

# Andrea Calanca

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## PERSONAL INFORMATIONS

Name ANDREA CALANCA  
Birth March 12<sup>th</sup>, 1981  
Address Via Fonte Tognola n. 4,  
37135 Verona  
Italy

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Linkedin <http://www.linkedin.com/profile/view?id=53047066>



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## EDUCATION

### PhD in Computer Science (2014)

University of Verona  
Thesis: Compliant Control Of Elastic Actuators For Human-Robot Interaction  
Supervisor: Prof. Paolo Fiorini  
Doctoral Committee: Prof. Darwin Caldwell, Prof. Antonio Bicchi

### Master Degree in Computer Engineering (2006)

University of Pavia  
Thesis: MIMO Identification of an Industrial Robot  
Vote 110/110 cum laude

### Bachelor Degree in Computer Engineering (2003)

University of Pavia  
Thesis: File System Design for a DSP Embedded Application  
Vote 110/110

### High School (2000)

Liceo Scientifico Tecnologico "E.Fermi"  
Short Thesis: How Physics Sounds  
Vote 94/100

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## EMPLOYMENT

### 2017 – Today

*Assistant Professor (Ricercatore a tempo determinato di tipo A) at University of Verona – Computer Science Department*

Teaching of classic and advanced topics in robotics, control theory and Cyberphysical laboratory.  
Research on upper limb exoskeleton design and control, emg-based control, robotic needle insertion and steering for surgical applications.

**2015 – 2017**

*Post Doc Researcher at University of Verona – Computer Science Department*

Teaching of classic and advanced topics in control theory. Research on force and impedance control, passive dynamics walkers, lower limb exoskeleton design, emg-based control.

**2015 – 2017**

*Adjunct Professor of Robotics at University of Brescia – Information Engineering Department*

*(Contratto di lavoro autonomo per l'attività didattica)*

Teaching of robot kinematics, dynamics and control. The course also includes laboratory exercises and practical projects.

**2014 – 2015**

*Advanced Control Specialist at Electrolux*

Investigation and development of advanced identification and control algorithms for dynamic balancing control of horizontal axis washing machines.

Related topics: System Identification, Joint States and Parameter tracking, Non-Linear Control.

**2011 – 2014**

*Phd Student at University of Verona – Computer Science Department*

Thesis: Compliant control of elastic actuators for human-robot interaction.

**2010 – 2011**

*Research Assistant at University of Verona – Computer Science Department*

Research on assistive active orthoses for the lower limbs, force control, pneumatic artificial muscles

**2009 – 2010**

*Research Assistant at University of Verona – Computer Science Department*

Research on algorithms for voice synthesis and voice enhancing based on physiological glottal models

**2008 - 2009**

*Audio DSP Engineer at Overloud (Audio DSP)*

Analysis and identification of reverberation structure for non-convolution algorithms

Related topics: Artificial Reverberation Algorithms, Real-Time Programming, Object Oriented Programming.

**2008**

*Automation Engineer at Sidel s.p.a. (Industrial Automation)*

Development and maintenance of control software for industrial machinery.

**2006 - 2008**

*Software Engineer at Provenia s.r.l. (ICT)*

Design and development of business software applications

Related topics: OO Architectures, Design Patterns, Generic Programming, Concurrent Programming.

**2003**

*University Stage at Charlie Lab s.r.l. (Audio DSP)*

Design and Development of a FAT File System within an Embedded Device for real-time audio streaming.

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**RESEARCH**

My research interests are in the area of robotics and control theory. Within the Altair Robotics Laboratory, I currently lead a team of ten members doing research on force control, assistive robotics,

emg-based control, soft robotics and needle steering for surgical applications. A special focus is in control technologies for advanced physical human-robot interaction including the control of assistive and rehabilitation devices and human-robot cooperation. I am also interested in exoskeletons, active orthoses and prostheses, passive dynamic systems, virtual sensing and data fusion, adaptive and learning systems and bio-inspired algorithms. The passion for translating theoretical concepts into practical applications led me to develop and patent control and DSP algorithms for market applications.

## RESEARCH Projects

Principal Investigator for the research project "Design of an emg-controlled upper limb robotic orthosis for muscular weakness" (**Progettazione di un'ortesi robotica per l'arto superiore con controllo mioelettrico e indirizzata a soggetti con debolezza muscolare**) funded by European Social Fund (Fondo Sociale Europeo). Budget: 92.70kEUR; Duration: October 2018 - October 2019, 4 temporary researchers hired.

