

# Matteo Matteucci

Curriculum Vitae et Studiorum

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My research has focused on the use of techniques and models from Pattern Recognition, Machine Learning, Signal Processing and Dynamic State Estimation for dealing with uncertainty in autonomous systems perception and intelligent data analysis. Autonomous robots, unmanned vehicles, and assistive technologies (where system autonomy is used to supply user physical or cognitive deficits) have been reference scenarios for developing models and algorithms to cope with uncertainty and incomplete knowledge.

**H-Index / i10-index / Citations:** 21 / 39 / 1341 (Source: Google Scholar)

**Publications:** 30 International Journal papers (24 without PhD supervisor, 11 from independent research, 13 with other research groups), 18 papers in International Books, more than 100 in International Conferences.

**International Activity:** Visiting Scholar for 1 year at Carnegie Mellon University where I got also a Master of Science in Knowledge Discovery and Data Mining. Active since its foundation in the Euron Special Interest Group on Good Experimental Methodologies & Benchmarking (GEM SIG) for the design of suitable benchmarks and experimental methodologies for intelligent systems. Expert on Benchmarking for the RoSta and on ELS (Ethical-Legal-Societal) issues for the euRobotics FP7 projects. Active in the IEEE RAS Standard Group in the "IEEE P1873/D1 Draft Standard for Robot Map Data Representation for Navigation". Part of IFAC Technical Committee "7.5. Transportation and Vehicle Systems - Intelligent Autonomous Vehicles". Program Committee of 8 International Conferences. Reviewer for 15 International Journals (out of which 7 IEEE Transactions) and more than 20 International Conferences & Workshops.

**Project Funding:** Project Coordinator of FP6 project RAWSEEDS, National Scientific Coordinator of PRIN 2009 project ROAMFREE, POLIMI Principal Investigator for FP7 project RoCKIn, POLIMI Principal Investigator & Project Technical Manager of AAL Joint Program project ALMA, Coordinator of "Brain-Computer Interfaces in Everyday Applications" Politecnico di Milano and Regione Lombardia grant.

**Research achievements/products:** An autonomous wheelchair with multi modal interface to support disabled people mobility (awarded with Antonio D'Auria SIRI Prize, and Intesa Startup Initiative), a benchmarking toolkit for simultaneous localization and mapping (often cited, as example of benchmarking and excellent EU project, by EU officers in their presentations), a Brain-Computer Interface based on P300 and ErrP potentials (presented to the general public and reported by the national and international press), a sensor fusion framework for the odometry of unmanned vehicle actually deployed and running on several vehicles at Politecnico di Milano (AIRLab and MERLIN) and Università di Milano-Bicocca (IRALab). Co-author of "*General Guidelines for Robotics Papers Involving Experiments*" (Euron GEM SIG).

**Technology Transfer:** 4 patents (2 Italian + 2 European counterparts), 1 start-up company founded by PhD students (Empatica), 2 tech-transfer award (Antonio D'Auria, Intesa San Paolo "Startup Initiative"), industrial collaboration/contracts (e.g. with Aerosekur, Indesit, Gaiotto, Infosolution, Noustat, Aermatica).

**Awards and Prizes:** Rotary Ambassadorial Scholarship; Dimitris N. Chorafas Foundation Award for best PhD thesis; the autonomous wheelchair project has been awarded with "Antonio D'Auria" and the Intesa San Paolo "Startup Initiative" prizes; advisor of Luigi Malagò awarded with the Dimitris N. Chorafas Foundation Award for best PhD thesis; tutor of the "Helios" project awarded as the best project of the first 6 years of Alta Scuola Politecnica, and of the "IRoKi" project which was another of the 6 finalists.

**Lecturer (grade, years):** Soft Computing (PhD, 5y), 3D Structure from Visual Motion (PhD,4y), Pattern Analysis & Machine Intelligence (MS, 4y), Metodologie per Sistemi Intelligenti (MS, 2y), Knowledge Engineering (BS, 5y), Fondamenti Informatica (BS, 4y), Teaching Assistant: Soft Computing (MS, 9y), Knowledge Engineering & Expert Systems (BS, 5y), Information Retrieval and Data Mining (MS, 1y), .

**Multidisciplinary research:** I pursue multidisciplinary both in the narrow sense of "within engineering" (i.e., Pattern Recognition, Machine Learning, Signal Processing, Dynamic State Estimation, Robotics), and in the broader sense of "involving other disciplines" (e.g., Neurosciences, Geology and Environmental Science, Medicine, Transportation Science, Bioengineering, Mathematics, Social Sciences).

Matteo Matteucci - "Laurea" degree 1999 (Politecnico di Milano), MS 2002 (Carnegie Mellon University), PhD 2003 (Politecnico di Milano) is Assistant Professor ("Ricercatore di Ruolo Confermato") at the "Dipartimento di Elettronica Informazione e Bioingegneria" of Politecnico di Milano. In 1999 he got a Laurea degree in *Computer Engineering* at Politecnico di Milano, in 2002 he got a Master of Science in *Knowledge Discovery and Data Mining* at Carnegie Mellon University (Pittsburgh, PA), and in 2003 a PhD in *Computer Engineering and Automation* at Politecnico di Milano (Milan, Italy).

He is actually working in both Robotics and Machine Learning, mainly applying, in a practical way, techniques for adaptation and learning to autonomous (robotics) systems in real world dynamic environments. His research is on robot control architectures, middleware for robot integration, reactive robot control, computer vision, adaptive color models, robust tracking for video surveillance, behavior modeling, and all sorts of learning machines (i.e., neural network, decision trees, mixture models, Bayesian networks, etc.) applied to real world scenarios.

He has published 30 (peer-reviewed) papers on international journals and more than 100 (peer-reviewed) contributions to international conferences and book chapters. He is part of the Program Committee of several conferences on Artificial Intelligence and Robotics, he is in the Technical Committee of Intelligent Autonomous Vehicles of the International Federation of Automatic Control, and he serves as reviewer for international journals and main conferences in his field of expertise.

He has been the Coordinator of the European project RAWSEEDS (2006-2009, <http://www.rawseeds.org>) a Specific Support Action in the FP6 for the development of a benchmarking toolkit for multi-sensor SLAM algorithms. He has been the National Scientific Coordinator (Principal Investigator) of the ROAMFREE project (2009-2013, <http://roamfree.dei.polimi.it>) for the development of method for the robust estimation of robot odometry by sensor fusion funded by the Italian Ministry for the University and the Research (MIUR) under the PRIN 2009 program.

He is currently the Principal Investigator for the Politecnico di Milano of the FP7 project RoCKIn (2013-2015, <http://www.rockinrobotchallenge.eu/>) for the design and execution of two international competitions for the benchmarking of autonomous robots in the home environment (RoCKIn@Home) and at work (RoCKIn@Work). He is the Politecnico di Milano principal investigator and Project Technical Manager of the European project ALMA (2013-2015, <http://www.alma-aal.org>), funded under the AAL Joint Program, for the realization of an Ambient Assisted Living system to support the autonomous mobility of the elderly. He is also investigator in the SINOPIAE project funded by Regione Lombardia and the Italian Ministry of University and Research (MIUR) for the development of an Unmanned Aerial Vehicle able to reconstruct the thermal dispersion of buildings at the district level through a visual and thermal custom payload.

## Education

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2000 - 2003 PhD in Computer Engineering and Automation at the Department of Electronics and Information of Politecnico di Milano (17/03/2013, Milan, Italy) [PhD Thesis title: *Evolutionary Learning of Adaptive Models within a Bayesian Framework*]. Advisor: Prof. Andrea Bonarini. Awarded with the Dimitris N. Chorafas Prize for the best PhD thesis by the Chorafas Foundation.

