting to predictive approaches, which rely on tools that learn from data and predict the behavior of the surrounding crowd and the users. Tools for the localization and navigation will serve the assistive vehicle for people affected by impairment.

**Type of scholarship:** DM 351/2022 – Project on PNRR (Italy’s Recovery and Resilience Plan)

**Research period abroad:** 8 months, Chalmers University of Technology, Sweden

**Research period in a research centre/company/P.A.:** Optional/To be defined
**Scholarship 18**

**Research theme title:** Advanced modeling and control of complex systems

**Contacts:** Prof. Luca Schenato (l.schenato@unipd.it)

**Curriculum of DAUSY:** C2 AS for Smart Environments

**Hosting University/Research Centre:** University of Padova

**Description:**

The project embraces the mission of the PNRR where control systems play a fundamental and pervasive role in the digital transition of society. In particular, the project aims to develop advanced modeling, estimation, control and optimization methodologies for complex systems using techniques such as distributed optimization, predictive control, multi-agent algorithms, data-driven machine learning approaches and social networks. Currently, the methodologies of control systems used in real applications are typically based on centralized architectures: with the advent of the Internet of Things, smart environments and factories, devices as well humans-in-the-loop, now have the ability to distribute the intelligent component in more sophisticated architectures, posing new challenges. The project aims to develop innovative control methodologies aimed at improving the scalability, robustness and adoption of such solutions.

**Type of scholarship:** DM 351/2022 – Project on PNRR (Italy's Recovery and Resilience Plan)

**Research period abroad:** 8 months, UC Santa Barbara - Department of Mechanical Engineering, USA

**Research period in a research centre/company/P.A.:** Optional/To be defined
Scholarship 19

**Research theme title:** Sensor network and data analysis to support decision and governance of complex systems

**Contacts:** Prof. Filippo D'Ippolito (filippo.dippolito@unipa.it)

**Curriculum of DAUSY:** C1 AS for Automation

**Hosting University/Research Centre:** University of Palermo

**Description:**

The effectiveness, efficiency and economy of public action depends on the degree of knowledge of complex systems that the public administration manages and governs, in particular in those situations in which public decision makers have to perform appropriate crisis management policies. Often, these systems are distributed and have complex dynamics, with mixed signal with continuous and discrete time nature. To better understand and govern these complex systems, distributed sensor systems and a suitable intelligent decision support system have to be considered. Suitable observers may be designed in order to better understand the complex dynamics of these systems based on a sensor network, able to capture suitable information needed to characterize the system. Moreover, appropriate data analysis and machine learning strategies should be developed in order to realize optimal decision policies. Regarding the system modeling, the hybrid dynamical systems constitute a suitable framework for representing physical systems that embed both continuous, discrete as well as event-based dynamics. For this reason, the PhD candidate will investigate the possibility to cast the above mentioned complex dynamics into the hybrid systems framework. This will constitute a solid methodological starting point to design observers and optimal decision policies. The activity will make use of an IoTGIS platform, developed in the laboratory of the hosting University, which is an IoT system connected to a GIS system, in a WEB framework suitable to acquire georeferenced measurements, through electronic devices, and allow to process and visualize them in a suitable way.

**Type of scholarship:** DM 351/2022 – Project on PNRR (Italy's Recovery and Resilience Plan)

**Research period abroad:** 6 months, LAAS-CNRS, France

**Research period in a research centre/company/P.A.:** 6 months, AMAT Palermo S.p.A., Provincial Health Authority of Palermo
Scholarship 20

Research theme title: Artificial Intelligence in Autonomous Robotic Service Fleet Management for the Smart Cities of the Future

Contacts: Prof. Lorenzo Pollini (lorenzo.pollini@unipi.it)

Curriculum of DAUSY: C3 AS for Monitoring and Security

Hosting University/Research Centre: University of Pisa

Description:

The aim of the training project is to lay the theoretical foundations for the automation of decision-making processes for autonomous vehicles and robots that will populate smart cities in the future. Public Administrations organize a large number of services, such as, for example, infrastructure maintenance, waste collection, cleaning of streets and common areas etc. and these services will be characterized by an ever-increasing level of automation. It is conceivable that many of the jobs carried out manually today will instead be carried out by automatic machines that will have to share spaces with human operators and citizens in general. To this end, it is necessary to identify tools, based on artificial intelligence and innovative decision and control algorithms, which will allow public administrations to implement mission management logics for the autonomous vehicles that will make up their service fleet. The goal is to equip public administrations with tools that make delegation to the machines of the necessary daily city care activities more autonomous, reliable and effective, including strategic fleet management, monitoring of operations, automatic management of emergencies and contingencies, automatic reporting generation and intelligent troubleshooting.