Principal Investigator for the research project "**Forecast**" funded by the European Union, Horizon 2020 research and innovation programme, through an Open Call issued by the EUROBENCH Project. The EUROBENCH project aims at creating the first benchmarking framework for robotic systems in Europe. The FORECAST project focuses on benchmarking force control algorithms for robotic locomotion applications such as exoskeletons and humanoids. Budget: 98.63kEUR; Duration: March 2018 - September 2020, 6 temporary researchers hired.

Technical leader of the **PROST** project ERC Proof of Concept Grants, with Grant Agreement No. 875523. PROST project aims at the technical and commercial validation of an Autonomous Prostate Biopsy System that will use robotic autonomy to reduce human errors in prostate cancer diagnosis.

Technical and scientific leader of the work package (WP) "Real Time Task Control" of the project **Autonomous Robotic Surgery** (ARS) funded by the ERC Advanced Grant 2016 category with Grant Agreement No. 742671. The WP concerns the real-time adaptation of the patient's model, the localization of surgical instruments within such a model and the execution of learned actions in position, force and impedance control. (2018 – Today)

Member of the UNIVR team of the **MURAB** project Autonomous Robotic Surgery funded by the European Union, Horizon 2020 research and innovation programme, Grant Agreement No. 688188. In this project I am involved the design and control of a robotic device for needle insertion and for the development of identification and control algorithms for needle steering. (2017 – Today)

Within the project "Movement disorder and rehabilitation of cerebral palsy" funded by Cariverona Foundation I was the technical manager of a small research group for the design and development of a mobile robotic orthosis for autonomous walking of cerebral palsy patients. (2009-2010)

Within the project "Integration of advanced voice synthesis features on embedded platform" (Integrazione delle funzionalità di centralino e delle funzionalità vocali avanzate su piattaforma embedded) funded by European Social Fund (Fondo Sociale Europeo) I developed algorithms for voice synthesis and voice enhancing based on physiological glottal models. (2010-2011)

## RESEARCH Contracts

Coordinator and technical manager for the research contract "Metodologie per l'analisi statistica di segnali eterogenei al fine di identificare anomalie rispetto alla storia pregressa di uno o più segnali", Contact n. 271507 - 03/09/2018 with the company C.S.T. s.r.l. (PIVA 10132000158), Budget 14k EUR;

Coordinator and technical manager for the research contract "Analisi di strategie esistenti di stima e ridistribuzione del carico in macchine di lavaggio rotative e sviluppo di un algoritmo di stima del carico basato su sensori giroscopici".

Contact n. 6785 - 13/01/2017 with the company Electrolux Italia S.p.a. (PIVA IT00065130932), Budget 23k EUR;

## **RESEARCH Collaborations**

Currently, I currently lead research team of ten people with several national and international collaborations. The team is composed by a PhD student, a master student, 6 research assistants funded by my projects, 2 research assistants funded by other projects. It follows the list of national and international collaborations ordered by project:

1. Design of an emg-controlled upper limb robotic orthosis for muscular weakness. Collaborators: Prof. Vincenzo Parenti Castelli, Prof. Rocco Veretechy, Dr. Giulio Spagnuolo, Dr. Luca Luzi, Dr. Emanuele Palazzi, University of Bologna. Prof. Thiago Boaventura, University of São Paulo, São Paulo, Brazil.

2. Analysis of the benefits of parallel elastic actuation in terms of force controllability with application to lower limb industrial exoskeletons for assistance in load lifting. Robo-Mate project (7th FP, grant agreement n 608979). Collaborators: Prof. Darwin Caldwell, Dr. Jesus Ortiz, Dr. Stefano Toxiri, Dr. Tomaso Poliero, Dr. Christian Di Natali, Italian Institute of Technology.

3. Benchmarking of force control algorithms within the EUROBENCH project. Collaborators: the funded project involves collaboration with the Agencia Estatal Consejo Superior De Investigaciones Cientificas (CSIC) and with the Italian Institute of Technology (IIT)

4. Algorithms for intention decoding based on neuro-musculoskeletal models in a pathological subject. Collaborators: Prof. Massimo Sartori, University of Twente, Netherlands.

5. Design and control of an active orthosis for the lower limb. Project "Movement disorder and rehabilitation of cerebral palsy in children" (contract signed on 21/02/2008 with the Don Calabria Multifunctional Center, Verona, which coordinated the project). Collaborators: Dr. Alessandro Cosentino, Institute Don Calabria, Prof. Nicola Smania, University of Verona, Faculty of Medicine, Prof. Carlo Capelli, University of Verona, Faculty of Motor Sciences.