2001 - 2002 Master of Science in Knowledge Discovery and Data Mining at the "Center for Automatic Learning & Discovery" (08/2002, Carnegie Mellon University, Pittsburgh, PA) [MS Thesis title: *ELeaRNT: Evolutionary Learning of Rich Neural Network Topologies*]. Advisor: Prof. Manuela Veloso.

1993 - 1999 Laurea degree in Computer Engineering at Politecnico di Milano (19/04/1999, Milan, Italy) [Thesis title: *Rappresentazione della conoscenza fuzzy e a intervalli per algoritmi di apprendimento per rinforzo applicati ad agenti situati*]. Advisor: Prof. Andrea Bonarini.

### **Academic Positions**

- Since 2008* Assistant Professor (Ricercatore di ruolo confermato) at the Department of Electronics and Information of Politecnico di Milano (Milan, Italy).
- 2005 - 2008* Assistant Professor (Ricercatore di ruolo) at the Department of Electronics and Information of Politecnico di Milano (Milan, Italy).
- 2003 - 2005* Research Assistant (research program Evoluzione tecnologica e nuove applicazioni delle basi di dati e dei sistemi informativi ) at the Department of Electronics and Information of Politecnico di Milano (Milan, Italy).
- 2000 - 2003* PhD Student in the Computer Engineering and Automation program at the Department of Electronics and Information of Politecnico di Milano (Milan, Italy).
- 2001 - 2002* Visiting Student at the Center for Automatic Learning and Discovery at Carnegie Mellon University (Pittsburgh, PA - USA).
- 2000 - 2002* Research Assistant (research program “Modelli di apprendimento automatico in ambienti dinamici”) at the Department of Electronics and Information of Politecnico di Milano (Milan, Italy).

### **Academic Roles and Affiliations**

- Since 2013* Representative (and co-founder in 2012) of the Assistive Technology Group of Politecnico di Milano - Polo Regionale di Como (<http://atg.deib.polimi.it>).
- Since 2012* Reviewer for the Italian Ministry of University and Research (Iscritto all’Albo Revisori MIUR).
- Since 2012* National Action co-Leader for the “Health & Wellbeing” Action Line of the Italian Node of European Institute for Innovation and Technology (EIT).
- Since 2010* Member of “Commissione Didattica Laurea Specialistica” for the Computer Engineering track of Politecnico di Milano - Polo Regionale di Como.
- Since 2009* Member of “Commissione Orari” for the Computer Engineering track of Politecnico di Milano - Polo Regionale di Como.
- Since 2008* “Delegato SAT” (Struttura Accademica dei Tirocini) for the Computer Engineering track at Politecnico di Milano - Campus Leonardo.
- Since 2007* Member of IEEE, the Institute of Electrical and Electronics Engineers (Computational Intelligence Society, Robotics and Automation Society).
- Since 2000* Member of the Artificial Intelligence and Robotics Lab of Politecnico di Milano.
- 2000 - 2005* Member of AI\*IA, Associazione Italiana per l’Intelligenza Artificiale.

### **Prizes and Awards**

- 2011* Winner, with the Industrial Partner Infosolution SpA, of “Premio Antonio D’Auria 2010 per progetti e prototipi di dispositivi mecatronici innovativi di ausilio a disabili motori” from Società Italiana di Robotica e Automazione ([infosolution.it](http://infosolution.it), [corriere.it](http://corriere.it), [robosiri.it](http://robosiri.it)).
- 2011* Winner, with the Industrial Partner Infosolution SpA, of the Intesa San Paolo “Startup Initiative” and the Italian round of the “Global Social Venture Competition” with the RobyWheelChair project ([infosolution.it](http://infosolution.it), [lobbyinnovazione.it](http://lobbyinnovazione.it)).
- 2003* Winner of the Dimitris N. Chorafas Foundation Award for the best PhD thesis.
- 2001-2002* Winner of the Rotary Foundation Ambassadorial Scholarship.

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**Lecturer and Teaching Assistant**

- 2014-2012-2010-2009: **Lecturer and coordinator** for the PhD course “3D Structure from Visual Motion: Novel Techniques in Computer Vision and Autonomous Vehicles” in the PhD Program in Information Engineering at Dipartimento di Elettronica Informazione e Bioingegneria of Politecnico di Milano.
- 2012-2010-2007-2005-2003: **Lecturer** for the PhD course “Soft Computing: Theory, Techniques and Applications” in the PhD Program in Information Engineering at Dipartimento di Elettronica Informazione e Bioingegneria of Politecnico di Milano.
- Since 2013 **Teaching assistant** on Data Mining for the course “Information Retrieval and Data Mining” of the Computer Engineering degree, Scuola di Ingegneria Industriale e dell'Informazione, Politecnico di Milano - Polo Regionale di Como.
- Since 2011 **Lecturer and coordinator** of the Laurea Specialistica course “Pattern Analysis and Machine Intelligence” for the Computer Engineering degree, Scuola di Ingegneria dell'Informazione, Politecnico di Milano - Polo Regionale di Como
- Since 2004 **Teaching assistant** on Natural Computation for the course “Soft Computing” in the Computer Engineering degree, Facolta' di Ingegneria Informatica, Politecnico di Milano - Campus Leonardo,
- 2009 - 2013 **Lecturer and coordinator** of the Laurea course “Knowledge Engineering” for the Computer Engineering degree, Facolta' di Ingegneria dell'Informazione, Politecnico di Milano - Polo Regionale di Como.
- 2006 - 2007 **Lecturer and coordinator** of the Laurea Specialistica course “Methods for Intelligent Systems” for the Computer Engineering degree, Facolta' di Ingegneria dell'Informazione, Politecnico di Milano - Polo Regionale di Como.
- 2003 - 2007 **Lecturer and coordinator** of the Laurea course “Fondamenti di Informatica” for the Electronics Engineering degree, Facolta' di Ingegneria dell'Informazione, Politecnico di Milano - Campus Leonardo.
- 2003 - 2007 **Teaching assistant** on Natural Computation for the Laurea course “Knowledge Engineering and Expert Systems” for the Computer Engineering degree, Facolta' di Ingegneria Informatica, Politecnico di Milano - Polo Regionale di Como.
- 1999 - 2001 **Teaching assistant** on C Language for the Laurea course “Fondamenti di Informatica (B)” for the Environmental Engineering degree, Facolta' di Ingegneria Civile, Ambientale e Territoriale, Politecnico di Milano - Campus Leonardo.

