
FABIO PREVIDI

Born in Milano (ITA), August 22 1968.

E-mail: fabio.previdi@unibg.it

Web: <http://move.unibg.it/previdi>

CURRENT POSITION

Full Professor in Control Systems at the Department of Management, Production and Information Engineering, University of Bergamo.

PREVIOUS POSITIONS

- ❑ 2006-2017 **Associate professor in Control Systems**, University of Bergamo
 - ❑ 2002-2006 **Assistant professor in Control Systems**, University of Bergamo.
 - ❑ 1999-2002 **Research assistant** at the Department of Electronic, Information and Bioengineering, Politecnico di Milano.
 - ❑ 1999. **Research Assistant** at the Centre for Systems and Control, Department of Mechanical Engineering, University of Glasgow (UK).
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EDUCATION

- ❑ 1987-1993 **Master of Science in Electronic Engineering (Control systems)** – Politecnico di Milano.
Thesis: “Identification of nonlinear dynamical systems using neural networks”. Advisor: Prof.ssa M. Sami.
- ❑ 1994-1995 **Master of Science in Physics** – University of Milan.
Thesis: “Development of a subspace identification method for the classification of light charged ions in nuclear physics experiments”. Advisor: Prof.ssa L. Zetta.
- ❑ 1996-1999 **PhD in Control Systems** – Politecnico di Milano.
Thesis: “Identification and control using local model networks”. Advisor: Prof. S. Bittanti.

RESEARCH

RESEARCH INTERESTS

In 2012 I founded the as **Control Systems and Automation Laboratory** of the University of Bergamo, Currently there are 3 post-doc researcher, 3 PhD students and 2 research assistants.

My research activity is divided into **methodological research** and **applications**, with a predilection for the latter. In particular, an important part of my work is focused on **technology transfer**, i.e. the implementation of control schemes and algorithms (in identification, control or diagnostics) to effectively apply, in different application and industrial sectors, the most innovative methodologies of the control research.

My activity is divided into two major issues, which do not exhaust the variety of my interests, but well represent them.

1) **Control systems and mechatronic**

This activity is about the development of new control methodologies (and/or architectures) for mechanical systems and machines (mainly used in industry). The research is applied to the design of automatic control methods for special machines (possibly also niche vehicles), in particular: bridge cranes, polymer dosers, extruders, self-balancing machines, suction systems etc ...In this area, fault diagnosis and health monitoring of machines and industrial plants play a very important role. Specifically, the research includes the development of innovative diagnostic and fault isolation methods for mechatronic systems, mainly in the industrial or aerospace sector. This area also includes biomedical applications of control, in particular the development of methods and control technologies for biomechanics, specifically rehabilitation systems based on Functional Electrical Stimulation.

2) **System Identification and Data Analysis**

I have always worked on these issues focusing mainly on the development of algorithms for the identification of nonlinear and/or time-varying models. Currently my research is focused on the application of Machine Learning methods to the identification of dynamical systems. More specifically, the research is focused on the use of kernel methods for semi-supervised identification. Also, there are many application cases of data engineering in different industrial sectors where such methods have been used.

FUND RAISING

2018-2020 SMART4CPPS – Smart Solutions for Cyber-Physical Production Systems

Funded by **Regione Lombardia**

16 partners, total budget 7.405.050 Eur, 30 months (april 2018-october 2020)

University of Bergamo (leader prof. Previdi) 694.250 Eur

Smart4CPPS is an initiative created within the "Smart Manufacturing" working group of AFIL (Lombardy Association for Smart Factory), and specializes in the Cyber-Physical System (CPS) paradigm, the backbone of Industry 4.0, on the specificities of Lombardy manufacturing industry, with its excellence in the production of components and machines. The proposed paradigm consists of Smart-CPS, which means that ICT technologies are no longer just support for production processes, but are integrated into components, machines, and environments that become CPS intercommunicating and intelligent. This requires: (i) innovative modular digital infrastructures, which allow efficient management of the industrial data in all phases of its life cycle (Realization Goal - OR1); (ii) innovative and low-cost smart components (OR2); (iii) smart machines that evolve to constantly maintain maximum productivity (OR3); (iv) and tools for the smart factory (OR4). The four ORs will be analyzed along six Pilot Projects in which the enabling technologies of the ORs will be validated. The initiative is organized in synergy with BEinCPPS-I4MS which is an expression of the European Vanguard regions, and which shares the mission for the creation of regional ecosystems of excellence.