6. Innovative series elastic actuation implementation for physical human-robot interaction. Collaborators: Prof. Mauro Serpelloni, Prof. Giovanni Legnani, University of Brescia.

7. Force control of surgical robots using MEMS resonators, within the Autonomous Robotic Surgery (ARS) project. Collaborators: Dr. Alberto Roncaglia, Dr. Luca Belsito, CNR Institute for Microelectronics and Microsystems, Physics and Matter Technologies Department

8. I am the promoter and coordinator for the exchange program between Department of Computer Science of the University of Verona and the Escola De Engenharia De São Carlos of the University of São Paulo

## **Credits, Honors and Awards**

MAKE4CASH 2012. An open-source competition for electronic projects and prototype held by Elettronica Open Source Community and ELETTRONICA IN Journal. Reward 1000 €

<https://it.emcelettronica.com/tag/make4cash>

ANTONIO D'AURIA PRIZE 2010. For projects and prototypes of innovative robotic devices to aid the motor disabled SIRI – Associazione Italiana di Robotica e Automazione (Italian Robotic and Automation Society). Reward 1500 €

Overloud BREVERB2 Credits - DSP algorithm for high quality non-convolution reverberation software, distributed by Overloud, <http://www.overloud.com/products/breverb2.php>

## **Invited Speaker, Workshop Organizer, Peer Reviewer, Supervisor**

Invited speaker at the workshop "Promoting elastic actuators for robotics (PEAR)" for the presentation "Force control of Series Elastic Actuators: overview, state of the art and perspectives" at the IEEE International Conference on Advanced Intelligent Mechatronics (AIM-2017), 3-7 July, 2017, Munich, Germany. <https://pearres.wordpress.com/workshop-aim17/>

Organizer of the workshop "Compliant Control for Physical Human-Robot Interaction with application to exoskeletons, active orthoses, wearable robots and haptics" at the 13th International Conference on Intelligent Autonomous Systems (IAS-13) 18 July 2014, Padua (Italy). <http://duerer.usc.edu/pipermail/robotics-worldwide/2014-April/007890.html>

Peer reviewer for the following international journals: IEEE Transaction on Robotics, IEEE Transaction on Mechatronics, IEEE Robotics and Automation Letters, IEEE Transaction on Control System Practice, IEEE Transaction on Control System Technology, IEEE Transaction on Industrial Electronics, IEEE Transaction on Neural System and Rehabilitation Engineering, Robotics And Autonomous Systems, Robotica (Cambridge Press), Mechatronics, International Journal Advanced Robotic Systems, Robotics and Computer-Integrated Manufacturing, Mechanical Systems and Signal Processing.

Peer reviewer for the following international conferences: IROS2012, IROS2013, IROS2014, IROS2015, IROS2016, IROS2017, IROS2018, CDC2013, IFAC2016, ICRA2014, ICRA2020, ICORR2015, BIOROB2014, BIOROB2016, Humanoids2018.

Supervisor for the thesis of 5 bachelor and 8 master students.

## **Conference Presentations**

"Introducing Series Elastic Links"

International Symposium on Wearable Robotics 2018, October 16-20, Pisa, Italy,

"Impedance Control of Series Elastic Actuators Using Acceleration Feedback"

International Symposium on Wearable Robotics 2016, October 18-21, Segovia, Spain.

"Force Control Beyond the Passivity Interaction Paradigm"

7th International Workshop on Human-Friendly Robotics, October 23-24, 2014, Pisa, Italy

"On The Role of Compliance In Force Control"

International Conference on Intelligent Autonomous Systems, July 15-19, 2014, Padua, Italy.

"An Active Orthosis For Cerebral Palsy Children"

1st International Conference on Applied Bionics and Biomechanics. October 14 - 16, 2010 Venice, Italy.

"A Prototype for Hip Compliant Actuation"

XI Congresso Nazionale Società Italiana di Analisi del Movimento in Clinica, 4-7 Oct 2010 (FE) Italy.