Type of scholarship: DM 351/2022 – Project on PNRR (Italy's Recovery and Resilience Plan)

Research period abroad: Optional/To be defined

Research period in a research centre/company/P.A.: Optional/To be defined
Scholarship 21

**Research theme title:** Advanced control allocation techniques for large multi-agent systems and large sensors/actuators networks

**Contacts:** Prof. Sergio Galeani (sergio.galeani@uniroma2.it)

**Curriculum of DAUSY:** C1 AS for Automation

**Hosting University/Research Centre:** University of Rome “Tor Vergata”

**Description:**

The ever-increasing requests in terms of performance, flexibility and resilience both in autonomous production environments (under the Industry 4.0 paradigm) and in more general automation and robotics scenarios (such as search-and-rescue missions, renewable energy production involving micro-grids, precision agriculture, water distribution networks, and so on) have motivated a strong interest in the development of large-scale, multi-agent systems, as well as of large-scale networks of sensors and actuators. In many applications, the key element to achieve challenging objectives relies critically on the ability to coordinate such multi-agent systems in an optimal but flexible way. An additional ingredient adding complexity to the task is given by the fact that the operating environment is frequently unknown (at least up to some degree), and then the devised strategies must strike a balance between exploiting a priori given models and leveraging on data measured in real time.

The goal of this project is to address the problems arising in large multi-agent systems and large sensor/actuator networks by developing innovative extensions of dynamic control allocation (DCA). Given an existing control loop equipped with a set of redundant actuators (that is, whose number exceeds the number of controlled outputs), DCA is an add-on compensation technique which can optimize the actuation demand without modifying the output response of the original control loop; the optimization criterion is usually in the form of a general Lagrange functional (and then tools from optimal control theory are involved) and can be changed in real time (thus providing flexibility in terms of goals). In order to address the considered applications, several challenging extensions have to be developed, including a dual theory for dealing with redundant sensors, and a data-driven identification and optimization (requiring the use of machine and reinforcement learning). Cross-fertilization with the redundancy resolution literature in robotics will also be considered, which might also lead to novel ideas for the control of extremely over-actuated systems such as soft/flexible robots.

**Type of scholarship:** DM 351/2022 – Project on PNRR (Italy’s Recovery and Resilience Plan)

**Research period abroad:** 6 months, Ohio State University - Department of Electrical and Computer Engineering, USA

**Research period in a research centre/company/P.A.:** Optional/To be defined
Scholarship 22

Research theme title: Mathematical theory for control and optimization of evolutionary phenomena

Contacts: Proff. Andrea Pinamonti (andrea.pinamonti@unitn.it), Fabio Bagagiolo (fabio.bagagiolo@unitn.it)

Curriculum of DAUSY: C1 AS for Automation

Hosting University/Research Centre: University of Trento

Description:

The goal of the present project is the study, the application and the development of mathematical theories for control and optimization of evolutionary phenomena motivated by engineering and real-life applications.

The typical differential equations for the evolution of the system under study can be often seen as describing evolution in an abstract environment such as functional and/or metric spaces. Such a point of view brings to important questions of mathematical nature which are also often enlightening for the possible applications to the motivating real-life models. Problems such as controllability, optimal control, optimal transport, motion planning will be the main examples of sources of mathematical questions and motivating applications.

Type of scholarship: DM 351/2022 – Project on PNRR (Italy’s Recovery and Resilience Plan)

Research period abroad: 6 months, LJLL - Laboratoire Jacques-Louis Lions, Sorbonne université, France

Research period in a research centre/company/P.A.: Optional/To be defined
Scholarship 23

Research theme title: Shared-control framework for smart human-vehicle cooperation in the context of autonomous and assisted driving

Contacts: Prof. Francesco Biral (francesco.biral@unitn.it)

Curriculum of DAUSY: C1 AS for Automation

Hosting University/Research Centre: University of Trento

Description:

Road transport systems represent a significant fraction of both the energy used and the pollution produced worldwide. Driving support systems that help reduce the energy footprint of vehicles have been mainly investigated by trying to optimize vehicle maneuvers, i.e., the style of acceleration and deceleration over short time horizons. Cooperative systems that promise to optimize the tactical-strategic level and consequently harmonize the movement of vehicles will only be fully usable when most of the vehicles are cooperative. The ability to correctly predict the other road users behavior and support the driver in taking the best maneuver (i.e. safer and using less energy) is a key functionality of autonomous driving and driving assistance systems.