The CAL is involved in two activities:

- i) the design of health monitoring systems for actuators (ballscrews and valves);

- ii) the design of an Artificial Intelligence systems for the end-of-line tuning of thermomagnetic switches for low-medium power systems.

2017-2019 SMARTLIVING4ALL

Funded by **Regione Lombardia**

4 partners, total budget 1.237.046 Eur, 18 months (November 2017-May 2019)

University of Bergamo (leader prof. Previdi) 292.925 Eur

The goal of this project is the development of technology to improve (in quality and safety) the everyday life of babies (less than 3 yo) and elderly.

The core of the activity are wearable sensors embedded in the normal clothes that are able to provide ECG, breath frequency, inertial measurements and temperature. The sensors are in connection with a hub (based in the bed/crib for babies, in the bedside table for adults) which is endowed with additional (environmental) sensors (microphone, camera, etc.). The hub is in communication with the home automation system and with the personal devices of parents (in the baby case) or relatives/caregivers (in the elderly case).

The CAL is in charge for the development of algorithms to be used in the various use case, as: to recognize the wellness state of the baby; to monitor the quality of sleep; to understand the typical behavior of the parents/caregivers and to anticipate their needs of information; to identify dangerous or emergency situations for the adults, like a fall, a discomfort, etc...

2017-2019 INTERNET OF BEAUTY – Smart and safe appliances for smart living

Funded by **Regione Lombardia**

4 partners, total budget 1.125.000 Eur, 18 months (November 2017-May 2019)

University of Bergamo (leader prof. Previdi) 180.000 Eur

The leading partner of this project is a transnational company leader in the production of small appliances, in particular for hair care. So, the main goal of this project is to design smart hair-dryers and hair straighteners endowed with additional sensors (inertial and proximity), computation capability and communication with the home automation systems. The appliances will host a IoT platform that will be able to auto-configure the device on the basis of sensor measurements and additional information about the hair features.

The CAL will design algorithms of image processing that will be able to extract the main features of the hair of the current user based on simple images. This information will be given to the hair-dryer for automatic configuration of the operating parameters, such as air temperature and flow. In addition, algorithms for increasing the user safety will be designed, such as fall or overheating detector.

2016-2019 REPRISE - Reliable Electro-mechanical actuator for PRImary Surface with health monitoring

Funded by the **European Union (H2020) Clean Sky 2 Joint Technology Initiative**

3 partners, total budget 995.000 Eur, 36 months (July 2016-June 2019)

University of Bergamo (leader prof. Previdi) 263.750 Eur

This project is part of the research for the development of electric actuators for primary flight surfaces of small aircrafts. The main objective is to develop condition assessment algorithms, that are able to provide indications on the current "health status" of the electromechanical component, giving quantitative indications for the maintenance programming.

The CAL is in charge for the development of the experimental activity on a real actuator installed on a test bench. The experiments will lead the specimen to a complete failure also by means of overload operation conditions and suitable fault injection, like lubricant partial or complete revomal.

On the basis of the available measurements (currents, position) a Change Detection algorithm will be developed. The algorithm is designed to identify changes in the stochastic properties of one or more time-varying features computed using the physical measurements.

2014-2017 ADAPTIVE - A modular and adaptive approach to the design of digital factories

Funded by **MIUR (Italian Ministry of Education University and Research)**

8 partners, total budget 11.100.000 Eur, 48 months (January 2014-December 2017)

University of Bergamo (leader prof. Previdi) 864.000 Eur

The ADAPTIVE project aims to develop technologies and solutions to improve the capacity of modern factories to be flexible and efficient, in order to respond adequately to the changes required by the increasingly fast dynamics of the market. The project aims at the development of innovative devices and machines to support the reconfiguration and adaptation of machines and robots, as a basis to support the ever faster market dynamics and with greater requests for customization.