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## TEACHING

2019/2020 Control Theory (Controlli Automatici) 6 ECTS  
Bachelor Degree in Computer Science, Department of Computer  
Science, University of Verona, Italy

2018/2019 Cyberphysical Laboratory 6 ECTS (Practical exercises on robot programming and control)  
Bachelor Degree in Computer Science, Department of Computer  
Science, University of Verona, Italy

2018/2019 Robotics (Robotica) 6 ECTS  
Master Degree Computer Science and Engineering, Department of Computer  
Science, University of Verona, Italy

2017/2018 Cyberphysical Laboratory 6 ECTS (Practical exercises on robot programming and control)  
Bachelor Degree in Computer Science, Department of Computer  
Science, University of Verona, Italy

2017/2018 System Theory (Sistemi Dinamici) 6 ECTS  
Master Degree Computer Science and Engineering, Department of Computer  
Science, University of Verona, Italy

2016/2017 Robotics (Robotica) 9 ECTS  
Master Degree in Computer Engineering, Department of Information Engineering, University of Brescia,  
Italy  
(contratto di lavoro autonomo per attività didattica)

2015/2016 Robotics (Robotica) 9 ECTS  
Master Degree in Computer Science, Department of Information Engineering, University of Brescia,  
Italy  
(contratto di lavoro autonomo per attività didattica)

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## PUBLICATION LIST

### International Patents:

A. Calanca, M. Bossi, D. De Vito

#### **Rotable Drum Laundry Machine and control method thereof**

Application number PCT/EP2018/083878, filing date: 06-12-2018, applicant: Electrolux Appliances  
Aktiebolag.

During the employment period in Electrolux Italia s.p.a. I was the creator and developer of a load  
estimation and rebalancing algorithm for horizontal axis washing machines aiming at reducing  
vibrations during basket spinning.

### International Journals:

A. Calanca, E. Dimo, R. Vicario, P. Fiorini, M. Serpelloni, and G. Legnani,

#### **Introducing Series Elastic Links for Affordable Torque-Controlled Robots**

Robot. Autom. Lett., vol. 4, no. 1, pp. 137–144, 2019.

S. Toxiri, A. Calanca, P. Fiorini, and D. G. Caldwell

**A Parallel-Elastic Actuator for a Torque-Controlled Back-Support Exoskeleton.**  
Robot. Autom. Lett., vol. 3, no. 1, pp. 1–8, 2018.

A. Calanca and P. Fiorini

**A Rationale for Acceleration Feedback in Force Control of Series Elastic Actuators.**  
IEEE Trans. Robotics, vol. 34, no. 1, pp. 48–61, 2018.

A. Calanca and P. Fiorini

**Understanding Environment-Adaptive Force Control of Series Elastic Actuators**  
IEEE/ASME Trans. Mechatronics, vol. 23, no. 1, pp. 413–423, 2018.

A. Calanca, R. Muradore, P. Fiorini

**Impedance Control of Series Elastic Actuators: Passivity and Acceleration-Based Control.**  
Mechatronics, vol. 47, pp. 37–48, 2017.

A. Calanca, P. Fiorini

**Impedance control of series elastic actuators based on well-defined force dynamics.**  
Robotics and Autonomous Systems vol. 96, pp. 81–92, 2017, Special Issue on Human-oriented Approaches for Assistive and Rehabilitation Robotics.

A. Calanca, R. Muradore, P. Fiorini

**A Review of Algorithms for Compliant Control.**  
IEEE Transactions on Mechatronics, vol. 21, no. 2, pp. 613–624, 2016.

A. Calanca, L. Capisani, and P. Fiorini,

**Robust Force Control of Series Elastic Actuators.**  
Actuators, Special Issue on Soft Actuators, vol. 3, no. 3, pp. 182–204, 2014.

A. Calanca, P. Fiorini

**Human-Adaptive Control of Series Elastic Actuators.**  
Robotica, Special Issue on rehabilitation Robotics, available on CJO, 2014.

C. Drioli, A. Calanca

**Speaker adaptive voice source modeling, with applications to speech coding and processing.**  
Journal of Computer Speech and Language, Special Issue on Glottal Source Processing, 2013.

A. Calanca, A. Cosentino, P. Fiorini

**A motor learning oriented, compliant and mobile Gait Orthosis.**  
Applied Bionics and Biomechanics, vol. 9, no. 1, pp. 15–27, 2012.

A. Calanca, L. M. Capisani, A. Ferrara, and L. Magnani

**MIMO identification of an industrial robot.**  
IEEE Transactions on Control Systems Technology. vol. 19, no. 5, pp. 1214 - 1224, 2011.

N. Smania, M. Gandolfi, V. Marconi, A. Calanca et al.

**Applicability of a new robotic walking aid in a patient with cerebral palsy.**  
European Journal of Physical and Rehabilitation Medicine, vol. 47, no. 0, pp. 1–7, 2011.

### **Book Chapters:**

S. Toxiri, A. Calanca, T. Poliero, D. G. Caldwell, and J. Ortiz

**Actuation Requirements for Assistive Exoskeletons: Exploiting Knowledge of Task Dynamics** in Wearable Robotics: Challenges and Trends, 2019, pp. 381–385.