**Other Teaching Activities**

- 2010 - 2012 **Tutor** for the Alta Scuola Politecnica (<http://www.asp-poli.it>) project “TSC4MiTo: The Social Computing for Milano and Torino”.
- 25/05/2012 **Invited seminar** “Robotics benchmarking from the inside: The RAWSEEDS Experience” for the PhD course on “Computing and Science” by Prof. Viola Schiaffonati and Prof. Francesco Amigoni from the Dipartimento di Elettronica e Informazione del Politecnico di Milano
- 09/04/2013, 04/05/2012, 29/04/2011 **Invited seminars** “Brain-Computer Interfaces @AIRLab” in the Laurea Specialistica course “Accessibility” by Prof. Licia Sbattella in Computer Engineering degree of Politecnico di Milano - Polo Regionale di Como
- 2009 - 2011 **Tutor** for the Alta Scuola Politecnica project “WillChair: reinventing the wheels ... into wills!” from which the project “Clever” has won the “[Lifeability Award](#)” in the Bioengineering category
- 2006 - 2008 **Tutor** for the Alta Scuola Politecnica project “SenSoBot: Sensors and control for Societal Robots”
- 2005 - 2007 **Tutor** for the Alta Scuola Politecnica project “WoMan: Windows On Man”, from which the project “Helios” has been awarded as the best multidisciplinary project for the past 6 years of Alta Scuola Politecnica during the event “[Riconoscere e premiare l'eccellenza e l'innovazione - una](#)

[sfida per l'Italia che crede nel futuro](#)" (ASP + Confindustria)

- 17/11/2006 **Lecturer** on Neural Networks for the course "Cybernetics" in the "Sapere a tutto campo" program at Università Bocconi
- 2005 - 2006 **Tutor** for the Alta Scuola Politecnica project "IRoPa: Intelligent Robotic Partners"
- 2005 - 2006 **Tutor** for the Alta Scuola Politecnica project "AMoRoSA: Autonomous Mobile Robots for Service Applications". The team "IeRoKi" (<http://www.ieroki.it/>) has been selected in 2012 among the 6 best ASP project in the 2006-2012 years (award won by the "Helios" project, 2005-2007 period)
- 06/09/2006 **Lecturer** on "Soft Computing: Neural Networks Theory and Applications" Continuous Education course for an Italian Company (company name undisclosed for NDA clause)
- 26/05/2005 **Lecturer** on "Dal filtraggio alla Kalman ai filtri a particelle" for the Laurea course "Robotica complementi" for the Computer Science degree, Facolta' di Scienze Fisiche e Naturali, Università degli Studi di Milano-Bicocca.
- 20/05/2005 **Lecturer** on "Tecniche di filtraggio Bayesiano" for the Laurea course "Robotica complementi" for the Computer Science degree, Facolta' di Scienze Fisiche e Naturali, Università Degli Studi Milano-Bicocca..
- 26/04/2004 **Invited seminar** on "Perchè oggi non servono (ancora) le tre leggi della robotica?" for the thematic session "Dall'Intelligenza Artificiale ai robot" for the Master Program in Scientific Communication at SISSA, Trieste.
- 04/2000 - 06/2000 **Tutoring activity** for the Laurea courses of "Fondamenti di Informatica" for the Engineering degrees of Politecnico di Milano, Campus Bovisa.
- 1997 - 1999 **Tutoring activity** (Computer Science, Calculus and Geometry) for the freshmen at Politecnico di Milano, a.a. 97/98 e a.a 98/99.

## ***Supervision of PhD Students***

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### **Advised PhD Student**

- 2012 - ... Andrea Romanoni (currently PhD student): working on 4D (3D geometry and temperature) urban district reconstruction from unmanned aerial vehicles using visual and thermal information.
- 2012 - ... Francesco Visin (currently PhD student): he is working in object recognition by deep learning for autonomous robots (indoor scenarios) and unmanned vehicles (urban scenarios).
- 2011 - ... Davide Cucci (currently PhD student): he is working on the development of a generic framework for robust odometry by multi sensor fusion.
- 2010 - 2013 Simone Ceriani, "Conditionally independent visual slam with integrated bundle adjustment". Scientific Project Officer at the European Commission Joint Research Centre ([linkedin](#)).
- 2008 - 2011 Luigi Malagò, "On the geometry of optimization based on the exponential family relaxation". (**Thesis award:** Dimitris N. Chorafas Foundation). Post-doc at Dipartimento di Informatica, Università degli Studi di Milano ([linkedin](#)).
- 2006 - 2009 Davide Antonio Migliore, "Monocular Simultaneous Localization and Mapping with Bearing-Only Tracking". Project Manager on Embedded Computer Vision Solutions at Evidence s.r.l. ([linkedin](#)).
- 2005 - 2009 Bernardo Dal Seno, "Toward an Integrated P300-And ErrP-Based Brain-Computer Interface". Site Reliability Engineer at Google ([linkedin](#)).

### **Co-Advised PhD Student**

- 2014 - ... Ludovico Russo (currently PhD student advised by Prof. Basilio Bona at Politecnico di Torino): working on Robot Visual Navigation and Cloud Robotics (Telecom Italia grant).
- 2013 - ... Vahid Jalili (currently PhD student advised by Marco Masseroli at Politecnico di Milano): working on data analysis of Next Generation Sequencing (NGS) data for the Genomic Computing project.
- 2010-2014 Martino Migliavacca (advised by prof. Andrea Bonarini at Politecnico di Milano), "The R2P framework for robot prototyping: methodological approach, hardware modules, and software components". Post-doc at the AIRLab, Politecnico di Milano ([linkedin](#)).

- 2008–2011 Maurizio Garbarino (advised by Prof. Andrea Bonarini at Politecnico di Milano), “*Modeling emotional interaction in affective computing experiments: a study on affect recognition in videogames*”. Chief Science Officer at Empatica S.r.l ([linkedin](#)).
- 2007–2010 Simone Tognetti (advised by Prof. Andrea Bonarini at Politecnico di Milano), “*A methodological framework for physiology based affective computing: definition and evaluation*”. CTO & co-founder of Empatica S.r.l ([linkedin](#)).
- 2006–2009 Daniele Marzorati (advised by Prof. Domenico G. Sorrenti at Università degli Studi di Milano-Bicocca) “*Uncertainty Modeling in 3D Vision-based SLAM*”. AI Application Engineer at Infosolution SpA ([linkedin](#)).
- 2003–2006 Melchiorre Caterina (advised by Prof. Angelo Cavallin at Università degli Studi di Milano-Bicocca) “*Progettazione ed applicazione di modelli quantitativi basati su reti neurali artificiali per la cartografia della suscettibilità connessa a movimenti di versante*”. Researcher at Uppsala University ([linkedin](#)).

## ***International Editorial Activities***

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### **International Committees**

- > IEEE Standardization Committee for P1873/D1 Draft Standard for Robot Map Data Representation for Navigation.
- > IFAC Technical Committee “7.5. Transportation and Vehicle Systems - Intelligent Autonomous Vehicles”.

### **International Conference Program Committees**

- > IAS 2014: Program Committee of the 13th International Conference on Intelligent Autonomous Systems.
- > IFAC 2014: Program Committee for International Federation of Automatic Control World Conference.
- > IAV 2013 - IAV 2010: Program Committee of IFAC Symposium on Intelligent Autonomous Vehicles.
- > CETC 2013: Program Committee of Conference on Electronics, Telecommunication and Computers.
- > PPSN 2012: Program Committee of International Conference on Parallel Problem Solving from Nature.
- > VS-Games 2011: Program Committee of International Conference in Games and Virtual Worlds for Serious Applications.
- > ACII 2011: Program Committee of International Conference on Affective Computing and Intelligent Interaction.
- > ISNN 2011: Program Committee of International Symposium on Neural Networks.
- > ICANN 2010: Program Committee of International Conference on Artificial Neural Networks.
- > ICDSC 2009: Program Committee of ACM/IEEE International Conference on Distributed Smart Cameras.
- > RoboPer 2008: Program Committee of International Workshop on Robotic Perception.
- > RoboVis 2007: Program Committee of International Workshop on Robot Vision.

### **Reviewer for International Journals and Magazines**

- > AICom (Artificial Intelligence Communication).
- > Automatica.
- > Computer Methods and Programs in Biomedicine.
- > Data and Knowledge Engineering Journal.
- > Evolutionary Computation.
- > IEEE Transactions on System Man and Cybernetics - Part C.
- > IEEE Transactions on Automation Science and Engineering.
- > IEEE Transactions on Evolutionary Computation.
- > IEEE Transactions on Instrumentation and Measurement.
- > IEEE Transactions on Neural Networks.