Higher Education initiatives (Postgraduate Masters and Research Doctorates) are part of the project.

The research is organized according to three main Research Goals (OR):

OR 1: Re-configurability and flexibility of robotic cells.

OR 2: Flexible, modular and adaptive manufacturing systems.

OR 3: Human-machine adaptive and efficient interfaces.

The CAL is involved in the OR2. Its duties are:

- the development of methods for automatic SW design for special machines (i.e. self-balancers, polymer processing etc...);
- the design and realization of a system for remote maintenance based on smartphones.

2014-2016 HOLMES - Health On Line Monitoring for Electromechanical actuator Safety

Funded by **Unione Europea (FP7)** Clean Sky Joint Technology Initiative

2 partners, total budget 490.000 Eur 24 months (July 2014-June 2016)

University of Bergamo (leader prof. Previdi) 136.000 Eur

This project is part of the research for the development of electric actuators for aircraft flight surfaces, with the aim of reducing or completely eliminating hydraulic systems. The main objective is the development of a fault detection algorithm to detect the occurrence of potentially serious failures of mechanical components. In particular, one of the goals is to achieve an effective diagnostic without using additional sensors (such as accelerometers widely used in mechanical fault detection) on the internal mechanical components (spheres, screws, ...). The idea is to monitor the indirect effects in the standard measurements to detect performance degradation.

The CAL assignment are:

- the development of the experimental activity using a test bench equipped with an electromechanical actuator subject to a load generated by an hydraulic actuator. Faults are artificially injected by reducing the sphere number, damaging the spheres themselves of the screw thread.
- the design of algorithms for fault detection based only on standard measurements, better using model free methods.

TOUCHPLANT

Funded by **Regione Lombardia**

5 partners, total funding 1.274.375 Eur, 20 months (January 2014-August 2015)

University of Bergamo (leader prof. Previdi) 242.000 Eur

The objective of this project is the development of an integrated (and cheap) system for remote monitoring and diagnostics of machines and plants, based on widespread and flexible technologies (such as smartphones or tablets) for the display of data and for remote maintenance.

In particular, the system is able to provide, in a selective way according to the user profile, the most useful information for it, going to increase and simplify the degree of human-machine integration regardless of the skills of the operator. The system provides many functionalities at "touch": from the specific information of the single machine to the productivity indicators of the entire plant.

The CAL task in the project is the development of a SW system that is capable of interacting with the machine electronics (through a Wifi-CANbus gateway), acquiring the diagnostic data and hrd-real-time synchronizing them to the audio-video streaming to be transferred to the remote maintenance center. Also, an app for mobile systems and a desktop application have been developed.

PRIN 2008 “Innovative modular micro robotic instruments for endoscopic transluminal surgery”

Funded by **MIUR (Italian Ministry of Education University and Research)**

4 partners, total budget 106.000 Eur, 24 months (January 2010-December 2012)

University of Bergamo (leader prof. Previdi) 23.595 Eur

The project goal is the development of a modular robot for endoscopic surgery as a natural evolution of passive instruments. In this project, a prototype of a single module has been designed.

The CAL task is the design of the position control system for the locking of the articulated robotic arm, which must move within the peritoneal cavity in a well-defined and controlled way. The activity was focused on simulations and methodological aspects, in particular the development of new control algorithms. A simulation model of the bi-phasic variable impedance actuator was developed on which control algorithms belonging to the Iterative Learning Control family (ILC) and of the direct data design methods were tested, in particular Virtual Reference Feedback Tuning (VRFT). In this particular case, a new method for calibrating cascade controllers was developed using a single experiment.