The goal of this project is to develop an autonomous driving framework, which is able to predict the future evolution of other vehicles in the scenario and suggest/support to the driver to execute the best maneuver for the given context in term of safety and fuel consumption. Thus, one main challenges will be the capability of the system to learn the vehicle dynamic from everyday use to improve its control ability, and secondly, defining the algorithm to explore imaginary (unperceived) situations that might occur. Artificial intelligence can help generate probable conditions and recommend energy-saving (and safe) behaviors even when the danger is not actual but only hypothetical. This will reduce unexpected events, related emissions and wasted energy. A third main challenge is the definition of the shared-control framework that ‘silently’ continuously monitor the driver and support/correct him/her in a transparent way.

Type of scholarship: DM 351/2022 – Project on Digital and Green Transition Study

Research period abroad: 6 months, Universität der Bundeswehr München, Germany

Research period in a research centre/company/P.A.: Optional/To be defined
Research theme title: Model-based design for increasing reliability and safety of autonomous systems

Contacts: Prof. Sauro Longhi (sauro.longhi@univpm.it)

Curriculum of DAUSY: C1 AS for Automation

Hosting University/Research Centre: Università Politecnica delle Marche

Description:

Autonomous systems represent a key enabling technology for the digital transition. For a system to reach autonomy, it must be indeed capable of collecting and properly processing a large quantity of information, and possibly employ it to ensure its proper functioning as well as the safety of the people next to it. It is thus of utmost importance that unexpected internal problems, such as faults, can be discovered and quickly addressed before degenerating into a total system failure, which may cause both economical and human losses. For instance, an autonomous aerial vehicle experiencing a fault should be at least able to land in order to avoid a crash, or a faulty industrial robot should be at least able to stop before causing harm to a human operator. This may be achievable thanks to the information on the internal states of the system and on the environment in which it operates. Moreover, whenever such information is augmented by a model, fault diagnosis and fault-tolerant control techniques represent an effective way to increase the reliability and safety of the system. Starting from relevant models available in the literature, the PhD candidate will be required to investigate the state of the art on linear and nonlinear techniques for fault detection and diagnosis, as well as fault-tolerant control techniques, using both active and passive approaches. These techniques will be then validated in one or more application scenarios, which may include unmanned vehicles, mobile robots, industrial manipulators and intelligent machines in general.

Type of scholarship: DM 351/2022 – Project on PNRR (Italy’s Recovery and Resilience Plan)

Research period abroad: 6-18 months, Department of Mechanical Engineering - Eindhoven University of Technology

Research period in a research centre/company/P.A.: Optional/To be defined
Scholarship 25

**Research theme title:** Decision and control techniques for collaborative robotics in automated warehouses

**Contacts:** Prof. Mariagrazia Dotoli (mariagrazia.dotoli@poliba.it)

**Curriculum of DAUSY:** C1 AS for Automation

**Hosting University/Research Centre:** Polytechnic of Bari

**Description:**

The Fourth Industrial Revolution, also known as Industry 4.0, is reshaping the way individuals live and work while providing a substantial influence on the manufacturing scenario. One of the key enabling technologies that has made Industry 4.0 a concrete reality is without doubt collaborative robotics, which is also evolving as a fundamental pillar of the next revolution, the so-called Industry 5.0 that reinserts proactively humans back into the automation chain, allowing operators and robots to work significantly more closely together. In contrast to robots that predominantly work independently from humans and often reside in a cage, collaborative robots (cobots) co-exist in the same environment together with humans, without renouncing to safety or efficiency.

The goal of this project is to develop innovative decision and control techniques for human robot collaboration (HRC) by ensuring the best trade-off between safety and ergonomics for the operator and efficiency for the industrial process. In particular, this project will focus on the automation of production processes in the context of internal logistics and therefore in industrial warehouses, not yet fully automated, in which there are significant margins for developing innovative solutions aimed at increasing productivity and profitability, with the simplification, planning, and scheduling of robot and operator activities in accordance with safety and ergonomics requirements.

The research will be applied to real logistic scenarios provided by ICAM Srl, which is an Italian company specialized in automated solutions for automated warehousing and Logistics 4.0.