- IEEE Transactions on Fuzzy Systems.
- IEEE Transactions on Robotics.
- IEEE Robotics and Automation Magazine.
- Computers in Biology and Medicine.
- Sensors.

### **Reviewer for International Conferences and Workshops**

- CETC 2013, Reviewer for the Conference on Electronics, Telecommunication and Computers.
- ICANN 2010, 2009 Reviewer for the International Conference on Artificial Neural Networks.
- ISIEA 2012, Reviewer for the IEEE Symposium on Industrial Electronics and Applications.
- PPSN 2012, Reviewer for the 12th International Conference on Parallel Problem Solving From Nature.
- ICRA 2014, 2011, 2010, 2008 Reviewer for the IEEE International Conference on Robotics and Automation.
- IROS 2013, 2012, 2010, Reviewer for the IEEE/RSJ International Conference on Intelligent Robots and Systems.
- IJCNN 2012, 2011, 2010, 2009, 2007, Reviewer for the International Joint Conference on Neural Networks.
- MED 2012, Reviewer for the 20th Mediterranean Conference on Control and Automation.
- TAROS 2011: Reviewer for the 12th Conference Towards Autonomous Robotic Systems.
- ISNN 2011, Reviewer for the International Symposium on Neural Networks.
- ACII 2011, Reviewer for the 4th biannual International Conference on Affective Computing and Intelligent Interaction.
- IAV 2010, Reviewer for the 7th Symposium on Intelligent Autonomous Vehicles.
- IEEE CIG 2010, Reviewer for the IEEE Conference on Computational Intelligence and Games.
- RoboCup 2010, 2009, 2008, 2007, 2006, 2005 Reviewer for the RoboCup International Symposium.
- CITSA 2009 Reviewer for the 6th International Conference on Cybernetics & Information Technologies, Systems & Applications.
- IFAC WC 2011, 2008, Reviewers for the International Federation of Automatic Control World Conference.
- IEEE WCCI 2008, Reviewers for the IEEE World Congress on Computational Intelligence.
- CIMSA 2008, Reviewer for the Computational Intelligence for Measurement Systems and Applications conference.
- IAS 2008, 2004, Reviewer for the International Conference on Intelligent Autonomous Systems.
- WILF 2007, Reviewer for the International Workshop on Fuzzy Logic and Applications.

### **Session Chair and Co-Chair**

- IROS 2012 Workshop on Progress, Challenges and Future Perspectives in Navigation and Manipulation Assistance for Robotic Wheelchairs. Session: "Autonomous wheelchair navigation and environment modelling".
- IFAC 2011, World Congress of the International Federation of Automatic Control. Sessions: "Mechatronics, robotics and components" and "Mission planning and decision making".
- ICRA 2007, IEEE International Conference on Robotics and Automation. Session: "Monocular SLAM".
- IAV 2004, 5th IFAC Symposium on Intelligent Autonomous Vehicles. Session: "Architectures".

### **Workshop and Conference Organization**

- IROS 2012 Workshop on Progress, Challenges and Future Perspectives in Navigation and Manipulation Assistance for Robotic Wheelchairs, Vilamoura, Algarve, Portugal, October 7th to 12th, 2012.
- ICAR 2009 International Workshop on "Benchmarking in Mobile Robotics – State of the Art, Open Challenges, and Research Roadmap –" at the 14th International Conference on Advanced Robotics, Munich, Germany June 22nd to 26th, 2009.



### Research Projects

- 2013 - 2015 **Principal Investigator** for Politecnico di Milano in the FP7-ICT-601012 project “RoCKIn: Robot Competitions Kick Innovation in Cognitive Systems and Robotics”. (<http://www.rockinrobotchallenge.eu/>).
- 2013 - 2015 **Project Technical Manager** and **Principal Investigator** for Politecnico di Milano in the AAL Joint Program project “ALMA: Aging without Losing Autonomy and Mobility”. (<http://www.alma-aal.org>).
- 2013 - 2015 **Investigator** and member for Politecnico di Milano of the **Technical Board** of WP3 activities (Comfort Manager) of project SHELL (Ecosistemi domestici condivisi ed interoperabili per ambienti di vita sostenibili, confortevoli e sicuri) funded finanziato by MIUR as part of the research program “Tecnologie per gli ambienti di vita”.
- 2012 - 2014 **Principal Investigator** (together with Prof. Marco Lovera) for the Department of Electronics and Information in the project SINOPIAE “Sistema prototipale multisorgente INtegrante tecniche di Osservazione multispettrale da satellite, aeromobile e a terra per il monitoraggio multi-scala della variazione di Indicatori ambientali legata ai costituenti Atmosferici e dispersione Energetica” funded by the Italian Ministry of University and Research and Regione Lombardia in the program “Progetti di Ricerca Industriale e Sviluppo Sperimentale per i settori strategici di Regione Lombardia”. (Scientific director Prof. Raffaella Brumana).
- 2012 - 2014 **Principal Investigator** for the Department of Electronics and Information in the project “Un Masterplan innovativo, aperto e digitale per gestire concretamente progetto Città Studi Campus Sostenibile” funded by Politecnico di Milano under the “5 per 1000” program. (Scientific director Prof. Alberto Longo).
- 2011 - 2013 **National Coordinator** of PRIN 2009 project “ROAMFREE: Robust Odometry Applying Multisensor Fusion to Reduce Estimation Errors” funded by the Italian Ministry of University and Research. (<http://roamfree.dei.polimi.it>).
- 2006 - 2009 **Project Coordinator** of the the sixth framework (FP6) project “RAWSEEDS: Robotics Advancement through Web-publishing of Sensorial and Elaborated Extensive Data Sets”. EU Project FP6-045144. (<http://www.rawseeds.org>).
- 2007 - 2008 **Principal Investigator** in the Research Grant “Brain-Computer Interfaces in Everyday Applications” by Politecnico di Milano and Regione Lombardia (within the joint program “Grant di Avvio alla Ricerca - Accordo di Collaborazione tra il Politecnico di Milano e la Regione Lombardia”).
- 2006 - 2008 **Investigator** in the Workpackage “Robotic Companion Exploiting Affective Feedback for Modeling Emotional State of the Patient and Adapting the Rehabilitation Treatment” of the IIT Funded Project on Rehabilitation within the Politecnico di Milano IIT Unit. (Scientific director of the workpackage Prof. Andrea Bonarini).
- 2003 - 2005 **Investigator** in the PRIN project MADSys “Sviluppo di metodologie e strumenti per lo sviluppo di comunità di agenti robotici” funded by the Italian Ministry of University and Research (MIUR). (Scientific director Prof. Andrea Bonarini).
- 2002 - 2003 **Principal Investigator** on “Adattativita' in ambienti dinamici tramite transductive learning e boosting” funded by the Young Researcher Project at Politecnico di Milano.

### Industrial Projects and Contracts

- 2012 - 2013 **Principal Investigator** in the research project “Studio fattibilità software di programmazione off-line” with Gaiotto Automation SpA.
- 2010-2013 **Investigator** in the research contract “QUADRIVIO” with AEROSEKUR in the project

- “QUADRIVIO” funded by FILAS SpA. (Scientific director Prof. Gianantonio Magnani).
- 2010-2013 **Principal Investigator** in the research project “Realizzazione di una interfaccia cervello-computer basata su potenziale P300” with Infosolution SpA in the project “ON: monitoraggio e autonomia nella assistenza domiciliare dei pazienti affetti da SLA” funded by FILAS SpA.
- 2009-2013 **Investigator** in the workpackage “Intelligenza di prodotto” of project Industria 2015 n. EE01\_00015 “Studio, progettazione e sviluppo di una nuova gamma di elettrodomestici caratterizzata da tecnologie innovative mirate a una notevole riduzione dei consumi energetici e dell’impatto ambientale” funded by Ministero dello Sviluppo Economico. (Scientific director of the workpackage prof. Andrea Bonarini).
- 2009-2012 **Investigator** in the research project “Metodi statistici e di machine learning per lo sviluppo automatico di ontologie di dominio” with Noustat S.r.l. (Scientific director of the workpackage prof. Andrea Bonarini).
- 2009-2010 **Investigator** in the research contract “Valutazione dell’efficacia della politica regionale di assegnazione agli E.E.L.L. di risorse finanziarie, in forme concertate, per interventi di sicurezza stradale e analisi dell’efficienza funzionale” funded by Regione Lombardia (Scientific director Prof. Lorenzo Mussone).