VISITING

Visiting researcher at

- June-August 2013 - Department of Mechanical Engineering, University of California Santa Barbara (USA)
- September 1999-March 2000 – Department of Mechanical Engineering, University of Glasgow (UK)
- September 1997 - Rutherford Appleton Laboratory, Didcot (UK)

ACTIVITIES IN SCIENTIFIC SOCIETIES

- Member of **IFAC Technical Committee TC8.2 Biological and Medical Systems**
- Member of **IFAC Technical Committee TC5.1 Manufacturing Plant Control**
- Member of **IEEE Control Systems Society**
- Member of **IEEE Industrial Electronics Society**

INVITED TALKS

“Research and innovation in Product Service Systems: challenges and future trends”

8th International Conference CIRP IPSS (Industrial Products-Service System), 20-21 June 2016, Bergamo (Italy)

ORGANIZATION OF SCIENTIFIC EVENTS

- **Organizing Committee member 2018 IFAC INCOM (Information and Control in Manufacturing)**, Bergamo (ITA), June 2018
- **Organizing Committee member 2011 IFAC World Congress**, Milano (ITA), August 2011
- **Organizing Committee member 2008 IEEE Multiconference on Systems and control MSC2008**, San Antonio, Texas (USA), October 2008
- **International Program Committee member 2006 IFAC Symposium on Modeling and Control in Biomedical Systems MCBMS2006**, Nantes (FRA), September 2006.
- **International Program Committee member 2006 International Symposium on Automatic Control**, Wismar (GER), September 2005.
- **National Organizing Committee member 2001 IFAC Workshop on Adaptation and Learning in Control and Signal Processing ALCOSP2001**, Como (ITA), August 2001.

PUBLICATIONS

43 papers in peer reviewed journals (ISI/Scopus - WoS)

84 papers in peer reviewed proceedings of international conferences (ISI/Scopus - WoS)

6 patents

<https://cal.unibg.it/publications/>

TEACHING

COURSES

Currently, I am teaching

- **Fondamenti di Automatica 9 CFU (Control Systems basics).**
- **Controlli Automatici 6 CFU (Advanced Control Systems)**
- **Automatica 6 CFU (Control Systems basics)**

In the past, I taught many courses, both at undergraduate and at graduate/doctorate level, mainly at the University of Bergamo and the Politecnico di Milano. In total, **31 annual courses** (9, 10 or 12 CFU).

1999/00-2002/03 (4 years)	Fondamenti di Automatica 10 CFU,	Management Eng., University of Bergamo
2001/02-2008/09 (8 years)	Automatica 10 CFU,	Computer Eng., University of Bergamo
2002/03-2003/04 (2 years)	Automazione Industriale 5 CFU,	Computer Eng., University of Bergamo
2004/05-2009/10 (6 years)	Controllo Digitale 5 CFU,	Computer Eng., University of Bergamo
2005/06-2007/08 (3 years)	Controlli Automatici 5 CFU,	Aerospace Eng., Politecnico di Milano
2006/07 (1 year)	Identificazione dei Modelli e Analisi dei Dati 5 CFU,	Computer Eng., University of Bergamo
2008/09 (1 year)	Fondamenti di Automatica 10 CFU,	Electric Eng., Politecnico di Milano
2008/09 (1 year)	Controlli Automatici per la Meccatronica 2,5 CFU,	PhD course in Mechatronics, Università di Bergamo
2009/10 (1 year)	Metodi di Identificazione dei Modelli per la Meccatronica 2,5 CFU,	PhD course in Mechatronics, Università di Bergamo
2009/10 (1 year)	Automazione Industriale 5 CFU,	Computer Eng., Politecnico di Milano
2009/10-2015/16 (7 years)	Fondamenti di Automatica 9 CFU,	Computer Eng., University of Bergamo
2010/11-2015/16 (6 years)	Controlli Automatici 6 CFU,	Computer Eng., University of Bergamo
2010/11-2015/16 (6 years)	Automatica 6 CFU,	Ing. Gestionale, University of Bergamo

SUPERVISION OF PHD STUDENTS

Current

1. 2019 – *System identification using kernel methods* – Matteo Scandella
2. 2019 – *Control systems methods for reactive trading and finance applications* – Gabriele Maroni