**Type of scholarship:** DM 352/2022 – Industrial Project

**Research period abroad:** 6 months, The State University of New Jersey, Department of Mechanical & Aerospace Engineering, USA

**Research period in a research centre/company/P.A.:** 12 months, ICAM s.r.l., Putignano, Italy
Research theme title: Decision and control techniques for fleets of cooperative robots in automated warehouses

Contacts: Prof. Mariagrazia Dotoli (mariagrazia.dotoli@poliba.it)

Curriculum of DAUSY: C1 AS for Automation

Hosting University/Research Centre: Polytechnic of Bari

Description:

In the Industry 4.0 paradigm, which aims at establishing intelligent, interoperable, and autonomous production environments, the problem of planning, management, and control fleets of Automated Guided Vehicles (AGVs) and/or Rail Guided Vehicles (RGVs) is receiving enormous interest for an efficient and sustainable logistics. Traffic management of cooperating robots for handling loads in automated warehouses of smart factories and distribution centers is indeed a significant challenge for the real-time control aimed at predicting and preventing congestion while ensuring an increase in productivity and business flexibility.

The goal of this project is to improve the performance of automated warehouses by developing scheduling algorithms for the activities carried out by the multi-robot system, together with path-planning, collision avoidance, driving, navigation, and control algorithms. In particular, conventional task allocation and path planning algorithms will be merged into machine learning frameworks with the aim of controlling AGVs’ and/or RGVs’ fleets in real-time and scheduling their activities in an optimal way by collecting and managing a large amount of data obtained by several simulated and real-world industrial scenarios. Thus, the main challenges will lie in defining machine learning techniques -such as supervised learning (e.g., artificial neural networks, support vector machines), unsupervised learning (e.g., principal component analysis), reinforcement learning and deep learning (e.g., convolutional neural networks, restricted Boltzmann machine and auto-encoders)- aimed at predicting and preventing congestion in vehicular traffic. In order to improve the efficiency of AGVs and/or RGVs, maximize productivity, and minimize downtime, scheduling algorithms will be also developed based on the integration of data-driven methods with simulation, optimization, and optimal control techniques.

Type of scholarship: DM 352/2022 – Industrial Project

Research period abroad: 6 months, Delft University of Technology - Department of Maritime and Transport, The Netherlands

Research period in a research centre/company/P.A.: 12 months, ICAM s.r.l., Putignano, Italy
Scholarship 27

**Research theme title:** Control, coordination and monitoring of autonomous agents, with application to the agrifood field

**Contacts:** Prof. Maria Domenica Di Benedetto (mariadomenica.dibenedetto@univaq.it)

**Curriculum of DAUSY:** C3 AS for Monitoring and Security

**Hosting University/Research Centre:** University of L’Aquila

**Description:**

The use of autonomous vehicles in agriculture is not new: in fact, the availability of sufficiently mature ICT methodologies and technologies and, above all, the ability to act in a confined and controlled environment, have made the industrial production of fully autonomous self-driving tractors sustainable. The advantages of such automation in agriculture in terms of production cycle efficiency are unquestionable. However, the problem becomes more complicated when one thinks of actions more complex than those required for tilling a flat, unobstructed field. Indeed, the morphology and the particular task to be performed may require the coordination of different agents cooperating to achieve a common goal. Unmanned Aerial Vehicles (UAVs) systems will be considered, with the joint use of Unmanned Ground Vehicles (UGVs) and their related technologies for data collection and subsequent field action. In general, the term "drones" identifies both UAVs and UGVs.

Achieving the above goals requires the innovative development of methodologies in the control domain, in different modeling contexts, such as nonlinear systems, finite-state automata, and hybrid systems. In some cases, it will also be important to be able to represent the behavior of the system based on the availability of data gained from experience. A period of activity in the partner company is planned to acquire knowledge specific to the agrifood application area.

**Type of scholarship:** DM 352/2022 – Industrial Project

**Research period abroad:** 6 months, University Polytechnic Hauts-de-France, France

**Research period in a research centre/company/P.A.:** 6 months, BluHub, Pescara
Scholarship 28

**Research theme title:** Development of solutions for mobile and collaborative robotics in complex environments

**Contacts:** Prof. Lorenzo Marconi (lorenzo.marconi@unibo.it)

**Curriculum of DAUSY:** C1 AS for Automation

**Hosting University/Research Centre:** Alma Mater Studiorum - Università di Bologna

**Description:**
In the recent years, there has been a rapid increase of mobile robots’ implementation in industrial settings, with a particular focus on automatic warehouse management. While advancements in mobile robots are contributing to the realization of a smarter and more efficient movement of goods inside warehouses, these results can only be achieved with good performances and repeatability in structured and simpler environment. As a consequence, the use of mobile robots in more complex environment (e.g.: agriculture, construction sites, rescue activities) is becoming of high interest for the expansion of robotics outside manufacturing.