### **Professional Activities**

- 04/2007 - 09/2007 Research Contract for the development of a Neural tool for sport engine diagnosis for an Italian Company (company name undisclosed for NDA clause).
- 12/2006 - 05/2007 Research Contract for consultancy on Emotion detection from biosignals for an Italian Research Center (company name undisclosed for NDA clause).
- 06/2000 - 09/2000 Special Research Contract: Ottimizzazione di paradigmi neurali per l’elaborazione di immagine, Politecnico di Milano, Department of Electronics and Information (Milan, Italy).
- 03/2000 - 04/2000 Special Research Contract: Progetto e prototipazione di un’architettura behavior based per robot autonomi, Politecnico di Milano, Department of Electronics and Information (Milan, Italy).
- 10/1999 - 11/1999 Special Research Contract: Sviluppo sistema per l’analisi di algoritmi di apprendimento , Politecnico di Milano, Department of Electronics and Information (Milan, Italy).

### ***Research Statement***

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Autonomous systems are systems able to plan, perceive, and act, so to affect their surrounding environment without the need for human intervention. Classical example are autonomous robots, unmanned vehicles, but also (ambient) assistive technologies where system autonomy is used to supply user deficits being either physical or cognitive. Out of the three activities of an autonomous system, perception is the main limiting factor for autonomous systems aiming at being deployed in the real world in a robust, adaptive, and reliable way.

My research in autonomous perception has focused on the use of techniques and models from Pattern Recognition, Machine Learning, Signal Processing and Dynamic State Estimation for dealing with uncertainty in perception so to allow autonomous systems to perceive their environment effectively (i.e., being able to cope with sensor uncertainty and incomplete knowledge). In doing this, three real-world scenarios have been investigated: environment perception from an autonomous robot, user state/intent perception by and autonomous system, perception of the environment by a set of distributed sensors.

In the following the results of my research in autonomous system perception and intelligent data analysis are described together with their current a future research perspective; selected references to relevant publications are given while the full list of my publications is reported afterwards.

## **Research Achievements, Results, and Products**

### MRT: the Milan RoboCup Team

From 2001 to 2009, after graduation, I participated to the Milan Robocup Team (MRT - <http://robocup.elet.polimi.it/MRT/>) a Robocup (<http://www.robocup.org/>) team of six autonomous soccer robots equipped with custom panoramic vision sensors [B12], adaptive color classification algorithms [B11][B7], and a conceptual model to integrate robot perception with information from teammates based on fuzzy logic [A8][A5]. The behavior of the robots was implemented using BRIAN, a system able to manage the interaction among fuzzy behavioral modules which I designed at the beginning of my PhD [A2]. This research gave me the opportunity to develop and verify “on the field” my perception algorithms able to deal with dynamic and non stationary environments. To cope with the complexity of designing and maintaining a team of robots, I worked at the design of the message oriented middleware “Device Communities Development Toolkit” (DCDT) [B13][D5], which has been used to program the MRT robots. After the RoboCup experience, and because of it, I pursue research in developing modular and flexible tools for the rapid prototyping of low-cost (service) robots. The last result is Rapid Robot Prototyping (R2P), a framework for the programming and integration of embedded systems in robotics (e.g., motor control board, inertial measurement unit, sonar sensors, etc.) which sports a publish/subscribe communication paradigm integrated over the CAN fieldbus [A27]. R2P is currently at a mature stage and we are now planning to present it as a commercial open source project.

### LURCH: an Autonomous Wheelchair with Multimodal Interfaces

Since 2007 I started the LURCH project for the development of an autonomous wheelchair which could help people not being able to move autonomously [B17]. This effort has resulted in an autonomous wheelchair which sports the “shared autonomy” paradigm: depending on the needs of the user, it supplies the needed autonomy from simple safety enhancer up to fully autonomous vehicle [D100]. Having this aim, beside the capabilities needed for autonomous operation I decided to implement several human computer interfaces from the simple ones (e.g., touch screen GUI or electromyographic sensor) to the most innovative ones (e.g., a Brain Computer Interface based on Event Related Potentials) [D56]. The project has reached the maturity of an industrial prototype and this has been recognized by the two prizes (Antonio D’Auria SIRI Prize and Intesa San Paolo “Startup Initiative” award) obtained by its RobyWheelChair industrial counterpart developed together with the industrial partner Infosolution SpA. Currently I am Technical Manager and “Responsabile Scientifico” of the EU AAL Joint Program project “ALMA: Aging without Losing Mobility and Autonomy” aimed at deploying two autonomous wheelchairs in real scenarios and at finalizing an industrial prototype.

### Simultaneous Localization and Mapping in Autonomous Robots and Unmanned Vehicles

In the field of incremental building of maps and localization for autonomous robots in unknown environments I worked, in cooperation with Università degli Studi di Milano - Bicocca, a complete SLAM (i.e., Simultaneous Localization and Mapping) system in six degrees of freedom based on trinocular and monocular vision sporting hierarchical map decomposition [D46][D34][D35]. In particular, I applied my background in statistics and modeling to the various aspects of localization, simultaneous localization with mapping, and data association with specific interests in measuring error modeling [D88][D71][D61]. Then I worked on a Visual SLAM system with multiple cameras able to build large scale visual maps (hundreds of meters, thousands of features) in real-time based on the Conditional Independence SLAM technique [A28]. This Visual SLAM system has then been combined with other odometric estimates through the ROAMFREE framework for multi odometric sensor fusion (e.g., inertial measurement units, laser range finder, single and multiple camera systems, etc.) to obtain an accurate and robust perception of the robot path [D104]. The resulting system has been deployed on the indoor robots at the AIRLab (e.g., the autonomous wheelchair LURCH) and in outdoor unmanned vehicles such as the QUADRIVIO all terrain robot at MERLIN (MERLIN (MEchatronics and Robotics Laboratory for INnovation - Politecnico di Milano) [D99] and the unmanned golf cart of the Urban Shuttle Autonomously Driven project at IRALAB (Informatics and Robotics for Automation Laboratory - Università degli studi di Milano-Bicocca) [D98].