Past

3. 2018 – *Methods for simulation and SW design of reconfigurable manufacturing systems* – Andrea Piccinini
4. 2018 – *Health monitoring in electromechanical actuators for small aircrafts* – Yamuna Maccarana
5. 2017 – *Learning meets control* – Mirko Mazzoleni
6. 2016 – *Integrated methodologies of software development and remote maintenance for semi-automated machines* – Paolo Sangregorio
7. 2016 – *Collision and impact detection algorithms in industrial systems* – Fabio Angeloni
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9. 2015 – *Engineering support system for sustainable optimization of automation tasks supervision* – Mauro Mazzolini
10. 2015 – *Control and estimation problems based on inertial measurements in industrial mechatronic systems* – Michele Ermidoro
11. 2014 – *Servomechanisms position control: innovative technologies and new control problems* – Damiano Belloli
12. 2014 – *Identification, estimation, filtering and control problems in the polymer processing industry* – Alberto Cologni
13. 2013 – *Design and implementation of an industrial Autonomous Guided Vehicle* – Matteo Madaschi
14. 2010 – *Motion control in self-balancing systems: design, implementation and integration with machine supervision systems* – Federico Fico

Supervisor of many graduate thesis.

TECHNOLOGY TRANSFER

- 1) Starting in 2002 I have developed many **research activities in collaboration with companies** funded by the firms themselves (research activity “for third parties”). Many of these activities led to scientific publications that, in many cases, are co-authored by industry researchers.
- 2) From 2006 to date I have been a **Member of the Scientific Technical Committee of the Intellimech Consortium for mechatronics**. The Intellimech Consortium is an association of companies, with industrial governance, with the aim of sharing pre-competitive research activities, technical training activities and industrial research activities through participation in calls for funding.
- 3) From 2012 to 2015 I was a **Member of the Board of the University Center for the Management of Innovation and Technology Transfer (GITT)**. The aim of the GITT is to favor industrial research activities and the development of services to companies with peculiar characteristics of interdisciplinarity.
- 4) As part of technology transfer activities for companies, I organized and provided **training courses on specific topics with university-level contents**. In particular:
 - Mechatronics Course with application to polymer dosing systems (20 hours) at DOTECA spa, San Martino Spino (MO), October 2011
 - Mechatronics Course (16 hours) at UMBRA Group, Foligno (PG), June 2010.
 - Mechatronics Course (16 hours) organized by Consorzio TCN (Numerical Computing Technologies and Training) at the FIAT Research Center, Orbassano (TO), March 2009.
 - Mechatronics Course (16 hours) organized by Consorzio TCN (Numerical Computing Technologies and Training), Bergamo, December 2007.
- 5) I have been invited to keep **invited talks on industrial issues in industrial research events**.
 - *"Industry 4.0 and maintenance: how it will change maintenance in the digital age"*, as part of the national conference "Innovating maintenance in the Industry 4.0 era: opportunities, critical issues and solutions", organized by MEGMI Executive Master in Management of Industrial Maintenance (University of Bergamo and Polytechnic of Milan), Bergamo, 6 April 2016.
 - *"Vibration active and semiactive control in agricultural machines: an introduction"* as part of the national conference "Experimental methods for the measurement of comfort, durability and performance of tractors, operators and components in the agricultural sector", organized by ISMA (Experimental Institute for the Agricultural Mechanization) of Treviglio (BG), 22 March 2005.
 - *"Control applications of mechatronic systems"* at the conference for industry in the Bergamo area organized by Net4Mec (Network for research and innovation in the mechanical industry in Lombardy), Dalmine (BG), 20 March 2003.

SERVICE FOR THE UNIVERSITY ORGANIZATION

- 2019-ongoing **Coordinator of the Research Committee**, Department of Management, Production and Computer Engineering
- 2018-ongoing **Member of the Board of the PhD course in Engineering and Applied Sciences**
- 2014-2016 **Member of the Board of the PhD course in Engineering and Applied Sciences**
- 2011-2016 **Delegate of the University Rector in the Board of the University Sport Centre (CUS)**
- 2012-2015 **Member of the Board of the University Center for the Management of Innovation and Technology Transfer.**
- 2015-ongoing **Member of the Research Board of the Department of Management, Production and Information Engineering.**
- 2010-2013 **Member of the Board of the PhD course in Mechatronics**
- 2005-2009 **Member of the Integrated Academic Senate**