The goal of this project is to develop software solutions for the collaborative use of mobile robots in complex and unstructured environments, such as agriculture (arable crops, orchards, etc.), construction sites, and harsh manufacturing scenarios. Robot navigation functionalities will be achieved through the development of a robust guidance systems for autonomous robot navigation in unstructured and dynamic environment, developing and implementing path-planning, collision avoidance, driving, navigation, and control algorithms. On the other side, the collaboration with humans will be achieved through the development of environment cognition techniques, based on machine vision, and immersive human-machine interaction through extended reality and natural human-robot communication.

The research will be applied to real scenarios provided by Stam S.r.l., an Italian SME specialized in innovative and collaborative robotic solutions for manufacturing and construction industries.

**Type of scholarship:** Project funded by the Hosting Institution

**Research period abroad:** 6 months, Wageningen Centre for Development Innovation, The Netherlands

**Research period in a research centre/company/P.A.:** 18 months, STAM S.r.l., Genova, Italy
Scholarship 29

**Research theme title:** Artificial Intelligence and Control Tools for Cognitive Satellite SAR Systems

**Contacts:** Prof. Giuseppe Notarstefano (giuseppe.notarstefano@unibo.it)

**Curriculum of DAUSY:** C1 AS for Automation

**Hosting University/Research Centre:** Alma Mater Studiorum - Università di Bologna

**Description:**

The availability of powerful devices for digital processing is bringing new opportunities for Radio Frequency (RF) payloads and microwave instruments as well as new challenges, due to higher sampled bandwidth and data rates to be processed. Artificial Intelligence (AI) and control methods include a set of techniques and theories worth exploring in the context of on-board data processing for such payloads, with many possible applications: data reduction (reducing the amount of data to be sent to the ground segment); algorithm acceleration (increasing the payload efficiency); increased operational autonomy (enabling smarter payloads with capabilities to autonomously change operational modes, among others).

Evaluating AI and control methods for a set of reference scenarios will pave the way for their deployment in future RF payloads and microwave instruments. This goal will be pursued through requirement analysis; model selection; optimization; validation and benchmarking in hardware with AI accelerators. Scenarios will need to be defined in the research project in the frame of current applications such as signal identification and very wideband spectrum monitoring for Radio Frequency Interference (RFI), focusing on cognitive SAR applications applicable to the Earth Observation domain, with on-board feature identification and autonomous resource allocation.

**Type of scholarship:** DM 352/2022 – Industrial Project

**Research period abroad:** 6 months, European Space Agency (ESA), The Netherlands

**Research period in a research centre/company/P.A.:** 6-12 months, Thales Alenia Space Italia S.p.A., Rome, Italy
Scholarship 30

Research theme title: Monitoring and optimally managing goods movements on multimodal networks

Contacts: Prof. Simona Sacone (simona.sacone@unige.it)

Curriculum of DAUSY: C2 AS for Smart Environments

Hosting University/Research Centre: University of Genova

Description:
The activity refers to the design of monitoring and optimal management of freight transport operations in networks with multiple transport modes available. In this context, not only offline planning, but also online monitoring and control activities are crucial for an effective and sustainable realization of the requested movements. The activity will specifically consider the following aspects:

- methods and tools for traffic evaluation and forecasting
- minimization of waiting times and management costs
- definition of innovative and effective management schemes as transport federative platforms (cooperative logistics), evolutive truck appointment systems and customs evolutive port tracking interoperability

Type of scholarship: DM 352/2022 – Industrial Project

Research period abroad: 6 months, Delft University of Technology

Research period in a research centre/company/P.A.: 12 months, Circle S.p.A., Genova. Italy
Scholarship 31

Research theme title: Motion planning, control and coordination of off-road autonomous mining trucks

Contacts: Prof. Paolo Falcone (falcone@unimore.it), Dr. Marianna Vivolo (marianna.vivolo@ivecogroup.com)

Curriculum of DAUSY: C2 AS for Smart Environments

Hosting University/Research Centre: University of Modena and Reggio Emilia

Description:

The main objective of this project is the development and the experimental validation of motion planning and control algorithms of off-road autonomous mining trucks.