### Benchmarking and Good Experimental Methodologies in Autonomous Robots

The development of novel methods and techniques in intelligent systems needs a proper methodology for the evaluation of real advancements in research; however, the field of Benchmarking and Good Experimental Methodologies in Robotics is still in its infancy. I have been actively involved in the design of suitable benchmarks for intelligent systems, in particular, for the benchmarking of Simultaneous Localization and Mapping systems through the coordination of the FP6 project RAWSEEDS for the creation of a Multi Sensor Benchmark for Simultaneous Localization and Mapping ([www.rawseeds.org](http://www.rawseeds.org)) [A10][B18][D38]. Since its constitution I have been part of the Euron Special Interest Group on Good Experimental Methodologies and Benchmarking (GEM SIG) and I worked on the writing of the "General Guidelines for Robotics Papers Involving Experiments" for the chapter regarding papers on "Simultaneous Localization And Mapping" ([www.heronrobots.com](http://www.heronrobots.com)). I participated as External Expert to the FP7 RoSta (Robot Standards) project in the benchmarking workpackage ([wiki.robot-standards.org](http://wiki.robot-standards.org)), and I am Politecnico di Milano Principal Investigator for the FP7 project RoCKIn ([www.rockinrobotchallenge.eu](http://www.rockinrobotchallenge.eu)) for the design and execution of two international competitions for the benchmarking of autonomous robots in the home environment (RoCKIn@Home) and at work (RoCKIn@Work). I am currently part of the IEEE RAS Standard Group for the definition of IEEE P1873/D1 Draft Standard for Robot Map Data Representation for Navigation, and founder member of the euRobotics AISBL (the Private counterpart of the Robotics PPP being the European Commission the Public one) Topic Group on "Evaluation of Research Results: Result Replication, Benchmarking, Challenges and Competitions".

### P300 + ErrP BCI: a Self-Correcting Brain-Computer Interface

While developing the autonomous wheelchair LURCH, lot of effort has been directed to the development of effective human robot interfaces, the most challenging one being an Event Related Brain-Computer Interface. In the years from 2007 to 2009 I studied an interface able to capture the user intent from brain activity so to transfer this intent to the autonomous wheelchair or to enable people suffering severe pathologies (e.g., Amyotrophic Lateral Sclerosis) to communicate. The result of this research activity is the first Brain Computer Interface integrating the classical P300 event related potential and the ErrP error potential [A25][A13]. In the winter of 2009 this BCI was used to control the autonomous wheelchair and this had quite a notoriety in the national and international press ([airwiki.elet.polimi.it](http://airwiki.elet.polimi.it)). To evaluate the effectivity of this novel self-correcting paradigm I have worked on a novel metric for the performance evaluation of a Brain-Computer Interface [A16] which I am currently extending to evaluate other pattern recognition based interfaces used as assistive devices (e.g., gesture recognition) and to be used within the design cycle of a machine user interface based on pattern recognition. In the past I was already involved in the development of communication systems for disabled people applying machine learning techniques for developing symbolic language prediction models for Alternative and Augmentative Communication [B8][B5] so I have also applied these techniques to the Brain-Computer Interface field in order increase the effectiveness of a Motor Imagery Brain-Computer Interface [A22].

### Biosignal Interpretation and Affective Computing

Beside clinical and end-user involvement (e.g., Ospedale S. Camillo di Venezia, Policlinico di Roma), my research activity on Brain-Computer Interfaces has been conducted in collaboration with researchers from the (former) Bioengineering Department of Politecnico di Milano and this gave birth to a series of fruitful collaborations on biosignal interpretations too. In particular I have contributed with my expertise in machine learning and pattern recognition to the development of algorithms for the detection of Obstructive Sleep Apnea [A14][A12] and the classification of sleep stages [A15] from ECG signals. My experience on EEG signal analysis (from Brain-Computer Interface research) has been applied also to the detection of Cyclic Alternating Patterns in sleep [A23][A20]. Out of these collaborations, came my interest in Affective Computing, i.e., the study and development of systems and devices that can recognize, interpret, process, and simulate human affects [D92][D90][D77]. The research on this field has lead two of my PhD students in starting up a company, Empatica S.r.l. ([www.empatica.com](http://www.empatica.com)), which produces a portable device (wristband) for the detection of user stress and emotions.

## VeTRA: a Model-based Multi Camera Vehicle Tracking System

Since 2008 I have been interested in visual tracking and user behaviour analysis. Beside specific advancements in background subtraction [A29][D36], the most relevant result is the development of VeTRA, a visual tracking system composed of multiple synchronized cameras for the analysis and the 3D reconstruction of vehicle traffic in roundabout intersections [A30]. VeTRA is able to reconstruct the 3D trajectory of vehicles, their type and their dimensions; the system has been evaluated on real data collected during a field survey for the evaluation of the roundabout effectiveness on behalf of Regione Lombardia. VeTRA is one of the tools developed within a methodology for the evaluation of the effectiveness of different road intersections in a transport system design [A26][A24].

## Geometry of Information in Estimation of Distribution Algorithms

Because of my background in statistics I have always used tools from Bayesian inference in autonomous systems perception and intelligent data analysis. I also applied those tools to Genetic Algorithms by proposing a Bayesian extension to Learning Classifier Systems in dealing with uncertainty [D32]. That is why I immediately found myself intrigued by the Estimation of Distribution Algorithm (EDA) approach in evolutionary computation. Because of their use of directed and undirected graphical models from Statistics EDAs allow a principled theoretical analysis of the way optimization is performed in this class of evolutionary algorithms. With a colleague from the Mathematics Department of Politecnico di Torino and a co-tutored PhD Student we have proved some theorems on the (Information) Geometry of Estimation Distribution Algorithms based on models from the exponential family [D72][D81] and their relationship with natural gradient descent and Gibbs samplers [D106]. This highly theoretical work has nevertheless lead to novel techniques in the Estimation of Distribution Algorithm field capable of learning the model to be exploited in the optimization process by leveraging on their Information Geometry properties [D97][D93].

## **Invited Talks and Papers**

- > Invited presentation titled "Benchmarking through competitions" to the EuRoC Challenge Design Workshop on 23rd of January 2014.
- > Invited presentation titled "*The Utility Metric*" to the Workshop on "BCI Performance Metrics" held during the 5th International BCI Meeting from June 3rd - June 7th, 2013. Submitted to the Journal of Neural Engineering as part of the contribution "Performance Measurement for Brain-Computer or Brain-Machine Interfaces: A Tutorial".
- > Invited seminar (26/01/2012) "*Integrating P300 and Error Potentials in a Single BCI: Algorithms, Techniques & Performance Assessment*" in the seminar program "Bioengineering Seminar Series" at the Department of Bioengineering of Politecnico di Milano
- > Invited paper at the 18th World Congress of International Federation of Automatic Control "*On Feature Parameterization for EKF-based Monocular SLAM*", in the Special Session on SLAM
- > Invited paper at the 5th Symposium on Intelligent Autonomous Vehicle "*A model to manage data reliability in behavior-based robotics*".

## **Full List of Publications**

### A. Articles in International Journals

- A30. Lorenzo Mussone, Matteo Matteucci, Marco Bassani, and Davide Rizzi. "*An innovative method for the analysis of vehicle movements in roundabouts based on image processing*". Journal of Advanced Transportation 47(6):581–594, 2013.
- A29. Andrea Romanoni, Matteo Matteucci, Domenico G Sorrenti. "*Background subtraction by combining Temporal and Spatio-Temporal histograms in the presence of camera movement*". Machine Vision and Application pp. 1-12, Published online 2013. In Press.
- A28. Simone Ceriani, Daniele Marzorati, Matteo Matteucci and Domenico G Sorrenti. "*Single and Multi*