A. Calanca, L. Bettinelli, E. Dimo, R. Vicario, M. Serpelloni, and P. Fiorini  
**Introducing Series Elastic Links** in *Wearable Robotics: Challenges and Trends*, 2019, pp. 465–469.

A. Calanca, R. Muradore, and P. Fiorini  
**Impedance Control of Series Elastic Actuators Using Acceleration Feedback.**  
in *Wearable Robotics: Challenges and Trends*, 2017, pp. 33–37.

A. Calanca, L. M. Capisani, A. Ferrara, and L. Magnani  
**An Inverse Dynamics-Based Discrete-Time Sliding Mode Controller for Robot Manipulators.**  
*Robot Motion and Control 2007*, Krzysztof Kozłowski ed., (LNCIS) Lecture Notes in Control and Information Sciences n. 360, chapter 12, pp. 137-146, Springer Verlag London Limited, ISBN: 978-1-84628-973-6

### Conferences:

S. Toxiri, T. Verstraten, A. Calanca, D. G. Caldwell, and J. Ortiz,  
**Using parallel elasticity in back-support exoskeletons: A study on energy consumption during industrial lifting tasks** in 2019 Wearable Robot. Assoc. Conf. WearRAcon 2019, no. 337596, pp. 1–6, 2019.

M. Carletti, D. Zerbato, D. Dall'Alba, A. Calanca, P. Fiorini  
**Robust 3D Pose Estimation of a Laparoscopic Instrument with three Landmarks**  
Accepted to Stag 2015, Annual conference of the Italian Eurographics chapter, October 15-16, Verona, Italy.

A. Calanca and P. Fiorini  
**On The Role of Compliance In Force Control.**  
International Conference on Intelligent Autonomous Systems, July 15-19, 2014, Padua, Italy.

A. Calanca, L. M. Capisani, A. Ferrara, and P. Fiorini  
**Improving Continuous Approximation of Sliding Mode Control.**  
16th International Conference on Advanced Robotics, November 25-29, 2013, Montevideo, Uruguay.

C. Drioli, A. Calanca  
**Speech modeling and processing by low-dimensional dynamic glottal models.**  
13th Annual Conference of the International Speech Communication Association (Interspeech).  
September 9-13, 2012 Portland, Oregon.

A. Calanca, C. Drioli  
**Voice processing by dynamic glottal models with applications to speech enhancement.**  
Interspeech 2011, 12th Annual Conference of the International Speech Communication Association.  
August 28-31, 2011 Florence, Italy.

A. Calanca, S. Piazza, P. Fiorini, A. Cosentino  
**An Active Orthosis For Cerebral Palsy Children.**  
1<sup>st</sup> International Conference on Applied Bionics and Biomechanics. October 14 - 16, 2010 Venice, Italy.

A. Calanca, S. Piazza, P. Fiorini  
**Force Control System for Pneumatic Actuators of an Active Gait Orthosis.**  
International Conference on Biomedical Robotics and Biomechatronics (BioRob), 3rd IEEE RAS and EMBS. September 26-29, 2010 Tokyo, Japan.

A. Calanca, A. Cosentino, P. Fiorini  
**A Prototype for Hip Compliant Actuation.**



XI Congresso Nazionale Società Italiana di Analisi del Movimento in Clinica, October 4 - 7, 2010 Ferrara, Italy.

**Workshops:**

A. Calanca

**Force control of Series Elastic Actuators: overview, state of the art and perspectives**

Workshop PEAR (Promoting elastic actuators for robotics) at the IEEE International Conference on Advanced Intelligent Mechatronics (AIM-2017), 3-7 July 2017, Munich, Germany.

A. Calanca, P. Fiorini

**Force Control Beyond the Passivity Interaction Paradigm.**

7th International Workshop on Human-Friendly Robotics, October 23-24, 2014, Pisa, Italy

A. Calanca, N. Piccinelli, P. Fiorini

**Human-Adaptive Control of Compliant Actuators.**

Roboassist 2014, ICRA14 Workshop, Honk Hong, China.

A. Calanca, L. M. Capisani, A. Ferrara, and L. Magnani

**An Inverse Dynamics-Based Discrete-Time Sliding Mode Controller for Robot Manipulators.**

ROMOCO 2007, Sixth International Workshop on Robot Motion and Control, June 11-13, 2007 Bukowy Dworek, Poland

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Verona, 10/12/19

Andrea Calanca