An off-road autonomous vehicle is expected to be capable of executing challenging driving tasks like, e.g., navigating through rough, uneven terrains, climbing high-slope paths, while operating in a wide range of load conditions. In this project we will assume that a sensing and perception stack is available, which provides the mining truck with the necessary information about the environment, including a description of the road surface ahead. Such a description must include road surface information such that the motion planning algorithm can plan a path that is compatible with the traversability capabilities of the vehicle. For this reason, the motion planning also needs a description of the current vehicle’s capability from the control layer. Design such a planning and control architecture is challenging. In particular, how to distill a description (in terms of state and input constraints?) of the vehicle’s capabilities w.r.t. the road surface is to be understood. We will explore predictive control approaches in this project, which are proven to be very much effective in embedding vehicle’s state and input constrains that could well describe the vehicle capability and the road surface shape.

The developed algorithms will be tested in a simulation environment first. Then, they will be experimental validated through an 8x8 off-road mining truck prototype manufactured by Iveco.

Type of scholarship: Project funded by the Hosting Institution

Research period abroad: 6 months, Department of Electrical Engineering, Chalmers University of Technology, Gothenburg, Sweden.

Research period in a research centre/company/P.A.: 12 months, Iveco Defense Vehicles, Bolzano BZ
Scholarship 32

**Research theme title:** Predictive maintenance, fault and anomaly detection for chemical and pharmaceutical processes

**Contacts:** Prof. Luca Consolini (luca.consolini@unipr.it)

**Curriculum of DAUSY:** C2 AS for Smart Environments

**Hosting University/Research Centre:** University of Parma

**Description:**

Pharmaceutical production involves complex and critical processes. Various sensors monitor process variables (for instance, temperatures and pressures) to ensure that all phases respect specifications, and that the drug product is of the desired quality. Pharmaceutical plants store process data for years of operation. Potentially, these data can be used to evaluate the state of the plant, and to detect possible faults. Sudden variations of process signals allow to detect anomalies, while slow variations of measured signals can be used to perform predictive maintenances.

In particular, this research will be focused on freeze-drying. This is a standard process in pharmaceutical industry, used to stabilize, store and increase the shelf life of drug products. The product has to be brought to a very low pressure and the lyophilization chamber has to be perfectly sealed. Even small external leaks can contaminate the entire drug batch. Since a single batch may contain thousands of product vials, freeze-dryer leakages are one of the most critical problems of the entire production chain of lyophilized drugs.

First, the research will evaluate mathematical models for lyophilizers, able to describe possible faults. Then, the research will formulate algorithms for identifying process anomalies and, in particular, for finding and separating internal and external leaks.

The research will be carried out in collaboration with pharmaceutical company GSK, which is the final user of the developed methods. The proposed algorithms will be implemented and tested in GSK production plant in San Polo di Torrile (PR).

**Type of scholarship:** DM 352/2022 – Industrial Project

**Research period abroad:** 6 months, GSK R&D center in Rockville, USA

**Research period in a research centre/company/P.A.:** 6 months, GSK production plan in San Polo di Torrile, Parma
Scholarship 33

**Research theme title:** Causal representation learning for time series monitoring in continuous food manufacturing processes

**Contacts:** Prof. Paolo Fiorini (paolo.fiorini@univr.it)

**Curriculum of DAUSY:** C3 AS for Monitoring and Security

**Hosting University/Research Centre:** University of Verona

**Description:**

The Industry 4.0 paradigm is allowing the acquisition of large volumes of data, thanks to the availability of sensors and the easy interconnectivity among machines. However, the correct and useful processing of the data collected is still far from being solved. This problem is affecting industries in all sectors, but it is more significant in continuous production, especially for processed food. Here, product quality is affected not only by the plant variables, but also by external variables, such as humidity, heat, and raw material quality. In this sector, quality is often demanded to production line workers who know how to adjust the plant parameter based on their experience. Unfortunately, the diversification of products, the variety of supplier quality and the retirement of production experts, makes it necessary to find alternate and more repeatable solutions.

A successful PhD thesis has addressed the problem of process modeling by introducing causality in the data collected to identify more precisely the relations existing among the variables and the steps of product processing. However, the results are still not sufficient to develop an accurate plant monitoring system and an advisory system that could indicate the parameter adjustments to the plant operators.