- Camera Simultaneous Localization and Mapping Using the Extended Kalman Filter*". Journal of Mathematical Modelling and Algorithms in Operations Research. pp. 1-35, Published online 2013. In Press.
- A27. Andrea Bonarini, Matteo Matteucci, Martino Migliavacca, Davide Rizzi. "R2P: An open source hardware and software modular approach to robot prototyping". Robotics and Autonomous Systems. Published online 2013. In Press.
- A26. Matteo Matteucci, Lorenzo Mussone. "An ant colony system for transportation user equilibrium analysis in congested networks". Swarm Intelligence 7(4):255-277, Springer, 2013.
- A25. Mauro Marchetti, Francesco Onorati, Matteo Matteucci, Luca Mainardi, Francesco Piccione, Stefano Silvoni and Konstantinos Priftis. "Improving the Efficacy of ERP-Based BCIs Using Different Modalities of Covert Visuospatial Attention and a Genetic Algorithm-Based Classifier". PloS one 8(1: e53946):1-10, 2013.
- A24. Lorenzo Mussone, Matteo Matteucci. "OD Matrices Network Estimation from Link Counts by Neural Networks". Journal of Transportation Systems Engineering and Information Technology 13(4):84 - 92, 2013.
- A23. Sara Mariani, Elena Manfredini, Valentina Rosso, Andrea Grassi, Martin Mendez, Alfonso Alba, Matteo Matteucci, Liborio Parrino, Mario Terzano, Sergio Cerutti, Anna Bianchi. "Efficient automatic classifiers for the detection of A phases of the cyclic alternating pattern in sleep". Medical and Biological Engineering and Computing. 50(4):359-372. 2012.
- A22. Tiziano D'Albis, Rossella Blatt, Roberto Tedesco, Licia Sbattella, Matteo Matteucci. "A predictive speller controlled by a brain-computer interface based on motor imagery". ACM Transactions on Computer-Human Interaction. 19(3):1-25. 2012.
- A21. Giancarlo Ferrigno, Guido Baroni, Federico Casolo, Elena De Momi, Giuseppina Gini, Matteo Matteucci and Alessandra Pedrocchi. "Medical Robotics". IEEE PULSE 2(3):55-61, 2011.
- A20. Sara Mariani, Elena Manfredini, Valentina Rosso, Martin O Mendez, Anna M Bianchi, Matteo Matteucci, Mario G Terzano, Sergio Cerutti, and Liborio Parrino. "Characterization of A phases during the Cyclic Alternating Pattern of Sleep". Clinical Neurophysiology 122(10):2016-2024, 2011.
- A19. Caterina Melchiorre, EA Castellanos, CJ van Westen, Matteo Matteucci. "Evaluation of Prediction Capability, Robustness, and Sensitivity in Non Linear Landslide Susceptibility Models, Guantánamo, Cuba". Computers & Geosciences 37(4):410-425, 2011.
- A18. Federico Maggi, Matteo Matteucci, Stefano Zanero. "Detecting Intrusions through System Call Sequence and Argument Analysis". IEEE Transactions on Dependable and Secure Computing 7(4):381-395, 2010.
- A17. Juha M Kortelainen, Martin O Mendez, Anna Maria Bianchi, Matteo Matteucci, and Sergio Cerutti. "Sleep Staging based on Signals Acquired through Bed Sensor". IEEE Transactions on Information Technology in Biomedicine 14(3):776-785, 2010.
- A16. Bernardo Dal Seno, Matteo Matteucci, Luca T Mainardi. "The Utility Metric: A Novel Method to Assess the Overall Performance of Discrete Brain-Computer Interfaces". IEEE Transactions on Neural Systems and Rehabilitation Engineering 18(1):20-28, 2010.
- A15. Martin O Mendez, Matteo Matteucci, Vincenza Castronovo, Luigi Ferini-Strambi, Sergio Cerutti, and Anna Maria Bianchi. "Sleep staging from Heart Rate Variability: time-varying spectral features and Hidden Markov Models". International Journal on Biomedical Engineering and Technology 3(3/4):246-263, 2010.
- A14. Martin O Mendez, J Corthout, S Van Huffel, Matteo Matteucci, Thomas Penzel, Sergio Cerutti, and Anna Maria Bianchi. "Automatic screening of obstructive sleep apnea from the ECG based on empirical mode decomposition and wavelet analysis". Physiological Measurement 31:273-289, 2010.
- A13. Bernardo Dal Seno, Matteo Matteucci, and Luca T Mainardi. "Online Detection of P300 and Error Potentials in a BCI Speller". Computational Intelligence and Neuroscience 2010(Article ID 307254), 2010.
- A12. Martin O Mendez, Anna Maria Bianchi, Matteo Matteucci, Sergio Cerutti, and Thomas Penzel. "Sleep Apnea Screening by Autoregressive Models From a Single ECG Lead". IEEE Transactions on Biomedical Engineering 56(12):2838-2850, 2009.

- A11. Federico Maggi, Matteo Matteucci and Stefano Zanero. "Reducing false positives in anomaly detectors through fuzzy alert aggregation". *Information Fusion* 10(4):300--311, 2009.
- A10. Simone Ceriani, Giulio Fontana, Alessandro Giusti, Daniele Marzorati, Matteo Matteucci, Davide Migliore, Davide Rizzi, Domenico G Sorrenti, Pierluigi Taddei. "Rawseeds ground truth collection systems for indoor self-localization and mapping". *Autonomous Robots* 27(4):353--371, 2009.
- A9. Caterina Melchiorre, Matteo Matteucci, A Azzoni, and A Zanchi. "Artificial neural networks and cluster analysis in landslide susceptibility zonation". *Geomorphology* 94(3-4):379-400, February, 2008.
- A8. Andrea Bonarini, Matteo Matteucci, and Marcello Restelli. "Problems and solutions for anchoring in multi-robot applications". *Journal of Intelligent and Fuzzy Systems* 8(3):245-254, 2007.
- A7. Andrea Bonarini, Matteo Matteucci, Marcello Restelli. "Learning Fuzzy Classifier Systems: Architecture and Exploration Issues". *International Journal on Artificial Intelligence Tools* 16(2):269--289, 2007.
- A6. Valentino DA Corino, Matteo Matteucci, and Luca T Mainardi. "Analysis of Heart Rate Variability to Predict Patient Age in a Healthy Population". *Methods of Information in Medicine* (2010):191-195, 2007.
- A5. Andrea Bonarini, Matteo Matteucci, and Marcello Restelli. "Concepts and Fuzzy Models for Behavior-Based Robotics". *International Journal of Approximate Reasoning* 41(2):110-127, January, 2006.
- A4. Valentina D A Corino, Matteo Matteucci, Luca Cravello, Ettore Ferrari, Antonio A Ferrari, and Luca T Mainardi. "Long-term heart rate variability as a predictor of patient age". *Computer Methods and Programs in Biomedicine* 82(3):248-257, 2006.
- A3. Matteo Matteucci, and Dario Spadoni. "Evolutionary learning of rich neural networks in the Bayesian model selection framework". *International Journal of Applied Mathematics and Computer Science* 14(3):423-440, 2004.
- A2. Andrea Bonarini, Giovanni Invernizzi, Thomas Halva Labella, and Matteo Matteucci. "An architecture to coordinate fuzzy behaviors to control an autonomous robot". *Fuzzy sets and systems* 134:101-115, February, 2003.
- A1. Andrea Bonarini, Claudio Bonacina, Matteo Matteucci. "An approach to the design of reinforcement functions in real world, agent-based applications". *IEEE Transactions on Systems, Man, and Cybernetics, Part B* 31(3):288--301, June, 2001.