The goal of this project is to develop a robust plant monitoring system that could predict with a reasonable level of accuracy the product quality and could suggest the appropriate parameter changes to the plant operators. We will expand the causality approach developed so far and will integrate it with other identification and modeling tools, e.g. supervised, unsupervised, and reinforcement learning, to better model the employees experience and to map it to corrective actions for the plant. Attention will be also given to the implementation parts of the project, to design and set up the appropriate infrastructure capable of handling the data flow, at different time rates and resolution.

**Type of scholarship:** DM 352/2022 – Industrial Project

**Research period abroad:** 6 months, Technische Universität Darmstadt – Computer Science Department, Germany

**Research period in a research centre/company/P.A.:** 12 months, Mafin S.r.l., Padova, Italy
Scholarship 34

Research theme title: Predictive Maintenance and Anomaly Detection for Agricultural Tractors

Contacts: Prof. Sauro Longhi (sauro.longhi@univpm.it)

Curriculum of DAUSY: C3 AS for Monitoring and Security

Hosting University/Research Centre: Università Politecnica delle Marche

Description:

The new technologies that the industrial revolution 4.0 has provided to autonomous systems have allowed to improve and automate different aspects of the systems, particularly thanks to the big amount of data now available to analyze and predict the system behaviour. This knowledge can improve the system monitoring and control and give an important contribution to develop better decision-making strategies and to optimize maintenance and costs for the autonomous systems.

The research activity aims to develop methodologies for the analysis of data from multiple sources (sensors onboard, data lake, etc.) in order to plan actions to be taken to improve the reliability and optimize the performance of the system components, while ensuring the safety of the people involved and the correct functioning of the components themselves.

Thus, the main challenges will lie in defining efficient techniques (data-driven and / or model-based) for predictive maintenance and anomaly detection for mechanical components aimed at predicting and preventing faults and anomalies.

The research will be applied to real scenarios provided by CNH Industrial Italia SpA.

Type of scholarship: DM 352/2022 – Industrial Project

Research period abroad: 6-18 months, Universite de Lorraine, CNRS - Faculté des Sciences et Technologies, France

Research period in a research centre/company/P.A.: 6-18 months, CNH Industrial Italia S.p.A., Modena, Italy
**Scholarship 35**

**Research theme title:** Self-diagnosis and total fault prediction solutions based on data and signals in autonomous machines for structural steel processing

**Contacts:** Prof. Sauro Longhi (sauro.longhi@univpm.it)

**Curriculum of DAUSY:** C1 AS for Automation

**Hosting University/Research Centre:** Università Politecnica delle Marche

**Description:**

In the context of Industry 4.0 the need for even more intelligent production systems organised as cyberphysical production systems (CPPSs) is increasing the focus on Predictive Maintenance (PdM) strategies to increase the utilization rate (availability) of production equipment and decrease the cost of downtime. By affecting equipment availability, PdM have a direct impact on the overall effectiveness of both equipment and throughput, generating both cost and time savings. The aims are to establish an intelligent, interoperable, and autonomous production environment. The problem of self-diagnosis and total fault prediction solutions is receiving enormous interest for an efficient and reconfigurable manufacturing environment. Collaborative robots or automatic devices for handling the tools change or to feed the automatic machineries without human intervention in an automated shopfloor of smart factories is indeed a significant challenge for the realtime control and management aimed at predicting and preventing downtime while ensuring an increase in machines availability, productivity, and production flexibility. The objective of this project is to estimate the wear of the automatic machineries, mainly in their critical components such as tools, motor operated devices, actuators, mechanical or electrical devices, etc. in order to go towards self-diagnosis and total fault prediction of these machines. Further investigations and results should relate to solutions to predict production and machines needs without human intervention. For the purposes of predictive maintenance, algorithms and solutions must be studied in a broad spectrum considering multiple approaches, such as signal-based, datadriven, machine learning and so on, the solutions must be focused on forecasting the residual useful life of the devices. analyzed and of the machinery in a more general sense.

**Type of scholarship:** DM 352/2022 – Industrial Project

**Research period abroad:** 6 months, Maynooth University - Department of Electronic Engineering, Maynooth, Co. Kildare, Ireland

**Research period in a research centre/company/P.A.:** 6-12 months, SCHNELL S.p.A., Colli Metauro, Italy
Admission procedure and requirements

More information: http://dausy.poliba.it/phd/application/
Requirements

- **Language requirements**
  - If English is not your native language, you need to demonstrate a degree of proficiency corresponding, at least, to the B2 level of the Common European Framework of Reference for Languages (CEFR).
  - Knowledge of Italian is preferred but not required.

- **Specific requirements**
  - **Candidates must hold an M.Sc. Degree (degree completed before October 31st),** preferably in Systems and Control, Electrical Engineering, Artificial intelligence (AI), Mechanical Engineering, or related subjects. **Moreover, candidates should fit the following profile:**
    - Being a talented and enthusiastic young researcher;
    - **Strong background in control and automation;**
    - Strong academic background and rich experience in engineering systems, embedded systems, and system design;
    - Good programming skills in MATLAB/Simulink and/or Python;
    - Being a team player with excellent communication and cooperation skills, in a dynamic and multi-disciplinary project-driven environment;
    - Creativity and ambition, hard-working and persistent mindset;
    - Ability to independently organize your work;
    - Good scientific writing skills.
Application procedure

All the information regarding the application are available at:

http://dausy.poliba.it/phd/application

Application opened on June 22\textsuperscript{nd}, 2022

Application will be closed on September 5\textsuperscript{th}, 2022, 9AM (CEST)

Evaluation of qualifications held and research proposal

Interviews will be between September 12\textsuperscript{th} – 23\textsuperscript{rd}, 2022

Official Ph.D. program start: November 1\textsuperscript{st}, 2022

The deadline for the application is September 5th, 2022, 9 AM (CEST).
Required attachments to application (only OFFICIAL templates MUST be used):

- A detailed **curriculum vitae** including research experience, project experiences, and/or any previous publications;
- A valid **identification document**;
- **Degree qualification certification for first (Bachelor) degrees and second (specialization/Master’s) degrees**;
- An **abstract of the thesis of the specialist/Master’s degree** (or five-year Single Cycle degree);
- The **candidate’s Master’s degree thesis** (or five-year Single Cycle degree);
- A **Ph.D. research proposal according to one of the available scholarships and using the template available on the website** [http://dausy.poliba.it/phd/application](http://dausy.poliba.it/phd/application)
Optional application attachments (Note that only the official templates for the required attachments must be used):

- A **self-certification for any other qualification** deemed suitable for evaluation (official template: Dichiarazione altri titoli);
- Two **letters of presentation** from professors or researchers in Italy or abroad;
- **Language certification**;
- Any **publications**.

Italian candidates may be required to provide additional self-declarations. Please refer to the official call for application for additional details.
Application procedure

The application has to be sent through the POLIBA ESSE3 platform

- visit the webpage [https://poliba.esse3.cineca.it/Home.do](https://poliba.esse3.cineca.it/Home.do);
- select MENU followed by REGISTRAZIONE;
- insert the required data.
Application procedure

- visit the webpage [https://poliba.esse3.cineca.it/Home.do](https://poliba.esse3.cineca.it/Home.do);
- access the restricted area (Area Riservata);
- update any personal data by selecting HOME, in particular the e-mail address to which all information on the selection procedure will be sent;
- select SEGRETERIA from the menu on the right, followed by TEST DI AMMISSIONE – ISCRIZIONI CONCORSO;
- select the DAUSY Ph.D. program;
- insert all the required information;
- attach all documents and self-certification using the official model;
- pay an administration fee of € 30 (deadline 09:00 AM 05 September 2022), using only the PagoPA method;
- missing payment on Esse3 will result in exclusion from the selection phase.
Admission examination

The selection board shall assign a maximum of 100 points to each candidate based on:

- **Maximum 20 points** based on an assessment of qualifications held (average exam marks, final degree mark, theses, Master’s degrees, post-graduate courses, language certification, publications, etc.);
- **Maximum 40 points**: based on an assessment of the Ph.D. research proposal done according to the template;
- **Maximum 40 points**: based on an interview to ensure a complete evaluation of the candidate and to verify the applicant’s aptitude for research and willingness to undertake experience abroad and areas of research interest.

Interviews will be between September 12th – 23rd, 2022
National Ph.D. Program in Autonomous Systems
http://dausy.poliba.it

Prof. Engr. Mariagrazia DOTOLI (mariagrazia.dotoli@poliba.it)

Full Professor in Automation
Department of Electrical and Information Engineering – Politecnico di Bari

Coordinator of the National Ph.D. Program in Autonomous Systems