#### B. Articles and Chapters in International Books

- B18. Giulio Fontana, Matteo Matteucci, Domenico G Sorrenti. *Rawseeds: Building a Benchmarking Toolkit for Autonomous Robotics*. *Methods and Experimental Techniques in Computer Engineering*, pp. 55-68, 2014.
- B17. Andrea Bonarini, Simone Ceriani, Giulio Fontana, Matteo Matteucci. "On the development of a multi-modal autonomous wheelchair". *HandBook of Research on ICTs for Healthcare and Social Services*. pp. 727-748, 2013.
- B16. Davide Eynard, Matteo Matteucci, Fabio Marfia. "A Modular Framework to Learn Seed Ontologies from Text". *Semi-Automatic Ontology Development: Processes and Resources*. Editors Maria Teresa Pazienza, and Armando Stellato. pp. 22-47. *Information Science Reference*. 2012.
- B15. Rossella Blatt, Andrea Bonarini, and Matteo Matteucci. "Pattern Classification Techniques for Lung Cancer Diagnosis by an Electronic Nose". *Computational Intelligence in Healthcare 4: Advanced Methodologies*, *Studies in Computational Intelligence* 309:397-423, 2010.
- B14. Davide Migliore, Matteo Matteucci and Pier Paolo Campari. "Improving Geodesic Invariant Descriptors through Color Information". *Computer Vision and Computer Graphics. Theory and Applications* 24:148-161, 2009.
- B13. Andrea Bonarini, Matteo Matteucci, and Marcello Restelli. "MRT: Robotics off-the-shelf with the modular robotic toolkit". *Software Engineering for Experimental Robotics Springer Tracts in Advanced Robotics* 30/2007:345-364, April, 2007.
- B12. Alberto Colombo, Matteo Matteucci, Domenico G Sorrenti. "On the Calibration of Non Single Viewpoint Catadioptric Sensors". *RoboCup 2006: Robot Soccer World Cup X* 4434:194-205, June, 2007.
- B11. Federico Anzani, Daniele Bosisio, Matteo Matteucci, Domenico Giorgio Sorrenti. "On-Line Color

- Calibration in Non-stationary Environments*". RoboCup 2005: Robot Soccer World Cup IX LNCS 4020/2006:396-407, June, 2006.
- B10. Andrea Bonarini, Daniele Lavatelli, and Matteo Matteucci. "A Composite System for Real-Time Robust Whistle Recognition". RoboCup 2005: Robot Soccer World Cup IX LNCS 4020/2006:130-141, June, 2006.
- B9. Andrea Bonarini, Matteo Matteucci, and Marcello Restelli. "Concepts and Fuzzy Models for Behavior-Based Robotics". Fuzzy Logic and Applications 2955/2006:72-79, January, 2006.
- B8. Nicola Gatti, and Matteo Matteucci. "CABA2L a Bliss Predictive Composition Assistant for AAC Communication Software". Enterprise Information Systems VI pp. 277-284, July, 2006.
- B7. Erio Grillo, Matteo Matteucci, and Domenico Giorgio Sorrenti. "Getting the Most from Your Color Camera in a Color-Coded World". RoboCup 2004: Robot Soccer World Cup VIII LNCS 3276/2005:221-235, March, 2005.
- B6. Andrea Bonarini, Matteo Matteucci, and Marcello Restelli. "Filling the Gap among Coordination, Planning, and Reaction Using a Fuzzy Cognitive Model". RoboCup 2003: Robot Soccer World Cup VII 3020/2004:662-669, August, 2004.
- B5. Nicola Gatti, Matteo Matteucci, Licia Sbattella. "An Adaptive and Predictive Environment to Support Augmentative and Alternative Communication". Computers Helping People with Special Needs LNCS 3118:983-990, 2004.
- B4. Andrea Bonarini, Matteo Matteucci, Marcello Restelli. "A framework for robust sensing in multi-agent systems". RoboCup 2001: Robot Soccer World Cup V LNCS 2377/2002:329-351, January, 2002.
- B3. Andrea Bonarini, Giovanni Invernizzi, Fabio Marchese, Matteo Matteucci, Marcello Restelli, Domenico Sorrenti. "Fun2Mas: The Milan Robocup Team". RoboCup 2001: Robot Soccer World Cup V LNCS 2377/2002:123-125, January, 2002.
- B2. Andrea Bonarini, Matteo Matteucci, Marcello Restelli. "Concepts for Anchoring in Robotics". AI\*IA 2001: Advances in Artificial Intelligence LNCS 2175/2001:327-332, January, 2000.
- B1. Andrea Bonarini, Claudio Bonacina, and Matteo Matteucci. "Fuzzy and Crisp Representations of Real-Valued Input for Learning Classifier Systems". Learning Classifier Systems LNCS 1813/2000:107-124, January, 2000.

#### C. National and International Patents

- C4. Italo Belmonte, Matteo Bianchi, Basilio Bona, Andrea Bonarini, Luca Carlone, Davide Girlando, Andrea Mangone, Matteo Matteucci. "Robotized Lighting Apparatus and Control Method". PCT/IB2010/001454 , 23rd December, 2010.
- C3. Italo Belmonte, Matteo Bianchi, Basilio Bona, Andrea Bonarini, Luca Carlone, Davide Girlando, Andrea Mangone, Matteo Matteucci. "Apparato di illuminazione robotizzato e metodo di comando". Patent Pending MI2009U 001066 , 16th June, 2009.
- C2. Cesare Alippi, G D'Angelo, Matteo Matteucci, Giorgio Pasquettaz, Vincenzo Piuri, Fabio Scotti. "A system and method for monitoring laser welds and giving an indication of the quality of welding". European Patent EP1371443 , 2006.
- C1. Cesare Alippi, G D'Angelo, Matteo Matteucci, Giorgio Pasquettaz, Vincenzo Piuri, Fabio Scotti. "A real time quality monitoring system for laser welding". PN TO2002A000508 , 14th June, 2002.

#### D. Papers in Proceedings of International Conferences and Workshops

- D108. Licia Sbattella, Luca Colombo, Carlo Rinaldi, Roberto Tedesco, Matteo Matteucci, Alessandro Trivilini. "Extracting emotions and communication styles from vocal signals". Proceedings of International Conference on Physiological Computing Systems (PhyCs), accepted.
- D107. Luigi Malagò, Matteo Matteucci. "Robust Estimation of Natural Gradient in Optimization by Regularized Linear Regression". Geometric Science of Information LNCS 8085:861-867, 2013.
- D106. Luigi Malagò, Matteo Matteucci and Giovanni Pistone. "Natural gradient, fitness modelling and model selection: A unifying perspective". In Proceedings of 2013 IEEE Congress on Evolutionary Computation



- (CEC) pp. 486--493, 2013.
- D105. Martino Migliavacca, Andrea Bonarini and Matteo Matteucci. "*RTCAN: a Real-Time CAN-Bus Protocol for Robotic Applications*". Proceedings of 11th International Conference on Informatics in Control, Automation and Robotics (ICINCO), pp. 353-360, 2013.
- D104. Davide Cucci, Matteo Matteucci. "*A Flexible Framework for Mobile Robot Pose Estimation and Multi-Sensor Self-Calibration*". Proceedings of 11th International Conference on Informatics in Control, Automation and Robotics (ICINCO). pp. 361-368, 2013.
- D103. Martino Migliavacca, Andrea Bonarini and Matteo Matteucci. "*Modular Development of Mobile Robots with Open Source Hardware and Software Components*". Proceedings of 17th annual RoboCup International Symposium. In Press. 2013.
- D102. Fabio Veronese, Hassan Saidinejad, Matteo Matteucci, Fabio Salice. "*Communication Oriented Brain Computer Interface in a Remote Monitoring System for Amyotrophic Lateral Sclerosis*". Assistive Technology: From Research to Practice (AAATE 2013). pp. 483-488, 2013.
- D101. Tiziano D'Albis, Rossella Blatt, Roberto Tedesco, Licia Sbattella, Matteo Matteucci. "*A predictive speller controlled by a brain-computer interface based on motor imagery*". Proceedings of the ACM SIGCHI Conference on Human Factors in Computing Systems (CHI), Paris (France), April, 2013.
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